CONSIDERATION ON THE VARIABILITY OF PLUVIOMETRIC REGIME IN OLTENIA IN THE INTERVAL 1961-2014

ION MARINICĂ[1]

***ABSTRACT.*- Consideration on the variability of pluviometric regime in Oltenia in the interval 1961-2014.** The paper analyzes the variability of pluviometric regime in Oltenia in the interval 1961-2014. Although, globally, 2014 has been the warmest year since the beginning of weather forecast, in Oltenia it has been the rainiest year registering the greatest pluviometric records. The paper also analyzes the variability of seasonal quantities of precipitation. The variation of annual, seasonal summer and autumn quantities of precipitation has recorded an increasing tendency in most of the territory, while the variation of seasonal winter and spring quantities of precipitation recorded a decreasing tendency. The paper is useful especially to specialist variab s in climate and hydrology. The analysis of ility of pluviometric regime in Oltenia in the interval 1961-2014 is a continuation of the extended studies of the regional climate variability which is of great use to specialists, doctoral and master students as well as all those interested in the evolution of climate (Bogdan, Marinică, Marinică A.F. 2014, A. F. Marinică, Constantin Marinică, Vătămanu, 2014.).

Key words: pouring rains, droughts, pluviometric records.

1. INTRODUCTION

The year 2014 has been the warmest year registered globally since the beginning of temperature measurement in 1880, according to NASA and National Oceanic and Atmospheric Administration (NOAA). In December 2014 the average ocean and land temperature was the highest in the last 134 years, according to measurements performed independently by NOAA and NASA. The December 2014 globally-averaged temperature was 0.77°C above the 20th century average. The Annual Global Analysis Report (2014) shows that the average land and ocean surface temperature were at 0.69° C above the 20th century average, surpassing the previous records of 2005 and 2010 by 0.04° C. Most of the global warming occurred during the last three decades, and the warmest ten years were registered beginning with 2000, if we do not consider 1998.

[1] Dr. C.S. II, MPP1, Centrul Meteorologic Regional Oltenia, ionmarinica@yahoo.com

According to Gavin Schmidt, Nasa's Goddard Institute for Space Studies "While the ranking of individual years can be affected by chaotic weather patterns, the long-term trends are attributable to drivers of climate change that right now are dominated by human emissions of greenhouse gases".

In 2014, ***the global average temperature across land surface*** was at 1.0° C above the last century average, being the fourth highest value of 1880 and up to present.

The global average temperature across ocean surface was 0.57° C higher than the average of the last 134 years, designating the highest value since temperature measurement has been performed. NOAA showed that the average temperature in the stratosphere (air layer comprised between 15 and 20 kilometers altitude) has decreased, while the temperatures in troposphere have increased, representing an indicator of global warming caused by greenhouse gases.

According to data analyzed by Rutgers University (New Jersey), the average surface of snow layer in the Northern hemisphere in 2014 was 63 million square kilometers, about half of values measured from the beginning of satellite observations in 1978.

The average surface of the ice-covered area in the Arctic Ocean was 28.4 million square kilometers, the sixth smallest surface covered with ice in the last 36 years. The ice layer surface in Antarctica registered a new record in 2014, for the second consecutive year, with a surface of 33.8 million square kilometers.

According to NOAA these record temperatures were due to the lack of El Niño phenomenon, the warm current in the Pacific Ocean. In the report published in April 2014, the Intergovernmental Group on Climate Evolution (GIEC) estimated that without any major and fast change in global energy industry, which is highly dependent on coal and oil, the increase if global average temperature will have been between 3.7 and 4.8 degrees Celsius by 2100.

According to GIEC researches, the world has little time left to act and limit the increase of global temperature to only 2.0° C by the end of this century, related to the level of temperature in pre-industrial era.

Nowadays, the experts consider that an increase of global warming to more than two degrees Celsius could cause climate changes and catastrophic consequences, such as the dangerous increase of ocean levels because of accelerated melting of arctic icebergs, the increasing frequency of catastrophic meteorological phenomena, the disappearance of some animal species caused by their habitat destruction and the increase of conflicts.

Bob Ward, responsible for Grantham Research Institute on Climate Change within London School of Economics, shows that "this temperature record in 2014 should draw the attention of governments all over the world on the extent of high risks of global warming and the urgent need to act. It is necessary to conclude an

international agreement to reduce carbon dioxide emissions within the Unites Nations summit on climate, in Paris, December 2015." (Source: Live Science).

As a consequence of abundant and pouring rainfalls during some intervals of time in Oltenia, 2014 has been a thermally normal year.

The global warming has also caused significant changes in the pluviometric regime. On extended surfaces the abundant and pouring rains have caused floods, landslips, damages of homes and regional or local infrastructure.

In Oltenia a rainy long period started after the exceedingly warm and droughty summer (the summer of 2013), in September 2013, and 2013-2014 has been the rainiest agricultural year registered in the South-West of the country since 1960. Thus, there has been an exceptional variability of daily, monthly, seasonal and annual quantities of precipitation. During 2014 there have been many consecutive exceedingly rainy months, with many intervals of pouring rains. In the same year, *the rainy intervals have been interrupted by two droughty months,* February – exceedingly droughty, and November – very droughty. The rainy period lasted until March 2015, and afterwards, weather changed, and became generally warmish, leading to a new long-term climate oscillation.

