

## **GLAZED FROST, A CLIMATIC HAZARD IN THE WEST PLAIN TO THE NORTH OF THE MURES RIVER**

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**ABSTRACT.** – **Glazed frost, a Climatic Hazard in the West Plain to the North of the Mures River.** The glazed frost is a particular climatic hazard, characteristic to the cold semester, which affects in the first place road transports, but also other sectors of economy. In the West Plain to the North of the Mures River, the glazed frost turns up on the annual average, around 3-4 days, decreasing to 2-3 days immediately to the South of Mures, as the air and soil temperature grows. In the Crișano-Someșană Plain, the frequency of glazed frost has increased during the latest years, and so has the degree of risk for this phenomenon. On the outlying southern territory, the linear tendency is of slight decrease, as the frequency of glazed frost has diminished during the latest years, as the air temperature has grown. The area favourable for producing glazed frost has moved northwards. This evolution will continue during the following years, as the air temperature grows, by replacing the favourable areas for producing it with northern ones.

**Key words:** glazed frost, climatic hazard, tendency, frequency, plain.

### **1. Introduction**

The glazed frost is a particular climatic hazard, characteristic to the cold semester, which affects road transports, but also other sectors of economy.

Sometimes the glazed frost may have a thickness of a few tenths of cm and in exceptional situations it can break the more fragile sustainers (aerial conductors, tree branches) with the weight of the ice mass. In that case telephone, telegraph, internet, power supply lines break off. In the farming regions, if the compact glazed frost layer lasts several days, it can lead to the suffocation of the autumn crops.

### **2. Data and Methods**

In the present work meteorological data have been used, as far as the annual number of days with glazed frost is concerned, from a number of 10 weather stations, during the period 1961-2002. Two of them are located out of the analyzed Plain sector: Sânnicolau Mare and Șiria. The data taken at those stations have been used to comparison. Not all stations had a common observation period as some of them were set up later on: Șiria (1984-2002), Ineu (1979-1997), Salonta (1983-1998) and Holod (1969-2002). For the stations Săcueni and Chișineu-Criș

data were available starting with the year 1970. All meteorological data used in the present work come from the Archive of the National Meteorology Administration.

The annual frequency of glazed frost and the distribution of the number of days with glazed frost on decades have been calculated. The extreme values, which are the hazards, have been emphasized. The linear and polynomial tendency of the number of days with glazed frost was plotted. The polynomial tendency has been done by using the 6<sup>th</sup> order polynomial.

### 3. Results and Discussions

**The average annual number of days with glazed frost.** In the West Plain to the North of the Mures River 1.2-3.9 days with glazed frost a year are recorded on the average. That number is higher to the North where, in the Someșului Plain, 3.2-3.9 days a year are recorded and lower in the Crișurilor Plain with an average of 1.2-3.7 days a year (table 1). The southwards diminution of the number of days is due to the higher values of air and soil temperature as the latitude lowers, which is an unfavourable factor to the occurrence of the phenomenon. Also the northern areas are more frequently exposed to the advections of polar continental or cold arctic air masses, coming from the East or North-East of Europe.

**Table 1.** The average annual number of days with glazed frost in the West Plain to the North of the Mures River.

Station/Period	SatuM	Săcueni	Oradea	Salonta	Holod
1961-2002	3,2	-	3,1	-	-
1970-2002	3,2	3,9	3,4	1,8	1,2
Station/Period	ChișCr	Ineu	Șiria	Arad	SânnicM
1961-2002	-	-	-	3,2	2,6
1970-2002	3,7	1,6	8,9	2,9	2,3

The highest values recorded in the Plain are in the lower areas of alluvial plain, because of the sedimentation of the cold air along the valleys, during the cold semester of the year and lasting low temperatures at the soil level, favourable to producing glazed frost. That is the case of the stations Săcueni (3.9 days) and Chișineu-Criș (3.7 days), where the temperature inversions are frequent in winter.

The table shows that the station Șiria has the highest average annual number of days with glazed frost (8.9 days). The high values recorded there are due to the location of the station at higher altitude (477 m), in the mountain sector. Consequently, the diminution of air and soil temperature as the altitude grows

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favours the occurrence of glazed frost. It is known in fact that glazed frost is more frequent as the altitude grows.

