HEAT WAVES FREQUENCY IN SOUTHERN ROMANIA, BETWEEN 1961 - 2013

Prof. ALEXANDRU SIMU
Liceul Teologic Greco-Catolic "Sfântu Vasile cel Mare" Blaj

ASTRACT: Heat waves frequency in southern Romania, between 1961 - 2013. *Heat waves are a weather-complex phenomenon, which in recent years has obviously increased the nature of climate risk. This type of risk affects human activity and this requires a careful study of how to produce and emphasize the phenomenon. The large number of warm tropical air invasions is the main cause of exceeding the normal, average values, and this has led to numerous weather risky events which are frequently associated to heat waves.*

Keywords: *heat wave, frequency, percentile, positive thermal singularities, advection.*

1. Introduction

Heat waves are a complex climatic phenomenon caused by advection of warm tropical air. Frequency, duration, time and spatial distribution in recent years, tend to become climate risk or hazards that affect in a negative way the human activity and have a profound impact on the environment. In literature they are called positive thermal singularities that are the result of large non-periodic variations in climate (I. Marinică, 2006).

2. Data and method of study

For this study we used the maximum daytime temperatures from 11 weather stations located in the south of Romania, located at altitudes and in different landscape units. Climatic data for the period 1961-2013 were taken from the website: http://eca.knmi.nl/dailydata/index.php in ASCII format and achieve statistically self reference tables and graphs.

Data processing was performed by the method of percentiles, provided by Excel software in several stages. In the first stage this method involves placing percentile function in the formula bar of the program, and as a benchmark was chosen 90th percentile (0.9), highlighting the probability of occurrence of the phenomenon of 90%. The identification of exceeded percentile was achieved by using a comparison function that indicates whether through one annual value was exceeded and zero if no value was exceeded. In the second stage using a macrocommand dates and maximum temperature values were extrated for the exceeded situations of percentile values. Identification was made through waves Excel filters, filters that allow displaying and selecting data in three columns: start date, end date, number of days (wave length). To study the frequency of massive heating phases were used only periods longer than three consecutive days which exceeded the percentile value, the situation removed from consideration a large number of singular situations. In order to select the seasonal heat waves were used flitrele columns: start date and end date and calendar data were ordered. When the tide took the time to pass from one season to another, was taken into account the number of days the majority, over 50% of days in two rows that belong to one of the two months. Thus, in the period in which the wave more than half the days belonging to the previous month, when the tide was added to the previous season or next season appropriate, if more than 50% of the days belonging to the first month of next season. The third stage involved the creation of

frequency tables and graphs through which evolution in time and space was highlighted.

3.Results

3.1. The Temporal Analysis of Heat Waves

This type of analysis reveals all weather stations in a high frequency of heat waves, lasting three or four days and whose average is 45% - 24% of the total, while the opposite is the waves which exceed 9 days and which represent 4% of the total as shown in the graph below (fig. 1).

The production of heat waves that exceed 10-11 days is exceptional.

Such exceptions have a very low frequency of occurrence between 1961 and 1981, one single wave being recorded at four of the eleven meteorological stations, which occured during a period of ten days. In the ninth decade of the last century a single exceedance of regular values has been registered at most stations, and it lasted ten days (Table no. 1).