Droughts occurred periodically, causing damages to vast regions, due to long scorching periods, aridity, scorching heat and tropical nights, which have increased thermal and hydric stress because of the lack of water. In Oltenia, maximum temperature values were outclassed in many months, not only in the cold season, but also in the warm season, and some excessively cold periods were registered in winter, thus being recorded some absolute minimum temperature values. The frequency of warm winters and scorching summers has increased.

2. DATA AND METHODS.

For this study, we processed data on precipitation from Oltenia meteorological stations, in the last 54 years, counting 10386 months, monthly and annual pluviometric records recorded and the analysis of variation chart tendencies for annual, seasonal and monthly precipitation (272 charts). Excel facilities have been of great use.

3. RESULTS AND DISCUSSION

Analysis of the annual minimum, average and maximum quantities of precipitation, percentage deviations from the averages and variation tendencies of the quantities of precipitation registered in Oltenia within the interval 1961-2014.

For the analyzed interval of 54 years, thee *annual means of precipitation* were comprised between 522.4 mm in Bechet in Oltenia Plain and 925.6 mm in

Apa Neagră in area of Subcarpathian Depressions, and in the mountainous area in Parâng 971.8 mm (Table no. 1), marking a gradual increase on relief forms from South to North.

The annual minimum quantities of precipitation were registered in droughty years and were comprised between 262.7 mm in Băileşti and Slatina meteorological stations in 1992 and 422.1 mm recorded in Voineasa in 2000. ***The percentage reports*** of the minimum quantities of precipitation from the multiannual means calculated for this interval of time were comprised between 36.5% in Apa Neagră (Padeş Commune, Gorj County) and 58.1% in Bechet in Danube Meadow, indicating the increase of drought intensity from North to South. The percentage report of the mean for the entire region of Oltenia was 50.9%, which indicates drought extension for the entire region in droughty years (table no.1).

Table 1. The annual minimum, average and maximum quantities of precipitation, percentage deviations from the averages and variation tendencies of the quantities of precipitation registered in Oltenia within the general interval 1961-20148*.

Meteorological station	Hm	Tend. V	Mean	Minimum			Maximum			P. O.
				mm	%M	Year	mm	%M	Year	
Dr. Tr. Severin	77	***-1.1333***	681.5	285.6	41.9	2000	1167.9	171.4	2014	`61-`14
Calafat	66	0.8551	535.1	263.8	49.3	2000	979.8	183.1	2014	`61-`14
Bechet	65	-0.0585	***522.4***	303.6	**58.1**	2000	***840.5***	160.9	2014	`61-`14
Băileşti	56	0.4053	566.1	***262.7***	46.4	1992	1032.8	182.4	2014	`61-`14
Caracal	112	-0.472	553.0	281.0	50.8	2000	937.3	169.5	2014	`61-`14
Craiova	190	2.6767	606.0	293.5	48.4	1992	1147.2	**189.3**	2014	`61-`14
Slatina	165	**4.294**	580.6	***262.7***	45.2	1992	1031.1	177.6	2014	`77-`14
Bâcleş	309	-0.9518	615.3	326.0	53.0	2011	1109.4	180.3	2014	`61-`14
Tg. Logreşti	262	-0.7233	672.9	383.6	57.0	2000	1140.0	169.4	2014	`61-`14
Drăgăşani	280	-0.2161	634.4	323.2	50.9	2000	1156.5	182.3	2014	`61-`14
Apa Neagră	250	2.091	**925.6**	338.1	***36.5***	2000	**1571.7**	169.8	2014	`61-`14
Tg. Jiu	210	0.2472	790.1	333.4	42.2	2000	1121.9	***142.0***	2005	`61-`14
Polovragi	546	0.6603	866.1	394.8	45.6	2000	1233.3	142.4	2005	`61-`14
Rm. Vâlcea	243	0.7454	708.4	350.2	49.4	2000	1134.9	160.2	2014	`61-`14
Voineasa	587	-2.6524	776.2	**422.1**	54.4	2000	1148.9	148.0	2007	`61-`14
Parâng	1585	-1.5154	971.8	524.4	54.0	2000	1332.5	137.1	1975	`61-`14
Mean Oltenia[2]		3.6468	668.0	340.2	50.9	2000	1108.2	165.9	2014	`77-`14
Ob. Lotrului	1404	2.1424	890.0	505.3	56.8	2011	1488.5	167.2	2007	`76-`14

* (Source: processed data, Oltenia MRC Archive)

(Hm=altitude of meteorological station, Tend. V = variation tendency, ,%M = percentage of the mean, years = year of registration, P.O. = compact period of observations, `61-`14 = 1961-2014)

[2]Related to the annual means of precipitation for the entire region, the commune compact period is imposed by the observation period from Slatina, which functioned with interruptions until 1976. Ob. Lotrului, Voineasa and Bâcleş meteorological stations became autonomous beginning with 2010 due to the fact that precipitation sensor is covered during the cold season, and the precipitation data from these stations are incomplete after 2010.

