VARIABILITY OF THE PRECIPITATIONS REGIME FOR THE FIRST DECADE OF XXIst CENTURY IN SOUTHWESTERN ROMANIA

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ABSTRACT.-Variability of the precipitation regime for the first decade of XXIst century in southwestern Romania. The first decade of the XXIst century was a period marked by an increase in frequency of extreme weather events. The period analyzed in this paper (2001-2010) was characterized by a high variability in terms of spatial and temporal distribution of precipitation amounts recorded. Some absolute monthly and annual records of rainfall values have been exceeded during this decade in Oltenia (southwestern Romania), standing out the years 2007 and 2008, like dry years, and 2004 and 2005, as excessively rainy years.

The aim of this paper is to analyze the spatial and temporal evolution of the annual amounts of rainfall recorded in southwestern Romania between 2001 and 2010. For this paper daily diagnostic data recorded in 14 synoptic weather stations in the Oltenia Regional Meteorological Center were used. The synoptic weather stations with reduced operating hours have been excluded from working in order to limit the errors. We calculated the averages for the past 10 years (2001-2010), for the series of 30 years (1961-1990, 1971-2000 and 1981-2010) and also for the past 50 years (1961-2010) and we compared the obtained values in order to observe the trendline of annual precipitation amounts. We used synthetics graphs and tables for a better overview of the characteristics of the precipitation amounts in the analyzed region.

Keywords: precipitation regime, variability, southwestern Romania.

1. INTRODUCTION

In the general context of the current climate variations (IPCC, 2007), the first decade of XXIst century was marked by pronounced pluviometric contrasts in temperate regions and also in Romania (Burada et al, 2009, Busuioc et al, 2007, Cazacioc, 2007, Georgescu and Stefan, 2010). Beside the air temperature, the precipitation amount is a representative parameter of climate changes that occurred recently and that is the reason this study proves its necessity and actuality. The analysis of the precipitations evolution over the last decade joins in the general mentioned theme.

The period analyzed in this paper (2001-2010) was characterized by a high variability in terms of spatial and temporal distribution of precipitation amounts recorded. In the mentioned decade in Oltenia (southwestern Romania) some absolute monthly and annual records of rainfall values have been exceeded,

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standing out the years 2007 and 2008, like dry years, and 2004 and 2005 as excessively rainy years.

Previous studies showed that periods of surplus in terms of rainfall intensity are higher and shorter for Romania (Croitoru, 2006, Clima Romaniei, 2008). The weather evolution (and thus the precipitation regime) is leading influenced by the general circulation of the atmosphere, by the cyclones and the anticyclones and also by the topography in the studied area (Clima Romaniei, 2008, Burada et al, 2009, Cordoneanu, 2009, Croitoru et al, 2009, Georgescu and Stefan, 2010, Ion-Bordei, 1988, Pop, 2003).

The aim of this paper is to analyze the spatial and temporal evolution of the annual amounts of precipitation recorded in south-western Romania between 2001 and 2010.

2. DATA AND METHODS

The studied region, Oltenia, is located in southwestern Romania, the field of research ranging from 22° to 25°E and 43° to 46°N (table 1). According to its geographical location it is also distinguished in terms of climate from other provinces of the country. It is located inside the Carpatho-Balkan Mountains, which influences the movement of air masses by meridian trajectories. Specific features of climatic elements in Oltenia are generated by its geographical position and by the complex and varied topography.