The lowest average annual values are recorded at the stations Holod and Ineu (1.2-1.6 days), due to their sheltered positions given by the depression landforms (Beiuș and Zarand Depressions), in the neighbourhood. Thus, the two stations are sheltered from the invasions of cold air masses, especially the ones coming from the East of the continent, brought by the North-East European Anticyclone. At Salonta, the lower number of days with glazed frost is taken on the low precipitation amounts which fall here (540.9 mm annually), because of the lower altitude of the station (95 m). This is the station with the lowest altitude and the lowest precipitation amounts in the Crișano-Someșană Plain.

We can conclude that in the West Plain to the North of Mures, the glazed frost occurs annually on the average about 3-4 days, getting lower, to 2-3 nearby to the South of Mures, as the air and soil temperature grows. To the East of the Crișurilor Plain and in Salontei Plain, because of certain local conditions like the closeness to the gulf-depressions or very low altitude, the glazed frost only occurs 1-2 days a year. To the southeast of the Crișurilor Plain, the closeness to the mountain sector present as a steep landform, makes the number of days to grow sharply (9 days), because of the higher altitude and increased precipitation amount.

**The maximum annual number of days with glazed frost.** Compared to the average annual number of 3-4 days with glazed frost, the maximum has grown to 10-16 days during the period 1961-2002 (fig.1-3). So, at the stations in the Someșului Plain, maximum 12-13 days were recorded whereas at the ones in the Crișurilor Plain were about 10-16 days. Only to the East of the Crișurilor Plain (Holod and Ineu stations) and in the Salontei Plain was recorded a maximum of 6-8 days. On the other hand, at the south-eastern border of the plain, at Șiria station 32 days were recorded. That is a month a year in which the phenomenon was reported.

The highest value at Șiria was recorded in 2001, and the highest value in the plain was recorded at Chișineu-Criș (16 days) in 1989. The years in which the highest number of days with glazed frost was recorded were as follows (fig.1-3):

- ◆ 1963 – a year with a high frequency of the phenomenon all over the country (Bogdan, 1978); in the western part of the country, glazed frost was more frequent to the South of the analyzed territory (10-13 days) and a little less in the Someșului Plain (8-9 days);

- ◆ 1989 – with a higher frequency to the South of the territory (10-20 days at Chișineu-Criș, Arad and Șiria) and in the Someșului Plain (8-9 days at Săcueni and Satu Mare);

- ◆ 1999 – with the highest number of days in the Someșului Plain (12-13 days), but also to the South-East of the Crișurilor Plain (18 days at Șiria);

- ◆ 2002 – with a high number of days with glazed frost at Șiria (17 days) and Oradea (13 days).

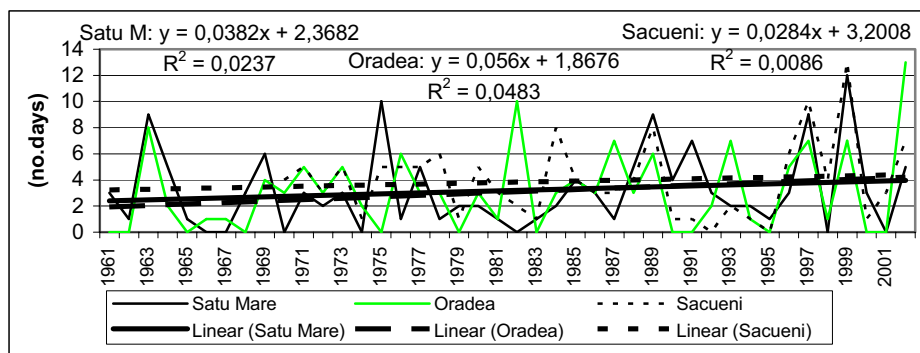


Fig. 1. The annual number of days with glazed frost and its linear tendency, in the West Plain to the North of the Mures River (1961-2002).