(Differences between percentage report (minimum/average)% - 100% give us negative percentage deviations of the annual minimum quantities of precipitation from the average). We observe ***two exceedingly droughty years***: ***1992*** in which minimum quantities of precipitation were registered in three meteorological stations: Băileşti, Craiova and Slatina and ***2000*** in which the lowest quantities of precipitation were registered in most part of Oltenia (13 stations of 16, a percentage of 81.3% of stations). 1992 is included in the very droughty period of 1992-1993, while 2000 in the excessively droughty period of 2000-2002. The annual pluviometric minimum value in Bâcleş in 2011 is uncertain because of the reasons mentioned in the footer and it would be correct to consider the value of 332.5 mm registered in 1992 as the minimum pluviometric value at this station when it functioned with personnel. The same observation is valid for Ob. Lotrului mountainous station, situated on the North-Western mountainside, close to Transalpina road, whose annual pluviometric minimum is correctly considered to be the value of 666.2 mm registered in 2000. The excessively droughty period of 2000-2003, due to its extremely low values of precipitation, associated with periods of dryness, scorching heat and canicula has outclassed the very droughty period of 1992-1993. We make a very special remark for ***2007*** in which the extremely intense drought registered in the first 7 months and especially in spring and in the first two months of summer caused significant damages in agriculture. In 2007 rainfalls began on 30 July and continued during all the other 5 months (August-December) leading to an excessively rainy year with extremely significant damages for agriculture caused by drought. The floods from August-November affected many localities and caused significant damages.

The annual maximum pluviometric values registered in the rainiest years, and were comprised between 840.5 mm registered in Bechet in 2014 and 1571.7 mm registered in Apa Neagră also in 2014, and in the mountainous area in Parâng the value of 1332.5 mm recorded in the rainy year of 1975 in the last century.

The rainiest years were ***2007*** in which the annual maximum pluviometric value was registered in Voineasa intramountainous depression, ***2005*** in which annual maximum pluviometric values were registered in two meteorological stations in Subcarpahians: Polovragi and Tg. Jiu. In 2005 the annual maximum pluviometric values were registered in many meteorological stations in Oltenia ***but they were outclassed by the exceedingly high values registered in the rainiest year of all history of pluviometric observations in Oltenia, namely the year 2014***. In 2005 the annual values of precipitation exceeded 1000.0 mm at 8 meteorological stations: ***Craiova*** (1079.0 mm), ***Drăgăşani*** (1025.8 mm), ***Apa Neagră*** (1288.1 mm), ***Tg. Jiu*** (1108.7 mm), ***Polovragi*** (1216.4 mm), ***Rm. Vâlcea*** (1081.0 mm), ***Voineasa*** (1087.2 mm) şi ***Parâng*** (1230.1 mm). 2005 is the first year in which the mean of precipitation calculated for the entire region exceeded 1000.0 mm (table no. 1), registering a mean of 1016.4 mm, a value exceeding the mean of 2014 with

91.8 mm. Also in 2005 for the first time a meteorological station in the plain – Craiova - registered a value which exceeded 1000.0 mm. After only 9 years this value was exceeded by the value of 1147.2 mm registered in 2014.

We observe that in 2014 the annual maximum pluviometric values were registered at 12 meteorological stations of 16 namely a percentage of 75.0% of Oltenia stations. We also observe that at 13 stations (81.3% of stations) the annual quantities of precipitation registered in 2014 exceeded 1000.0 mm and only at three stations in the plain area the annual values were < 1000.0 mm. The annual values registered in 2014 at the following meteorological stations: Dr. Tr. Severin, Calafat, Bechet, Băileşti, Caracal, Craiova, Slatina, Bâcleş, Tg. Logreşti, Drăgăşani, Apa Neagră and Rm. Vâcea (therefore 12 stations of 16 that is 75.0% of Oltenia stations) became absolute pluviometric records, highly exceeding the records of the last century.

The year ***2014 is a year of absolute records in the variability field of annual precipitation in Oltenia***. The percentage reports of the annual maximum quantities of precipitation from the annual means were comprised between 142.0% in Tg. Jiu and 189.3% in Craiova, and percentage deviation of the average for the entire region was 165.9%, which means that regularly rainy periods occur all over Oltenia. Differences between percentage report (maximum/average)% - 100% give us positive percentage deviations of the annual maximum quantities of precipitation from the average.

The analysis of linear tendencies of the annual values of precipitation charts at Oltenia meteorological stations shows that the values of decrease factor (negative tendencies) and of increase factors (positive tendencies) are comprised between -1.1333 in Dr. Tr. Severin in the extreme South of Oltenia and 4.294 in Slatina in the East of the region. The mean for the entire region of Oltenia was 3.6468, meaning that the annual quantities of precipitation have increased in the entire region, a fact also indicated by the high number of pluviometric records registered in the interval 2005-2014.