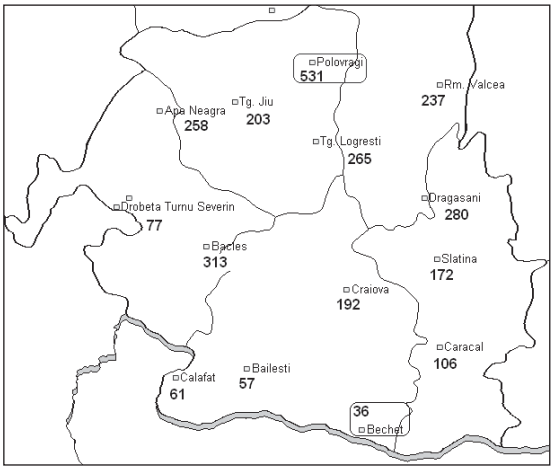

Fig. 1. ***The location of the studied region. Altitude (m) of synoptic weather stations***

In terms of altitude, the counted synoptic weather stations range between 36 m (Bechet, Dolj county) and 531 m (Polovragi, Gorj county). Most of the synoptic weather stations (12) are located in the plain areas (altitude below 300 m) and only two are located in the hilly area (altitude between 300 and 800 m) (fig. 1).

The fragmentation of the landscape is one of the major causes of the different conditions of development for the atmospheric processes and phenomena such as for the climate variations (Stancescu, 1983). The annual rainfall regime,

averaged over the period 1961-2010, ranges from 522.2 mm (Bechet) to 917.8 mm (Apa Neagra) (figure 2). The highest amounts of rainfall were recorded in hilly and mountain regions, as a result of orographic convection caused by the Carpathian Mountains (Cordoneanu, 2009, Ion-Bordei, 1988).

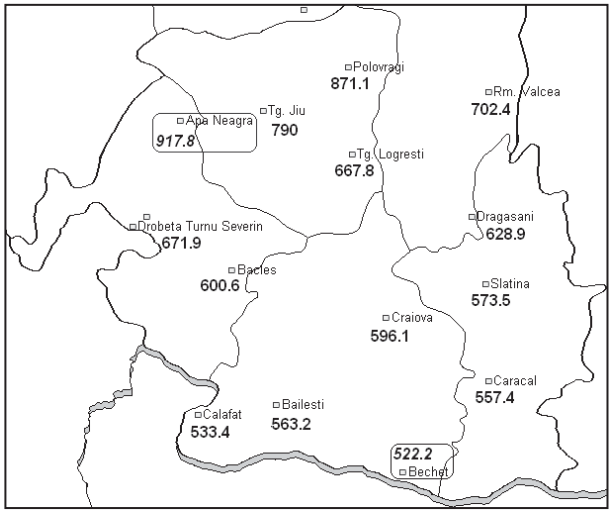

Fig. 2. ***Spatial distribution of averages precipitations amounts (mm), over the interval 1961-2010***

Table 1. ***Coordinates of the synoptic weather stations***

Synoptic weather station	Lat N (˚)	Long E (˚)	Alt (m)
Craiova	44°18'	23°52'	192.0
Bailesti	44°01'	23°19'	57.0
Calafat	43°59'	22°56'	61.0
Bechet	43°47'	23°56'	36.0
Tg Jiu	45°02'	23°15'	203.0
Apa Neagra	44°59'	22°51'	258.0
Polovragi	45°09'	23°48'	531.0
Tg Logresti	44°52'	23°42'	265.0
DrTrSeverin	44°37'	22°37'	77.0
Bacles	44°28'	23°06'	313.0
Slatina	44°26'	24°21'	172.0
Caracal	44°06'	24°21'	106.0
Rm Valcea	45°05'	24°21'	237.0
Dragasani	44°39'	24°14'	280.0

Spatial and temporal variability of rainfall is also conditioned by the altitude (figure 3), by the topography, including orientation of slope, etc. Since the second half of the 20th century human activity, and especially the process of urbanization and industrialization, have led to an increasing number of the condensation nuclei followed by the increasing in the frequency of rainfall (Clima Romaniei, 2008).