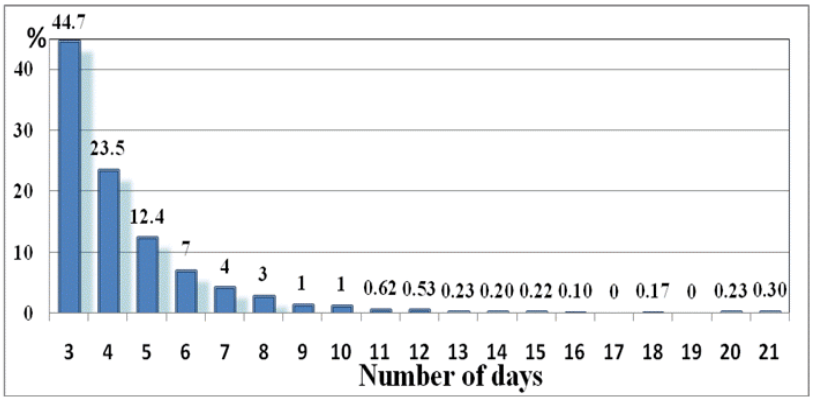

Fig. 1. The average frequency of the duration time

Table no. 1 *Distribution in times of heat waves, with more than 10 days*

Weather station	1961-1970			1971-1980			1981-1990			1991-2000			2001-2010			2011-2013		
	No. Years	No. Waves	No. Days	No. Years	No. Waves	No. Days	No. Years	No. Waves	No. Days	No. Years	No. Waves	No. Days	No. Years	No. Waves	No. Days	No. Years	No. Waves	No. Days
București Băneasa							1	1	10	1	2	14	4	5	18	1	1	11
Buzău	1	1	10				2	2	10	3	4	15	3	4	20	2	2	11
Călărași							1	1	10	2	2	15	2	3	13	2	2	11
Constanța							1	1	10	1	1	15	4	6	18			
Craiova										2	2	12	5	6	20	2	3	12
Drobeta Tr. Severin										1	1	11	3	4	15	3	6	13
Galați	1	1	10				1	1	10	2	2	12	2	4	14	2	3	11
Râmnicu Vâlcea				1	1	12				2	2	11	4	7	18	2	4	20
Roșiori de Vede	1	1	11	1	1	10	1	1	11	2	2	10	4	4	21	2	2	11
Sulina							1	1	10	2	2	12	2	2	15	2	3	15
Tulcea							1	1	10	2	2	12	3	4	11	2	3	14

Between 1991 - 2000 the seven weather stations have produced two annual waves whose duration varied between 10 and 15 days, within two years. In the first decade of the XXI century 4-6 waves were recorded at all stations, the least being at Sulina 2, and the most were at Râmnicu Vâlcea 7.

This occurred over a period of 2 and 5 years. The duration of the waves during this decade has significantly increased from 11 to 21 days (Fig. 2).

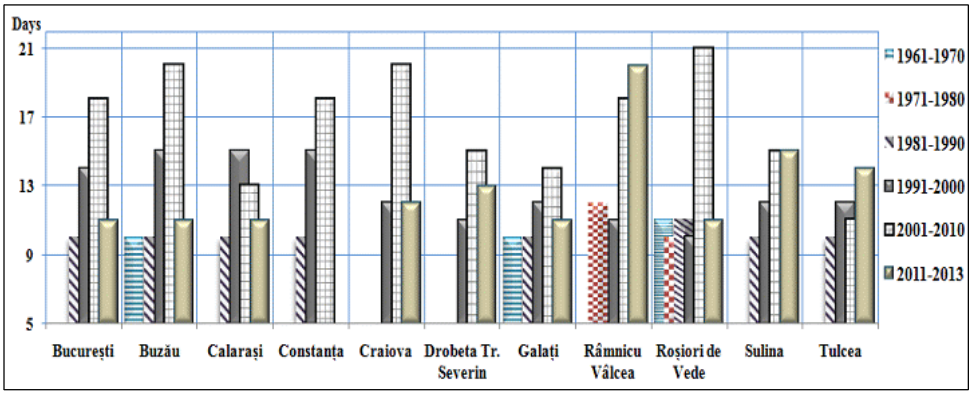

Fig. 2. Time evolution of heat waves

In three years of the second decade of this century 3 waves occurred within two years at the stations from Dobrogea, in Buzau, Calarasi, 2 waves in Rosiorii de Vede, 4 waves in Ramnicu Valcea, one in Bucharest and 6 in Turnu Severin, which represents the maximum number. The distribution of warm air invasions on seasons reveals a nearly uniform distribution, except in the coastal stations where in winter the exceedances of 28% -30% occur.

In the rest of the stations, summer is the season with the most frequent waves 26% -28%, the minimum values being recorded in Drobeta Turnu Severin 23%, and the maximum of 29% in Bucharest (Fig. 3).