The representation on map of Oltenia region highlights the increase and decrease areas of the annual quantities of precipitation: a decrease area in the South-East of Oltenia, an increase area in most part of Oltenia plain extended towards the Southern hill limit, a decrease area in the Southern limit of Oltenia hills, an increase area in the Northern half of Subcarpathian and hills and a decrease area in the mountainous area. The increase area are connected with the ascending moves of the cloudy systems which are especially associated with the Mediterranean Cyclones which nuance Oltenia pluviometric regime and lead to the dynamic convection amplifying the precipitation processes. The decrease area are connected with the descendant moves of the cloudy systems which are especially associated with the Mediterranean Cyclones which nuance Oltenia pluviometric regime and lead to the dynamic convection decreasing the precipitation processes,

and suggesting the existence of wave-like cloudy systems above Oltenia relief. All these show a high variability of annual quantities of precipitation both in time and space, in Oltenia.

Analysis of precipitation values in winter. *In winter, the means* were comprised between 103.6 mm in Bechet in the extreme South and 208.9 mm in Apa Neagră in the area of Subcarpathian Depressions, and *the seasonal mean* for the entire region was 134.8 mm (table no. 2).

The seasonal pluviometric minimum values in winter were comprised between 11.2 mm registered in Voineasa during the winter of 2001-2002 and 36.5 mm registered in Mehedinți Hills in Bâcleș in the same winter. The mean of pluviometric minimum values in winter, calculated for the entire region was 24.3 mm.

Table 2. The seasonal average quantities of precipitation in winter (pluviometric records), seasonal minimum values, seasonal maximum values, percentage deviations from the averages and variation tendencies of the quantities of precipitation registered in Oltenia within the general interval 1961-2014*.

Meteorological station	**Hm**	**Tend. Vi**	**Mean**	**Minimum**			**Maximum**			**P. O.**
				mm	**%M**	**Winter**	**mm**	**%M**	**Winter**	
Dr. Tr. Severin	77	-0.3764	163.7	14.3	8.7	`01-`02	313.9	191.7	`69-`70	`61-`14
Calafat	66	-0.1694	117.8	21.5	8.7	`01-`02	225.0	191.8	`09-`10	`61-`14
Bechet	65	-0.625	***103.6***	32.4	18.3	`75-`76	229.9	191.0	`62-`63	`61-`14
Băileşti	56	-0.7024	126.4	24.6	31.3	`01-`02	281.0	221.9	`62-`63	`61-`14
Caracal	112	-0.7457	112.3	31.3	19.5	`75-`76	240.0	222.3	`62-`63	`61-`14
Craiova	190	0.0723	125.3	27.4	27.9	`01-`02	226.4	213.7	`09-`10	`61-`14
Slatina	165	**0.2115**	104.5	**36.5**	21.9	`01-`02	***185.6***	180.7	`83-`84	`77-`14
Bâcleş	309	-1.0463	125.3	21.5	**34.9**	`01-`02	265.9	***177.6***	`68-`69	`61-`14
Tg. Logreşti	262	-0.683	133.2	17.4	17.2	`01-`02	286.4	212.2	`69-`70	`61-`14
Drăgăşani	280	-0.5994	114.5	26.6	13.1	`01-`02	230.5	215.0	`69-`70	`61-`14
Apa Neagră	250	0.1284	**208.9**	17.4	23.2	`01-`02	**414.6**	201.3	`69-`70	`61-`14
Tg. Jiu	210	-0.5978	168.3	12.2	8.3	`01-`02	331.9	198.5	`69-`70	`61-`14
Polovragi	546	-0.4199	154.2	20.2	***7.2***	`01-`02	359.0	197.2	`69-`70	`61-`14
Rm. Vâlcea	243	-0.1365	122.7	18.1	13.1	`01-`02	264.0	**232.8**	`69-`70	`61-`14
Voineasa	587	***-0.9448***	125.2	***11.2***	14.8	`01-`02	313.2	215.2	`69-`70	`61-`14
Parâng	1585	-0.4928	150.6	55.7	8.9	`01-`02	292.6	250.2	`67-`68	`61-`14
Mean Oltenia		-0.4454	134.8	24.3	17.3		278.7	207.1		`77-`14
Ob. Lotrului	1404	-0.6044	146.1	18.4	12.6	`11-`12	265.2	181.5	`04-`05	`76-`14

* (Source: processed data, Oltenia MRC Archive)

The percentage report of pluviometric minimum values from the multiannual seasonal means were comprised between 7.2% in Plovragi and 34.9% in Bâcleș, and of the minimum means for the entire region was 17.3%, designating exceedingly low temperatures. 2001-2002 was the most droughty winter, in which 14 records of the seasonal pluviometric minimum values were registered in winter (that is 87.5% of Oltenia meteorological stations) (meteorological stations: Dr. Tr. Severin, Calafat, Băilești, Craiova, Slatina, Bâcleș, Tg. Logreşti, Drăgăşani, Apa

Neagră, Tg. Jiu, Polovragi, Rm. Vâlcea, Voineasa şi Parâng). In the winter of 1975-1976 only two records of seasonal pluviometric minimum values were registered (in Bechet and Caracal or in other words, only in these two stations the minimum values of the droughty winter of 1975-1976 weren't outclassed in the winter of 2001-2002). At Ob. Lotrului meteorological station, which wasn't included in calculating the general mean because of the above reasons, the seasonal minimum value was registered in the winter of 2011-2012.