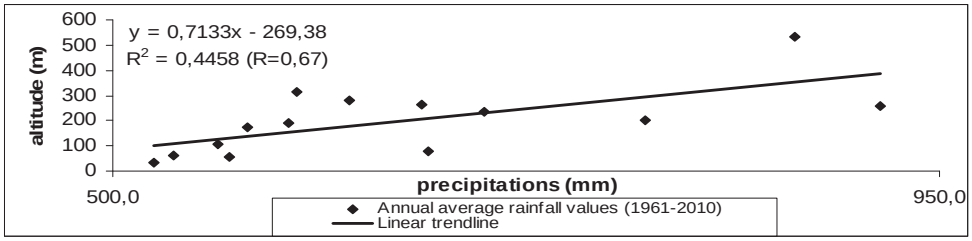

Fig. 3. ***Correlation between annual average rainfall values (1961-2010) with altitude***

The variation curve of multi-annual monthly average amounts of rainfall has a main maximum in June and a main minimum in February. The Mediterranean climate influence is highlighted by the occurrence of a precipitation secondary maximum in December (figure 4).

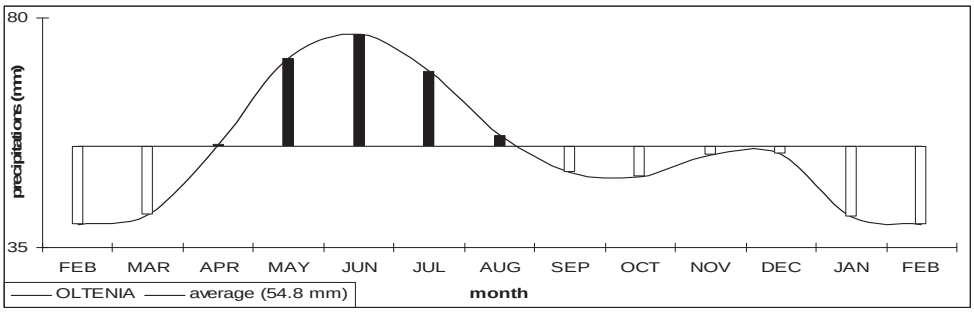

Fig. 4. ***The monthly variation of average annual precipitation values (1961-2010)***

For this study monthly precipitation amounts from 14 synoptic weather stations of the NMA network, located in southwestern Romania were used. In order to eliminate the errors the part-time synoptic weather stations have been excluded from study and for the studied ones, the choice was made considering their territorial representation and also in terms of data homogeneity. We analyzed the monthly and annual precipitation amounts series recorded between 1961 and 2010. Data were managed and validated by the NMA.

Statistical methods were employed (Wilks, 2006) in order to determine annual and multi-annual means, median, maximum and minimum values of the interval, standard deviations, coefficient of variation, trends. The multi-annual averages for the past 10 years (2001-2010), for the series of 30 years (1961-1990, 1971-2000 and 1981-2010) and also for the past 50 years (1961-2010) were calculated and than were compared in order to identify the trends and the fluctuations of the precipitation amounts for the analyzed intervals. Synthetics graphs and tables were added for a better overview of the precipitation amounts characteristics in the analyzed region.

3. RESULTS AND DISCUSSIONS

The temporal variability of precipitations is determined by advective and dynamic processes (atmospheric general circulation features and thermodynamic structure of the atmosphere). Multi-annual variation of precipitation amounts between 2001 and 2010 can be seen looking at the series of data from synoptic weather stations counted (table 2).

The equations of trendlines highlighted the positive regression coefficients (table 3), but different in size. Thus an increasing in the amounts of rainfall during the first decade was revealed, more pronounced in Bailesti, Bechet, Targu Jiu, Apa Neagra, Tg Logresti, Dr Tr Severin, Caracal or more discrete in Craiova, Calafat, Polovragi Bacles, Slatina, Rm Valcea, Dragasani.

The multi-annual averages calculated for the 2001-2010 decade exceed those calculated for the 1961-2010 period at all the synoptic weather stations in the region. Except the year 2008, characterized by a lack of rainfall for the majority of synoptic weather stations, in the other years of the decade exceeding average

annual precipitation amounts were recorded. In the analyzed period the annual average precipitation amounts ranged from 574.6 mm/year at Bechet (southern region) to 1083.8 mm/year at Apa Neagra (hilly region) (table 2). In the most cases (except Apa Neagra), median values were lower than the average value, differences ranging up to -52.5 mm at Tg Jiu, so that the distribution values is tilted to the right.