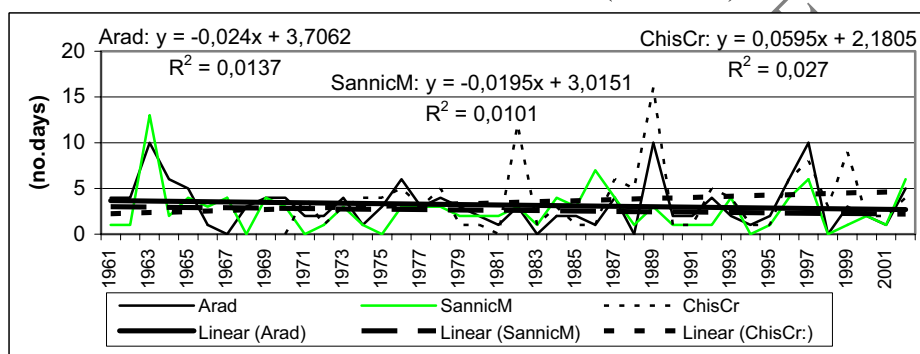


Fig. 2. The annual number of days with glazed frost and its linear tendency, in the West Plain to the North of the Mures River (1961-2002).

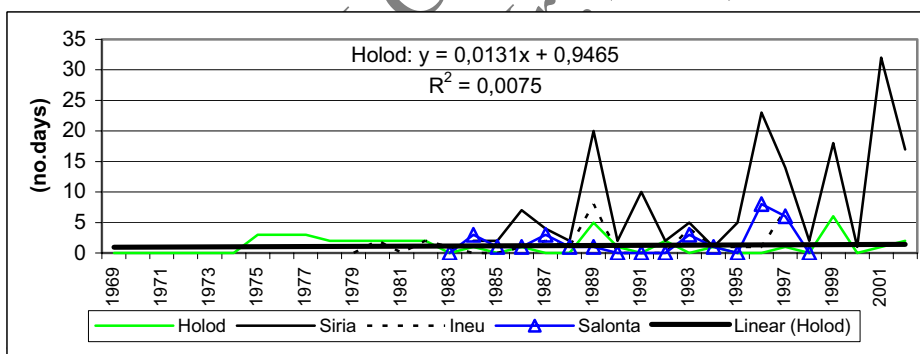


Fig. 3. The annual number of days with glazed frost and its linear tendency, in the West Plain to the North of the Mures River (1969-2002).

Other years with a higher frequency of the phenomenon were 1982, 1996, 1997 etc.

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One can notice that during 1961-2002, at the stations in the West Plain to the North of Mures, the annual maximum number of days with glazed frost was recorded towards the end of the analyzed period, especially in the interval 1989-2002. Therefore we can speak about a *growth of the frequency of this dangerous meteorological phenomenon in the western part of the country, in the latest years*. Only to the South of the plain the annual maximum number was recorded either at the beginning of the period (13 days at Sânnicolau Mare in 1963), or at its beginning and its end (10 days at Arad in 1963, 1989 and 1997). The occurrence of the maximum number of days at the beginning of the analysis period, on the territories to the South of Mures, shows that the air temperature growth in the past years has influenced the producing glazed frost, by diminishing its frequency.

**The annual minimum number of days with glazed frost** is zero for all the weather stations in the plain. Șiria is the only station which had no years without glazed frost, but the station is located in other relief conditions. There, the annual minimum number was 1 day and occurred in the years 1994 and 2000. Those were the warmest years of the entire analyzed period, which determined conditions unfavourable for producing glazed frost in the cold semesters of those years.