The seasonal pluviometric maximum values in winter were comprised between 185.6 mm in Slatina registered in the winter of 1983-1984 and 414.6 mm in Apa Neagră registered in the winter of 1969-1970, and the mean of seasonal maximum values for the entire region was 278.7 mm, representing 207.1% of the seasonal mean for the entire region (slightly higher than the average double).

The percentage report of pluviometric maximum values from the multiannual seasonal means was comprised between 177.6% in Bâcleș and 232.8% in Rm. Vâlcea. Most of the seasonal pluviometric maximum values were registered in the winter of 1969-1970 (at 8 meteorological stations of 16 – 50% of Oltenia stations: Dr. Tr. Severin, Tg. Logreşti, Drăgăşani, Apa Neagră, Tg. Jiu, Polovragi, Rm. Vâlcea and Voineasa). All values from table no.2 are seasonal pluviometric records for Oltenia meteorological stations in winter in the last 54 years. Other pluviometric records were registered in the following winters: 1962-1963 (at three meteorological stations), 1967-1968 (at two meteorological stations), 1968-1969 (at one meteorological station), 1983-1984 (at one meteorological station) and 2009-2010 (at two meteorological stations), and in Ob. Lotrului they were registered in the winter of 2004-2005.

The linear tendencies of variation of the seasonal quantities of precipitation were negative at 13 meteorological stations of 16 (that is on 81.3% of Oltenia territory the quantities of precipitation during winter are decreasing) and fell within -0.9448 in Voineasa and 0.2115 in Slatina in Getic Piedmont, and the mean for the entire region was -0.4454. Slightly increasing tendencies are registered in Slatina (0.2115) in Getic Piedmont, in Craiova (0.0723) where the meteorological station is located in the Southern limit of Oltenia Hills and in Apa Neagră (0.1284) in the area of Subcarpathian Depressions.

Analysis of precipitation values in spring. *In spring, the means* were comprised between 141.7 mm in Bechet in the extreme South and 235.5 mm in Apa Neagră in the area of Subcarpathian Depressions, and *the seasonal mean* for the entire region was 179.1 mm (table no. 3), exceeding the winter mean with 44.3 mm. *The seasonal pluviometric minimum values in spring* were comprised between 38.1 mm in Băileşti registered in the spring of 1983 and 107.2 registered in Apa Neagră in the spring of 1986, and the mean of seasonal minimum values was 70.5 mm exceeding the seasonal minimum values in winter with 46.2 mm.

Table 3. The seasonal average quantities of precipitation in spring (pluviometric records), seasonal minimum values, seasonal maximum values, percentage deviations from the averages and variation tendencies of the quantities of precipitation registered in Oltenia within the general interval 1961-2014*.

Meteorological station	Hm	Tend. Vp	Mean	Minimum			Maximum			P. O.
				mm	%M	Spring	mm	%M	Spring	
Dr. Tr. Severin	77	***-0.7824***	183.4	67.3	36.7	2011	374.9	204.4	2014	`61-`14
Calafat	66	-0.2054	145.9	42.0	28.8	1983	319.5	219.0	2014	`61-`14
Bechet	65	0.4129	***141.7***	52.8	37.3	1968	318.9	225.1	2014	`61-`14
Băileşti	56	-0.4068	152.4	***38.1***	***25.0***	1983	***272.0***	178.5	1987	`61-`14
Caracal	112	-0.3927	143.0	51.8	36.2	1986	309.5	216.4	2014	`61-`14
Craiova	190	0.4634	159.0	68.0	42.8	2002	376.9	237.0	2014	`61-`14
Slatina	165	**1.5064**	148.9	38.3	25.7	2000	364.7	**244.9**	2014	`77-`14
Bâcleş	309	-0.6777	173.2	66.3	38.3	2011	356.1	205.6	2014	`61-`14
Tg. Logreşti	262	-0.5937	174.6	67.3	38.5	2002	361.8	207.2	1980	`61-`14
Drăgăşani	280	-0.0933	166.3	74.7	44.9	2000	393.1	236.4	2014	`61-`14
Apa Neagră	250	0.3908	**235.5**	**107.2**	45.5	1986	**516.4**	219.3	2014	`61-`14
Tg. Jiu	210	-0.4567	198.8	92.2	46.4	2002	335.0	168.5	1987	`61-`14
Polovragi	546	0.2257	222.8	94.8	42.5	2002	461.4	207.1	2012	`61-`14
Rm. Vâlcea	243	-0.0704	180.4	61.2	33.9	1986	365.8	202.8	2014	`61-`14
Voineasa	587	-0.6013	186.7	87.5	**46.9**	2002	299.8	***160.6***	2014	`61-`14
Parâng	1585	-0.1293	**253.1**	**117.7**	46.5	1990	414.1	163.6	1970	`61-`14
Mean Oltenia		-0.0881	179.1	70.5	39.3		365.0	203.8		`77-`14
Ob. Lotrului	1404	0.218	227.6	106.5	46.8	1986	350.1	153.8	2008	`76-`14

* (Source: processed data, Oltenia MRC Archive)

Seasonal minimum values are percentage values of the multiannual means comprised between 25.0% registered in Băileşti in the spring of 1983 and 46.9% in Voineasa registered in the spring of 2002. Therefore, the seasonal means are values comprised between ¼ of seasonal means and almost ½.