Table 2. ***Simple statistical parameters of the used precipitation amounts time series (2001–2010)***

Synoptic weather station	Mean (mm)	Median (mm)	Maxima (mm)	Data	Rel dev of max (%)	Minima (mm)	Data	Rel dev of min (%)
Craiova	711.8	681.8	1082.3	2005	52.1	484.1	2008	32.0
Bailesti	621.0	608.9	850.0	2005	36.9	442.4	2001	28.8
Calafat	594.3	570.4	809.5	2005	36.2	443.8	2004	25.3
Bechet	**574.6**	557.9	807.8	2005	40.6	433.7	2008	24.5
Tg Jiu	889.9	837.4	1121.9	2005	26.1	695.5	2001	21.8
Apa Neagra	**1083.8**	**1088.9**	1434.8	2010	32.4	767.1	2001	29.2
Polovragi	991.1	943.1	1233.3	2005	24.4	708.2	2008	28.5
Tg Logresti	698.5	647.3	978.6	2005	40.1	511.1	2008	26.8
DrTrSeverin	709.7	707.3	876.4	2010	23.5	501	2001	29.4
Bacles	638.6	614.5	909.0	2005	42.3	496.7	2008	22.2
Slatina	682.8	680.0	999.1	2005	46.3	486.6	2008	28.7
Caracal	618.1	596.8	901.8	2005	45.9	444.4	2008	28.1
Rm Valcea	775.2	745.6	1085.3	2005	40.0	493.3	2008	36.4
Dragasani	718.0	713.0	1034.5	2005	44.1	509.5	2001	29.0
Mean	*736.2*		*1008.9*		*37.0*	*529.8*		*28.0*

Table 3. ***Variation of the regression coefficient (mm/decade)***

Synoptic weather station	Regression coefficient (2001-2010)
Craiova	6.01
Bailesti	15.76
Calafat	6.05
Bechet	9.46
Tg Jiu	14.34
Apa Neagra	54.73
Polovragi	7.80
Tg Logresti	9.44
Dr Tr Severin	21.58
Bacles	2.23
Slatina	2.23
Caracal	10.56
Rm Valcea	4.39
Dragasani	4.57
Mean	*12.1*

Analyzing the time series of precipitation amounts for the period 1961-2010 in Oltenia, different trends were identified, with highest slopes in the last decade (table 4).

Calculation of linear trend indicates a small decrease in the amount of annual rainfall for the period 1961-2010 for the whole region. For the intervals 1961-1990 and 1971-2000 more significant slopes were calculated, corresponding to the negative regression coefficients (-0.2, -4.4 and respectively, -6.5). For the period 1981-2010 an increase in annual precipitation amounts (emphasized by 7.2 positive regression coefficient) was identified and it was less significant compared to that of the previous decade (the regression coefficient value was 12.1, fig. 6).

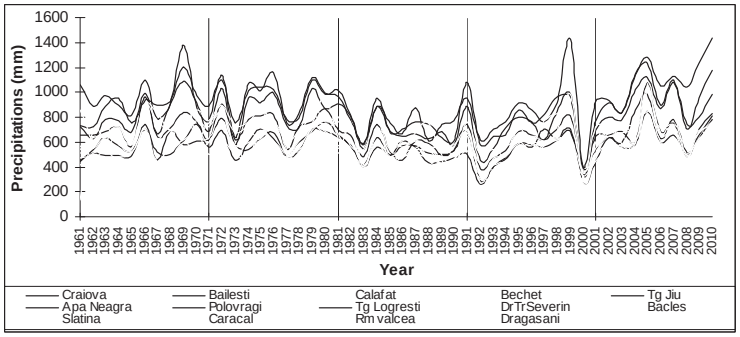

Table 4.*Regression coefficient*

Period	Regression coefficient (1961-2010) (mm/year)
1961-2010	-0.2
1961-1990	-4.4
1971-2000	-6.5
1981-2010	7.2
2001-2010	12.1