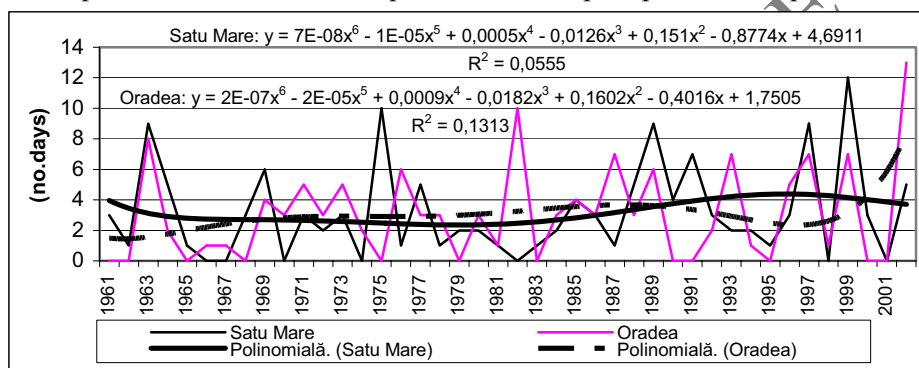
At the weather stations in the West Plain to the North of Mures, the number of years in which glazed frost was absent, was about 2-16 years. The highest number of years without glazed frost was pointed out at the eastern stations, located in the neighbourhood of the gulf-depressions (16 years at Holod out of the total of 34 analyzed years), and smallest in the low alluvial plains (2 years at Săcueni and Chișineu-Criș) where temperature inversions that keep the cold air to the ground thus producing glazed frost, are frequent.

**Table 2.** The annual frequency (%) of producing glazed frost in the West Plain to the North of the Mures River (1961-2002).

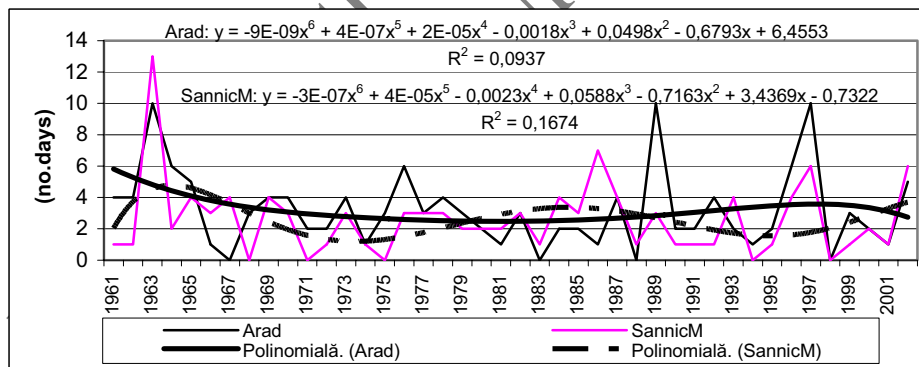
STATION	SatuM	Săcueni	Oradea	Salonta	Holod
Annual frequency	83,3	93,8	71,4	62,5	52,9
STATION	ChișCr	Ineu	Șiria	Arad	SânnicM
Annual frequency	93,8	63,2	100,0	90,5	88,1

In the table 2 is shown the annual frequency of producing glazed frost in the western part of the country. One can notice that it grows with the altitude (100% at Șiria) and lowers in conditions of shelter, on the eastern side of the plain where the cold advections of air masses are stopped by the Apuseni Mountains range. In that case, the glazed frost has a frequency of only 50-70% while at the other stations it gets to 80-95%.

The graphs in the figures 1-3 show that the curves course that represent the annual number of days with glazed frost at the 10 weather stations, is not entirely similar. There are years in which high values are pointed out at several stations, but not at all of them. This dissimilarity is due to the fact that glazed frost depends on precipitation, which constitutes a parameter variable in time and space as well as the air and soil temperature, wind speed, features of the subiacent surface etc., which can vary a lot from one place to another. The same thing can be observed in figures 4-5, where the *polynomial tendency* of the annual number of days with glazed frost, pointed out at neighbouring stations with the longest observation period, show the same *dissimilarity*. So, if a period of years with increased frequency of the phenomenon occurs at a certain station, the exact opposite is recorded at the neighbouring station. All these show that *glazed frost is a highly variable phenomenon in time and space*, as well as precipitation it depends on.



**Fig. 4.** The polynomial tendency of the annual number of days with glazed frost, in the West Plain to the North of the Mures River (1961-2002).