Most of the minimum seasonal records were registered in the spring of 2002 in 5 meteorological stations (31.3%), 3 records in 1986, two in 1983, 2000 and in 2011, and in 1968 and 1990 one record.

Seasonal pluviometric maximum values in spring were comprised between 272.0 mm registered in Băileşti in the spring of 1987 and 516.4 mm registered in Apa Neagră in the spring of 2014.

The values in table no. 3 are records of the seasonal pluviometric maximum values in spring in the last 54 years registered in Oltenia meteorological stations. We observe that at 11 meteorological stations (that is 68.8% of Oltenia meteorological stations) spring pluviometric records were registered in the spring of the rainiest year – 2014 (Dr. Tr. Severin, Calafat, Bechet, Caracal, Craiova, Slatina, Bâcleş, Drăgăşani, Apa Neagră, Rm. Vâlcea and Voineasa), confirming once again that ***2014 has been the year of pluviometric records in the last 54 years in the South-West of Romania.***

The mean of seasonal pluviometric mean calculated for the entire region was 365.0 mm, 86.7 mm higher than the winter mean, representing 203.8% of the multiannual mean. We also observe that 1987 had two pluviometric records in Băileşti and Tg. Jiu, 1980 had only one record in Tg. Logreşti, 1970 one record in the mountainous area in Parâng and 2012 a record in Polovragi. Seasonal pluviometric maximum values in spring are percentage values of the multiannual means comprised between 160.6% in Voineasa and 244.9% in Slatina.

The linear tendencies if variation of the seasonal quantities of precipitation in spring were comprised between -0.7824 in Dr. Tr. Severin and 1.5064 in Slatina, and were negative at 11 meteorological stations of 16 (on 68.8% of the region territory), positive at 5 meteorological stations: one situated in Danube Meadow (Bechet), one in the Southern limit of Oltenia hills (Craiova), one in Getic Piedmont (Slatina) and two in the area of Subcarpathian Depressions (Apa Neagră and Polovragi). The mean of variation tendencies for the entire region of Oltenia was -0.0881, which shows that in spring the quantities of precipitation are slightly decreasing.

Analysis of precipitation values in summer.

In summer, the means were comprised between 145.9 mm in Calafat in the South-West of the region and 296.5 in Voineasa, and the mean for the entire region was 218.7 mm, exceeding with 39.6 mm the spring mean (table no. 4).

The seasonal pluviometric minimum values were comprised between 24.4 mm registered in Calafat in the droughty summer of 1965 and 136.1 mm in Voineasa in 1987, and the mean of seasonal pluviometric minimum values for the entire region was 62.5 mm (28.6% of the multiannual mean), being 8.0 mm lower than the spring mean, therefore ***summer drought is more intense than spring drought.*** Pluviometric minimum values in spring are percentage values of the multiannual means comprised between 16.7% in Calafat and 45.9% in Voineasa.

Distribution on years of the seasonal pluviometric minimum values shows that between 1987 and 2003 pluviometric minimum values registered at 4 meteorological stations, in 2000 at 3 stations, in 1990 and 2012 at two stations and in 1965 at two stations.

Seasonal pluviometric maximum values were comprised between 307.6 mm registered in Calafat in the summer of 2005 and 609.8 mm in Polovragi in the summer of 1991, and the mean of seasonal maximum values was 480.3 mm, exceeding with 272.0 mm (more than double) the spring mean, meaning that summer pouring rains are more intense than spring rains.

The distribution on years of these records of seasonal pluviometric maximum values shows that in 2005, there were recorded 9 of 16 seasonal pluviometric records in summer (that is on 56.3% of the territory), four records in 1975, two in 1999 and one in 1991.

Table 4. The seasonal average quantities of precipitation in summer (pluviometric records), seasonal minimum values, seasonal maximum values, percentage deviations from the averages and variation tendencies of the quantities of precipitation registered in Oltenia within the general interval 1961-2014*.