Fig. 5. ***Times series of annual precipitation amounts (1961-2010)***

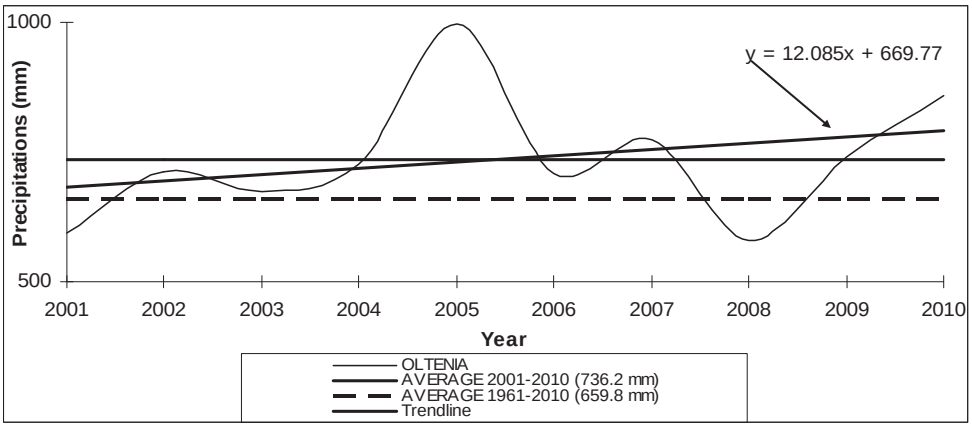

Fig. 6. ***Annual variation of the average precipitation amounts (2001-2010) (in mm)***

Compared to the average (12.085), during the last decade different trends have been revealed in the region, but all positives with lower or higher slopes (table 3, fig 7).

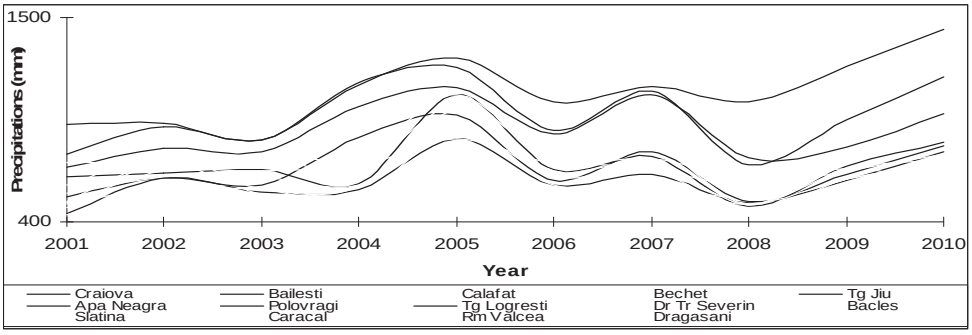

Fig. 7. ***Annual variation of the precipitation amounts (2001-2010) (in mm)***

4. CONCLUSIONS

The study of spatial distribution and temporal variability of precipitation regime highlighted the differences between synoptic weather stations. The spatial distribution is explained primarily by local features related to the topography, with the largest amounts of rainfall in hilly and mountain regions.

Analyzing the time series of precipitation amounts for the period 1961-2010 in Oltenia, different trends were identified with a more pronounced increase in the last decade. Calculation of linear trend indicates at the scale of the whole region a small decrease in the amounts of annual rainfall for the entire period 1961-2010 with the highest slopes for the intervals 1961-1990 and 1971-2000 (the negative regression coefficients -0.1786 and respectively, -4.4379 and -6.513).

Between 1981 and 2010 an increase in annual precipitation amounts was observed (highlighted by positive regression coefficient 7.1737), more prominent in the last decade (the coefficient was 12.085)

During the last decade different trends have shown in the region, but all positives and all showing a more intense or a more moderate growth.

This first descriptive study is an initial phase in developing a more extensive work for the south-western part of Romania.

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