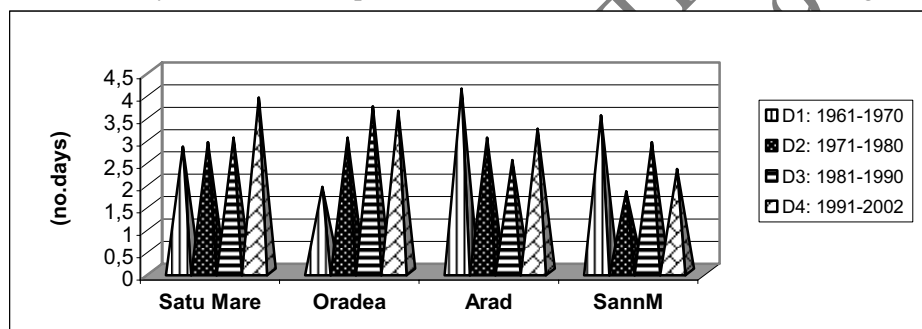


**Fig. 5.** The polynomial tendency of the annual number of days with glazed frost, in the West Plain to the North of the Mures River (1961-2002).

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Opposite to the polynomial tendency, the *linear tendency* is much clearer. It has been represented for 7 of the 10 stations. All the stations have a *growth* tendency, except for those from southern border of the analyzed area. The tendency shows that *in the Crișano-Someșană Plain, the frequency of glazed frost has grown in the latest years, and so has the risk degree for this phenomenon*. However, the growth is not alarming as the growth rate is insignificant. The highest growth is in Oradea, with a coefficient of determination  $r^2 = 0.0483$ . The cause for the growth of the glazed frost frequency in Oradea is the easiness with which cold air masses penetrate from the eastern Europe, canalized along the Crișului Repede Valley, which with its morphological disposition is favourable to these advections, as well as to the diminution of the number of days with solid precipitation and thus to the growth of the number of days with liquid precipitation in the latest years, during the cold semester.

To the South of the studied territory, at Arad and Sânnicolau Mare, the tendency is of *slight diminution*, as the frequency of glazed frost is lowering during the latest years, as the air temperature grows. On the graphs of the stations Ineu, Șiria and Salonta, because of the too short row of observation years they dispose of, the tendency has not been represented as it was considered unconvincing.



**Fig. 6.** The average annual number of days with glazed frost over the four decades of the period 1961-2002, in the West Plain to the North of the Mures River.

The graph in figure 6 points out the evolution of the average annual number of days with glazed frost from a decade to another, during the period 1961-2002. Whereas to the South of the territory the glazed frost had the highest frequency in the first decade, in its centre and North it intensifies during the last two decades. At the southern limit of the plain, glazed frost diminished during the four decades, while at the other stations it grew, as shown by the linear tendency. So, at Sânnicolau Mare and Arad, glazed frost diminished from 4 days a year in the first decade, to 2 (Sânnicolau Mare) or 3 days (Arad) in the last decade. The poorest decades were here the second or third. At Oradea and Satu Mare glazed frost grew gradually from 2 days (Oradea) or 3 days a year (Satu Mare) in the first

decade to 4 days a year in the last decade. In the first decade, glazed frost had the lowest frequency because the cold semester was colder and precipitations were mostly solid. As the air temperature was growing, during the latest years, the frequency of glazed frost was growing too, because of the liquid precipitation fallen on cold surfaces at the soil level. So, *the area favourable for producing glazed frost has moved northwards*. This evolution will continue during the following years, as the air temperature grows, by replacing the areas favourable for producing it, with northern ones.

#### **4. Conclusions**

In the West Plain to the North of the Mures River, glazed frost is most frequently presents in the lower areas of the alluvial plain, where the temperature inversions are frequent in winter. During 1961-2002, the annual maximum number of days with glazed frost was recorded towards the end of the analyzed period, especially in the interval 1989-2002.

*In the Crișano-Someșană Plain, the frequency of glazed frost has increased during the latest years. On the outlying southern territory, the tendency is of slight decrease, as the frequency of glazed frost has diminished during the latest years, as the air temperature has grown. To the West of the country, the area favourable for producing glazed frost has moved northwards. This evolution will continue during the following years, as the air temperature grows, by replacing the favourable areas for producing it with northern ones.*

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