ASPECTS REGARDING THE ANNUAL FREQUENCY AND THE TREND OF THE SQUALL PHENOMENON IN MARAMUREŞ

Şerban Eugenia*, Linc Ribana**

*University of Oradea, Faculty of Environmental Protection, 26 Gen. Magheru St., 410048, Oradea, Romania, e-mail: eugeniaserban@yahoo.com
**University of Oradea, Department of Geography, Tourism and Territorial Planning, 1 University St., 410087, The Territorial Studies and Analyses Centre (CSAT), e-mail: ribanalinc@yahoo.com

Abstract

The paper analyzed the spatial and temporal variability of the squall phenomenon that occurred in Maramureş county. In this regard, the meteorological data on the annual number of days with squall were used, from 4 weather stations, during the period 1961-2007. The mean, maximum and minimum annual number of days with squall, the frequency of the phenomenon, the decennial distribution and the linear trend of the annual number of days with the phenomenon were analyzed. The result was that in Maramureş county is recorded, on average, between 0.2-1.2 days with squall per year. The largest mean annual number is reported at the northernmost station, Sighetu Marmaţiei, then at Baia Mare. The squall does not occur every year on the analyzed territory. Baia Mare station records the highest annual frequency of occurrence of the phenomenon, and Iezer the lowest. The linear trend of the annual number of days with squall is increasing at Baia Mare and Ocna Şugatag stations and decreasing at Sighetu Marmaţiei and Iezer stations.

Key words: number of days with squall, climatic hazard, frequency, trend

INTRODUCTION

Squall is a complex meteorological phenomenon, frequently associated with Cumulonimbus clouds with great vertical development (over 10 km high). Therefore it is often accompanied by showers, lightning, thunder and even hail. Squall begins and ends suddenly, lasts less, but the wind direction is changing rapidly, sometimes up to 180°. The wind speed must reach at least 8 m/s, while the value of 11 m/s must be exceeded for at least one minute. During the phenomenon, the wind is gusting. The squall differs from the strong wind phenomenon, which begins gradually, takes a long, sometimes several days and generally does not change its direction.

Squalls may occur ahead of some very unstable cold fronts or may be due to the intense thermal convection movements of the air from the hot afternoons of summer, which generate very high Cumulonimbus clouds. Because the squalls can cause great damage, they are considered climatic hazards (according to „Directions for Weather Stations/Instrucţiuni pentru staţiile meteorologice", I.N.M.H., 1995; Ţuţuriga, 1987; Moldovan, 2003).

In Romania, the squall most often affects the Western, Southwestern and Northwestern territories. However, it can be found in other regions of the country, its intensity increasing in recent years.

MATERIAL AND METHOD

The paper analyzed the spatial and temporal variability of the squall phenomenon that occurred in Maramureş county. In this regard, the meteorological data on the annual number of days with squall were used, from 4 weather stations located in the county. The stations with a common observation period were chosen: Baia Mare, Sighetu Marmaţiei, Ocna Şugatag, Iezer. The analyzed period was 1961-2007 (47 years).

The weather stations are located at different altitudes, covering both depression regions and high mountainous region: Baia Mare (216 m), Sighetu Marmaţiei (275 m), Ocna Şugatag (503 m), Iezer (1785 m).

All the meteorological data used in this paper come from the database of the National Meteorological Administration of Romania.

In the present study we analyzed the mean, maximum and minimum annual number of days with squall, the frequency of the phenomenon, its spatial and temporal variability. We studied also, the decennial distribution of the number of days with squall and the linear trend of the annual number of days with the phenomenon.

RESULTS AND DISCUSSION

In Maramureş county is recorded, on average, between *0.2-1.2 days with squall* per year (Tab. 1). The largest mean annual number is reported at the northernmost station, Sighetu Marmaţiei (1.2 days), located on the border of our country, in the Depression of Maramureş. That is because the north of the country is traversed most often by the cold fronts of the Icelandic Cyclones, which cross Europe. The pronounced instability often associated with these fronts, in the warm semester of the year, creates favorable conditions for producing squalls.