Meteorological station	**Hm**	**Tend. Vv**	**Mean**	**Minimum**			Maximum			P. O.
				mm	**%M**	**Su-mmer**	**mm**	**%M**	**Su-mmer**	
Dr. Tr. Severin	77	-0.1957	171.7	49.6	28.9	2003	434.7	253.2	1999	`61-`14
Calafat	66	0.5825	***145.9***	***24.4***	***16.7***	1965	***307.6***	210.8	2005	`61-`14
Bechet	65	-0.1755	155.4	49.0	31.5	2003	408.4	262.8	1975	`61-`14
Băileşti	56	0.587	155.3	33.3	21.4	1987	370.0	238.2	2005	`61-`14
Caracal	112	-0.3131	178.3	38.9	21.8	2003	425.3	238.5	2005	`61-`14
Craiova	190	**0.8315**	184.6	47.2	25.6	2012	490.8	**265.9**	2005	`61-`14
Slatina	165	0.8305	201.0	50.5	25.1	1987	436.9	217.4	2005	`77-`14
Bâcleş	309	0.4634	180.0	48.2	26.8	1990	452.0	251.1	2005	`61-`14
Tg. Logreşti	262	0.4847	217.0	79.0	36.4	2003	476.9	219.8	2005	`61-`14
Drăgăşani	280	0.0328	210.4	67.8	32.2	2012	475.2	225.9	2005	`61-`14
Apa Neagră	250	0.6727	249.5	64.9	26.0	2000	576.5	231.1	1999	`61-`14
Tg. Jiu	210	0.4873	244.4	53.2	21.8	2000	475.8	194.7	2005	`61-`14
Polovragi	546	0.1178	294.2	81.3	27.6	1987	**609.8**	207.3	1991	`61-`14
Rm. Vâlcea	243	0.4461	250.4	82.3	32.9	1990	515.6	205.9	1975	`61-`14
Voineasa	587	0.0102	**296.5**	**136.1**	**45.9**	1987	517.2	***174.4***	1975	`61-`14
Parâng	1585	***-0.6832***	364.3	95.0	26.1	2000	**712.2**	195.5	1975	`61-`14
Mean Oltenia		0.2612	218.7	62.5	28.6		480.3	219.6		`77-`14
Ob. Lotrului	1404	1.8588	336.5	188.6	56.0	2000	577.6	171.6	2005	`76-`14

*(Source: processed data, Oltenia MRC Archive)

Therefore, ***for summer the rainy year 2005 is a year of pluviometric records,*** although the summer of 2014 was excessively rainy (in June and July), no seasonal records were registered due to the low quantities of precipitation in August 2014. The pluviometric maximum values in summer are percentage values of the seasonal multiannual means comprised between 174.4% in Voineasa and 265.9% in Craiova, and their mean for the entire region is 219.6% of the multiannual seasonal mean (more than double).

The linear tendencies of variation of the seasonal quantities in summer were positive at 12 meteorological stations of 16 (on 75.0% of the territory) and were comprised between -0.6832 in Parâng in the mountainous area and 0.8315 in Craiova in the central part of the region, and the mean of tendencies for the entire region was 0.2612, which shows that overall the seasonal quantities of precipitation in summer have increased in the last 54 years.

The slightly negative tendency were registered at 4 meteorological stations (25.0% of Oltenia stations): in Dr. Tr. Severin in the West of the region where the influence of the sub Mediterranean climate is well seized by climate parameters, in Bechet in Danube Meadow, at Caracal in Romanați Plain and in the mountainous area in Parâng.

Analysis of precipitation values in autumn.

In autumn, the means were comprised between 120.1 mm in Caracal in Romanați Plain and 232.4 mm in Drăgășani, and the mean for the entire region was 155.7 mm, being 63.0 mm lower than the summer mean (table no. 5).

The seasonal pluviometric minimum values in autumn were comprised between 13.7 mm registered in Băileşti in the droughty autumn of 1986 and 44.5 mm in Voineasa in the autumn of 2011, and the mean of pluviometric minimum values for the entire region was 24.9 mm representing 16.0% of the seasonal mean, being almost 1/3 of the summer mean and registering a decrease of 37.6 mm.

Table 5. The seasonal average quantities of precipitation in autumn (pluviometric records), seasonal minimum values, seasonal maximum values, percentage deviations from the averages and variation tendencies of the quantities of precipitation registered in Oltenia within the general interval 1961-2014*.

Meteorological station	Hm	Tend. Vt	Mean	Minimum			Maximum			P. O.
				mm	%M	Autumn	mm	%M	Autumn	
Dr. Tr. Severin	77	0.0321	163.9	15.8	***9.6***	1986	384.4	234.5	1972	`61-`14
Calafat	66	0.5308	126.5	24.9	19.7	1986	297.8	235.4	1972	`61-`14
Bechet	65	0.2272	123.0	18.7	15.2	1986	305.4	248.3	1972	`61-`14
Băileşti	56	0.5499	133.0	***13.7***	10.3	1986	330.8	248.7	2007	`61-`14
Caracal	112	0.8132	***120.1***	24.6	20.5	1992	357.4	297.6	1972	`61-`14
Craiova	190	0.979	136.4	16.6	12.2	1986	375.6	275.4	1972	`61-`14
Slatina	165	**1.8322**	122.4	26.2	21.4	1986	***281.4***	229.9	2007	`77-`14
Bâcleş	309	0.3766	136.8	14.0	10.2	2011	360.8	263.7	1972	`61-`14
Tg. Logreşti	262	0.1131	148.9	16.4	11.0	2011	394.2	264.7	1972	`61-`14
Drăgăşani	280	0.3145	141.7	30.5	21.5	1986	447.7	**315.9**	1972	`61-`14
Apa Neagră	250	0.5908	**232.4**	31.6	13.6	1986	470.9	***202.6***	1972	`61-`14
Tg. Jiu	210	0.4506	180.9	27.9	15.4	2011	429.2	237.3	2007	`61-`14
Polovragi	546	0.5505	195.6	26.0	13.3	2011	**472.7**	241.7	1972	`61-`14
Rm. Vâlcea	243	0.3481	155.6	30.0	19.3	2011	458.5	294.7	1972	`61-`14
Voineasa	587	***0.5333***	168.2	**44.5**	**26.5**	2011	364.8	216.9	2007	`61-`14
Parâng	1585	0.1151	205.0	37.3	18.2	2011	422.8	206.2	2007	`61-`14
Mean Oltenia		0.4271	155.7	24.9	16.0		384.7	247.1		`77-`14
Ob. Lotrului	1404	0.912	188.7	7.8	4.1	2011	453.7	240.4	2007	`76-`14