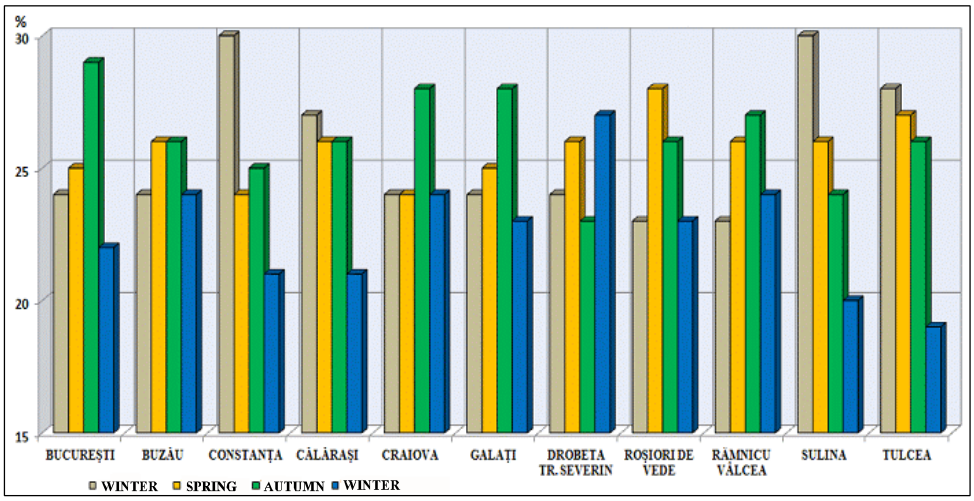

Fig. 3. Seasonal frequency of heat waves

3.2. The Spatial analysis of heat waves

Analyzing the spatial distribution of the years and the number of waves we can conclude with two major aspects Thus, between 1961-2000, during 40 years there is a great uniformity in the distribution of the number of waves , the years and the number of days in which they occurred. After 2001 there is an uneven distribution in the analysed geographic area which highlights specific climatic variability particular for the south of Romania.

If we consider the map distribution (Fig. 4) of the total number of heat waves at the weather stations we notice that there are two areas where the normal values can be frequently exceeded.

Thus in Oltenia and Craiova a number of 307 heating stages were recorded at weather stations and 291 in central Muntenia, Bucharest and Calarasi. The fewest phases of heating occur on the seashore in Constanta Sulina and Tulcea, due to the Black Sea thermoregulation role.

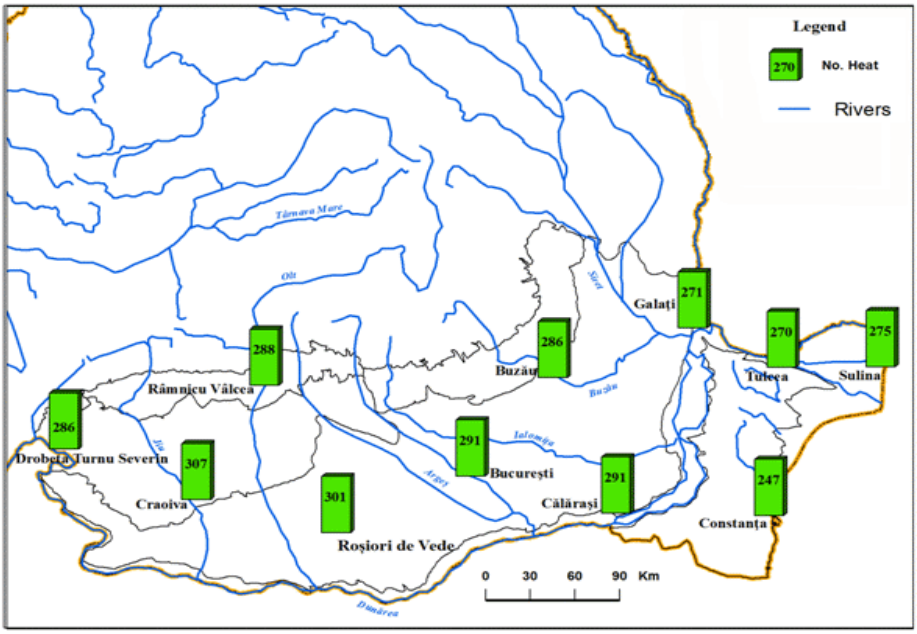

Fig. 4. The geographical distribution of heat waves

4. Conclusions

Heat waves or positive thermal singularities, are recorded at all weather stations in Romania, but the most frequent as number and intensity are specific in the south of the country where the anticyclonic activity generates advections of generated continental tropical and maritime tropical air which once inside the country become continental. In all southern weather stations a large number of stages overcome normal temperatures.

The highest frequency had the phases which lasted 3-4 days, and on the opposite side there are the waves which are longer than 10-15 days.

From the first decade of the XXI century. we can notice an increase in the annual frequency of heat waves which have an extreme character,and which last more than 10 days due to the climate change and global warming of the atmosphere. These abnormal situations can also generate climate risk phenomena with a negative impact on economic activity and population.

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