Table 1

The mean and maximum annual number of days with squall, in Maramureş (1961-2007)

STATION	Baia Mare	Sighetu Marmaţiei	Ocna Şugatag	Iezer
Mean annual no.	0.9	1.2	0.6	0.2
Maximum annual no.	5	8	4	2
Year when the maximum no. occurred	1984	1972	1999	1963, 1966, 1993

On contact with the mountains, in Baia Mare station, the squalls have also a high frequency (0.9 days yearly), because they become more intense at the feet of the slopes (especially since it's about the southern slopes of Igniş Mountains, which get more sunlight). Here, the air masses enter a forced upward movement, having a shape of vortex. Above, on the slopes of

the mountains, the upward movement weakens, so that the wind speed decreases and the squalls are dissipating (Drăghici, 1988, quoted by Moldovan, 2003). As a result, the mean annual number is lower at the higher stations Ocna Şugatag and Iezer. The lowest number of days with squall from Iezer (0.2 days) is due to the high altitude of the station and to the fact that, in the high mountain sector, more days with strong wind are recorded, and not squall.

The annual maximum number of days with squall rose to 2-8 days, being higher in the same stations: Sighetu Marmaţiei and Baia Mare (Tab. 1). The year when the maximum number of days with squall occurred is random. At Baia Mare, the year that the maximum number was recorded coincides with that of the close station Satu Mare, found by the author in a previous study (Şerban et al., 2010).

In the figures 1-2 is not observed a similarity in the distribution of the highest annual values, over the period 1961-2007, at the 4 stations, a sign that the varied landforms influence more the territorial distribution of the phenomenon. Thus, if in Sighetu Marmaţiei the most cases of squall are reported in the interval 1961-1978, at Iezer they occur between 1963-1970 and at Ocna Şugatag in the period 1993-2004. Only Baia Mare station has a more uniform distribution of the cases of squall in the analyzed period.

The linear trend of the annual number of days with squall (Fig. 1-2) is *increasing* at Baia Mare and Ocna Şugatag stations and *decreasing* at Sighetu Marmaţiei and Iezer stations. The most pronounced decrease is recorded in Sighetu Marmaţiei and is due to lack of the phenomenon between 1992-2007. Given the relief conditions relatively similar of this station with those of Ocna Şugatag station (their position within the Depression of Maramureş), we consider that the lack of the phenomenon a so long period of time is rather due to a human error (unrecognizing of the phenomenon by the operators and its absence from the registers of observations of the station).

The minimum annual number of days with squall was 0 days, at all analyzed stations. The squall was absent from the weather stations in several years. It lacked the most at Iezer station and the least at Baia Mare.

Table 2 shows the annual frequency of squall occurrence in Maramureş. During 1961-2007, the squall had the highest annual frequency at the stations Baia Mare (51.1% of the total years) and Sighetu Marmaţiei (40.4%). The lowest frequency was recorded at the highest station, Iezer (10.6%), where the squall occurs rarely. Thus, we can say that in Maramureş, *the squall does not occur every year*. However, one notes periods of consecutive years with phenomenon. More common are the periods of 2-3 consecutive years, but may also occur periods of 5-7 consecutive years.

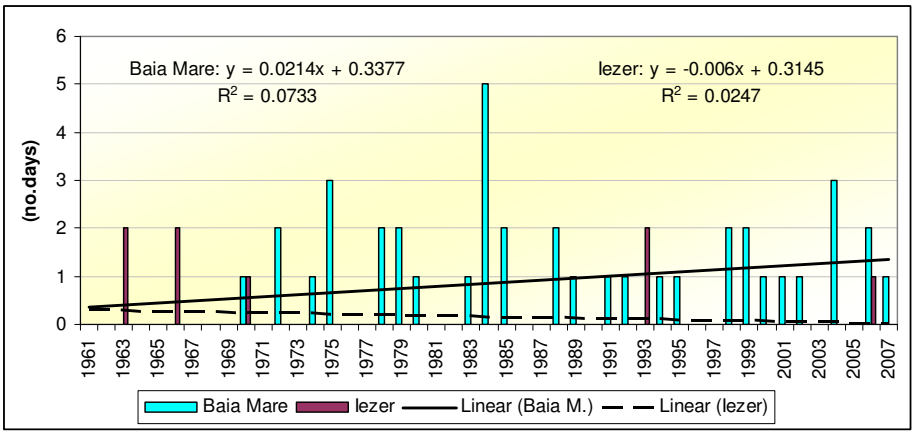

Fig. 1. The annual number of days with squall and its linear trend, at the weather stations Baia Mare and Iezer (1961-2007)