* (Sursa: date prelucrate din arhiva CMR Oltenia

Therefore, ***autumn drought is more intense than summer drought, especially when it comes after a droughty summer.*** Pluviometric minimum values in autumn are percentage values of the multiannual seasonal means comprised between 9.6% in Dr. Tr. Severin and 26.5% in Voineasa.

Most of the records of the pluviometric minimum values in autumn were registered in the droughty autumn of 1986 that is at 8 meteorological stations of 16 (50.0% of the region territory), in the droughty autumn of 2011 minimum values were registered at 7 meteorological stations (49.8% of the region territory), and in

1992 at only one station (in Băileşti). We also observe the extremely droughty autumns of 1986, 1992 and 2011.

The seasonal pluviometric maximum values in autumn were comprised between 281.4 mm registered in Slatina in the autumn of 1972 in Getic Piedmont and 472.7 mm in Polovragi in the same autumn. The mean of the pluviometric maximum values in autumn was 384.7 mm representing 247.1% of the seasonal mean for the entire region, being almost twice and a half higher than it.

Most records of the seasonal pluviometric maximum values were registered in the excessively rainy autumn of 1972, at 11 meteorological stations of 16 (on 68.8% of the region territory), and the other pluviometric maximum values were registered in the exceedingly rainy autumn of 2007 (at 5 meteorological stations, 31.2% of Oltenia territory). The pluviometric maximum values in autumn are percentage values of the seasonal multiannual means comprised between 202.6% in Apa Neagră and 315.9% in Drăgăşani. Therefore, we observe ***the excessively rainy autumn between 1972 and 2007***, the last occurred after an excessively droughty period March-July and caused a significant climate oscillation.

The linear tendencies of variation of the seasonal quantities in autumn were positive (increasing) at 13 meteorological stations of 16, that is on 81.3% of Oltenia territory the seasonal quantities of precipitation have increased. At only three meteorological stations the variation tendencies were slightly decreasing (negative): in Tg. Logreşti in Oltenia Hills, in Voineasa in the intramountainous depression with the same name and in the mountainous area in Parâng.

CONCLUSIONS

We can draw the following interesting conclusions regarding the variability of pluviometric regime in the last 54 years:

The mean of seasonal quantities of precipitation for the entire region in winter is 134.8 mm representing 20.2% of the annual mean of precipitation, the spring mean is 179.1 mm representing 26.8% of the annual mean, the summer mean is 218.7 mm representing 32.7% of the annual mean, and the autumn mean is 155.7 mm representing 23.3% of the annual mean. Consequently, the highest quantities of precipitation are registered in summer, due to the high degree of weather instability and to high quantities of water vapors contained in warm atmosphere during summer.

The rainiest year was 2014, the richest winter in precipitation was 1969-1970, the rainiest spring was 2014, the rainiest summer was 2005 and the rainiest autumn was 1972.

The poorest winter in precipitation was 2001-2002, the most droughty spring was 2002, the most droughty summers were 1987, 2000, 2003, 2007 (June and July), 1990 and 2012, the most droughty autumns were 1986 and 2011.

The variation tendencies of the quantities of precipitation were increasing on most part of the territory for annual quantities, seasonal summer and autumn quantities and decreasing on most part of the territory for the seasonal winter and summer quantities.

During rainy periods, floods, hail and wind gusts caused significant damages, and the effects of drought have been destructive especially for agriculture.

REFERENCES

1. Bogdan Octavia, Marinică I., Marinică Floriana Andreea, 2014, *Caracteristici climatice ale iernii 2010 – 2011 în Oltenia* Academia Română, Institutul de Geografie, Revista Geografică T. XIX –XXI 2012-2014 Serie nouă Bucureşti 2014, Edit. Ars Docendi 2014, Universitatea din Bucureşti, pp. 37-48.
2. Andreea Floriana Marinică, Dana Maria (Oprea) Constantin, Ion Marinică, Victor Viorel Vătămanu (2014), *Considerations on the exceptionally rainy year 2014 in the south-west of Romania*, International Journal of Academic Research in Environment and Geography Vol. 1, No. 2, December, 2014, pp. 8 – 17, E-ISSN: 2313-769X © 2014 HRMARS, www.hrmars.com, Work in this journal is licensed under a Creative Commons Attribution 4.0 International License.
3. http://stirileprotv.ro/stiri/actualitate/
4. www. Live Science.com