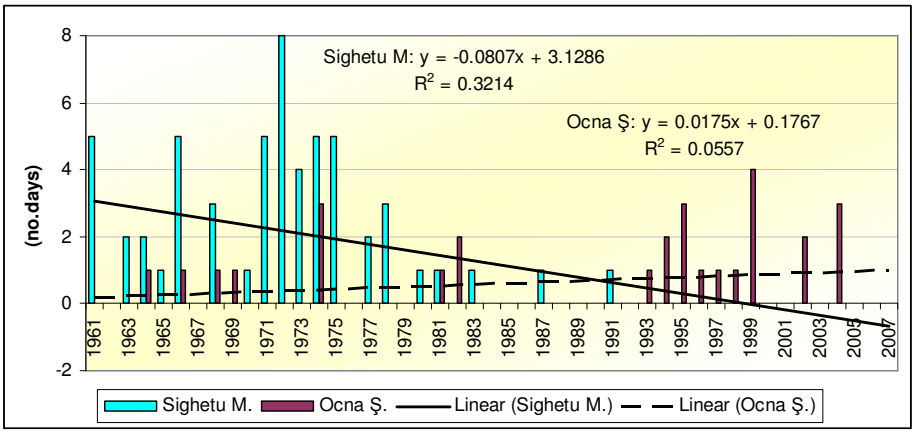

Fig. 2. The annual number of days with squall and its linear trend, at the weather stations Sighetu Marmației and Ocna Şugatag (1961-2007)

Table 2

The annual frequency of squall occurrence in Maramureş (1961-2007)

STATION	Baia Mare	Sighetu Marmației	Ocna Şugatag	Iezer
No. years with squall	24	19	16	5
Frequency (%)	51.1	40.4	34.0	10.6

Baia Mare station records the highest annual frequency because the unstable air masses easily penetrate the territory of Western Plain, the squalls forming along the line of instability (squall-line). From here, the air masses are channeled on Someşului Valley and entered into the Depression of Baia Mare. On the other hand, the low territories of Northwestern

Romania are often affected by the phenomenon, because they are frequently crossed by the weather fronts of Icelandic Depressions. Add to these the intense thermal convection of air from the hot afternoons of summer, which intensifies the weather fronts, generating hazardous weather phenomena.

Figure 3 shows the distribution of the decennial number of days with squall. Neither in this case there is a similarity in the distribution of decennial values, at the 4 stations. Thus, while in Baia Mare most cases were reported in the last decade, in Sighetu Marmației they occurred in the second decade, in Ocna Şugatag in the 4th decade and in Iezer in the first decade. However, one can notice, as in the previous case, the trend of increase of the decennial values at Baia Mare and Ocna Şugatag stations and of decrease in the other two stations.

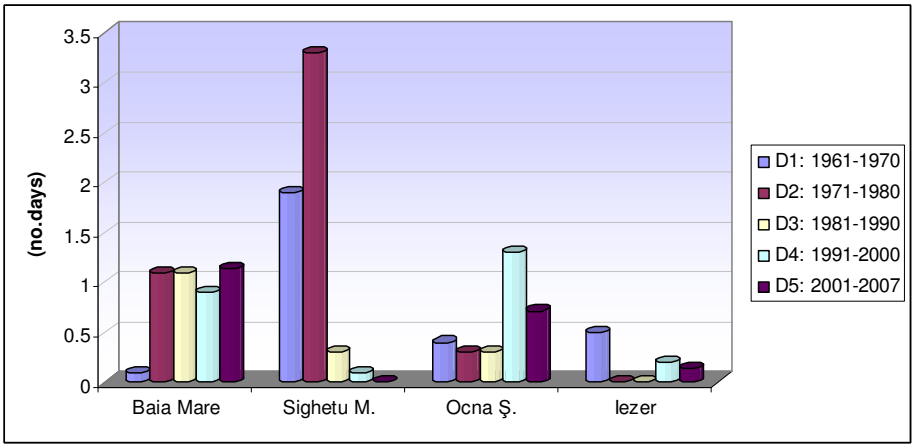

Fig. 3. The decennial number of days with squall in Maramureş (1961-2007)

CONCLUSIONS

In Maramureş county is recorded, on average, between 0.2-1.2 days with squall per year. The largest mean annual number is reported at the northernmost station, Sighetu Marmației, then at Baia Mare. The annual maximum number of days with squall rose to 2-8 days.

The squall does not occur every year on the analyzed territory. Baia Mare station records the highest annual frequency of occurrence of the phenomenon, because the unstable air masses are channeled on Someşului Valley, penetrating easily into Baia Mare Depression. The lowest frequency is recorded at the highest station, Iezer, where there are more days with strong wind, and not squall.

Over the period 1961-2007 is not observed a similarity in the distribution of the annual and decennial values, at the 4 stations, a sign that

the varied landforms influence more the territorial distribution of the phenomenon.

The linear trend of the annual number of days with squall is increasing at Baia Mare and Ocna Şugatag stations and decreasing at Sighetu Marmaţiei and Iezer stations.

REFERENCES

1. Bogdan O., Marinică I., 2007, Hazarde meteo-climatice din zona temperată. Factori genetici şi vulnerabilitate – cu aplicaţii la România. Ed. „Lucian Blaga", Sibiu, 422 pp.
2. Bryant E.A., 1991, Natural Hazards. Cambridge University Press, 294 pp.
3. Cristea M., 2004, Riscurile climatice din bazinul hidrografic al Crişurilor. Ed. Abaddaba, Oradea, 186 pp.
4. Ion-Bordei E., 2009, Rolul lanţului alpino-carpatic în evoluţia ciclonilor mediteraneeni. Ed. Printech, Bucureşti, 138 pp.
5. Ionac N., 2000, Thunderstorm hazard – impact and safety. Analele Univ. Bucureşti, Seria Geografie, anul XLIX, Bucureşti, pp.103-108
6. Mateescu E., Oprişescu R., 2000, Furtuna – fenomen meteorologic periculos pentru agricultură. Comunicări de Geografie, vol.IV, Ed. Univ. din Bucureşti
7. Măhăra Gh., 2006, Variabilităţi şi schimbări climatice, Ed. Univ. Oradea, 74 pp.
8. Măhăra Gh., Linc R., 1993, Anomalii termice în Munţii Codru-Moma. Analele Univ. din Oradea, Seria Geografie, tom III, Oradea, pp.54-57
9. Moldovan F., 2003, Fenomene climatice de risc. Ed. Echinox, Cluj-N., 209 pp.
10. Şerban E., 2010, Hazarde climatice generate de precipitaţii în Câmpia de Vest situată la nord de Mureş. Ed. Univ. din Oradea, pp.177-195
11. Şerban E., 2012, Aspects concerning the vulnerability toward squall of the territory of the Western Plain of Romania, North of the Mures River. Analele Univ. din Oradea, Fasc. Protecţia Mediului, vol.XIX, anul 17, pp.912-915
12. Şerban E., Man T., Chiorean C., 2010, The analysis of the frequency and the trend of the squall phenomenon in the Western Romanian Plain, North of Mureş River. Analele Univ. din Oradea, Fasc. Protecţia Mediului, vol.XV, anul 15, pp.968-975
13. Teodoreanu E., 2007, Se schimbă clima? O întrebare la început de mileniu. Ed. Paideia, Bucureşti, 319 pp.
14. Ţuţuriga L., 1987, Aspecte privind fenomenul de vijelie în Câmpia Banato-Crişană a României. Studii şi Cercet., Meteor., no.1, IMH, Bucureşti, pp.101-113
15. ***, 1987, Geografia României, vol.III: Carpaţii Româneşti şi Depresiunea Transilvaniei. Ed. Academiei R.S.R., Bucureşti, pp.55-88
16. ***, 1995, Instrucţiuni pentru staţiile meteorologice. Efectuarea observaţiilor meteorol. şi prelucrarea lor în scopuri climatologice. INMH, Bucureşti, 162 pp.
17. http://www.hazardero.home.ro/
18. http://www.meteoromania.ro/anm/
19. http://www.wetterzentrale.de/
20. https://www.natgeo.ro/dezbateri-globale/mediu/9632-fenomene-extreme-din-romania