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SHORT LASTING CLIMATIC RISKS IN ROMANIA. COMPARATIVE CASE STUDY: LATE RIMES THAT TOOK PLACE IN MAY - 1952 AND 2011

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Short lasting climatic risks in Romania. Comparative case study: late rimes that took place in May - 1952 and 2011

Gabriela Adina Moroșanu

Short lasting climatic risks in Romania. Comparative case study: late rimes that took place in May - 1952 and 2011. The study regarding the late rime on the territory of Romania, by comparing the causes that were at the basis of rime production in May of 1952 and 2011, proves the wide dimension of the hydrometeor, that is characterized by whitish materials bed on the soil surface, and on the objects on the soil, on clear sky, or with weak winds, and relatively high humidity. Due to a repeated series of rimes (like the ones in 1952), this climatic phenomenon can produce a series of damages at most of the crops, through its duration, and especially through its intensity, and by cumulating the effects from one phase to another. The complexity of the synoptic conditions that define late rimes and the effects on agricultural cultures in the first stages (blossom or the formation of the fruits in fruit trees and grapes), as well as the similarity of thermal aberrations and the way of manifestation of arctic air advections, allowed several conclusions to de drown. These regard the territories that are affected the most, the intensity of the phenomenon for each of the two cases, as well as the elaboration of some empirical models for foreseeing the occurrence of late rimes, with the help of nomograph method, with different assurances.

Key words: late rime, advections, clear sky, nomograph.

Fenomene climatice de risc de scurtă durată în România. Studiu de caz comparativ: Brumele târzii din luna mai - anii 1952 și 2011. Studiul privind fenomenul de brumă târzie pe teritoriul României, prin compararea cauzelor care au stat la baza producerii brumei în luna mai a anilor 1952 și 2011, dovedește dimensiunea amplă a hidrometeorului, ce se caracterizează prin depuneri de materiale albicioase pe suprafața solului și pe obiectele de pe sol pe timp senin, sau cu vânturi slabe și umeazeală relativă ridicată. Datorită unei serii repetate (ca cele din 1952), acest fenomen climatic poate produce o serie de daune majorității culturilor, atât prin durata sa, cât mai ales prin intensitatea sa, și prin cumularea efectelor de la o fază la alta. Complexitatea condițiilor sinoptice care definesc brumele târzii și efectele asupra culturilor agricole surprinse în faza de înspicare, precum și similitudinea abaterilor termice și a modului de manifestare a advecțiilor de aer arctic, a permis formularea câtorva concluzii cu privire la teritoriile cele mai efectate, la intensitatea fenomenului pentru fiecare din cele două cazuri, dar și elaborarea unor modele empirice de a prevedea producerea brumei târzii cu ajutorul metodei nomogramei cu diferite asigurări.

Cuvinte cheie: brumă târzie, advecții, timp senin, înspicare, nomogramă.

1. INTRODUCTION

”Rime” is a climatic phenomenon, made of fin ice crystals beds that are whitish on the soil surface and on the objects on the soil [1]. Meteorologically, the rime is a hydrometeor characteristic to the benign sky weather, no winds or weak winds (of 0-2m/s) and relatively high humidity (over 80%)[2].

The rime is in general, associated to the risk hydro - climatic elements that took place in the cold season. The common element to all risk phenomena during the cold season being represented by negative temperatures that they generate and by the over cold vapors in the closeness of soil surfaces, vegetation, electricity cables, fences, cars, etc; the vapors are then condensed and laid down under different forms and crystalline structures on those surfaces. An assignation needs to be made as well: why ”climatic” and not ”atmospheric” or ” meteorological”? If we consider the episodic moment when they were formed, they represent meteorological risks. If we consider the fact that they are produced in the atmosphere, they are atmospheric risks. If we consider the specific parameters that characterize them (appearance date, disappearance date, frequency in time and space, etc) and also that allow us to draw a few conclusions regarding the most affected territories and their mode of occurrence, than we operate with multiannual arrays of statistical dates, for which the medium and extreme values are calculated. As a result they can only be called climatic risks or meteo-climatic [3].

2. DATA AND METHODS

The research methods employed are the cartographic method, used for processing the map of the distribution of minimum temperatures at ground level in Romania on the 22nd of May 1952 and in the analysis of the synoptic maps and satellite images for the 21th of May 1952 and the 8th and 9th of May 2011 respectively, the statistical method and the bibliographical research method. The programme used in designing the map was ArcGIS 10.0. For the creation of the graphical elements supporting the scientific arguments regarding the frequency and average number of days with late rime, a number of correlations have been made, beginning with the empirical method and finishing with more modern ones, applicable in the geo-informatic environment.

Also, the structuring of the information was achieved by using the analysis and synthesis method and the deduction method, in order to characterize the climatic phenomena of extreme hazard in Oltenia. The numerical data comes from Meteorological Annuaries [4] and are accompanied by data from scientific works and from the Regional Weather Center of Oltenia [5] (Bâcleș, Craiova and Bechet weather stations). The synoptic maps have been selected according to their availability on-line [6].

3. GENESIS AND STRUCTURE

The synoptic conditions that lead to rime appearance are represented by the climatic a periodic variations, whose intensity amplifies or diminishes, are directly proportional with the structure characteristics of the subjacent surface, especially with the depression – like relief [9]. Generally, they are caused by the waves of cold that transport the polar air, especially the continental arctic air from Greenland or from the Eurasian continent (the Greenlandic anticyclone and East-European anticyclone respectively and, very rare, the Siberian anticyclone, that determines the advective cooling); also, the predominance of the anticyclone weather favors the appearance of the radiative cooling [2]. The position of the baric centers, the succession and the misalignment direction of the air masses, as well as the frequency and intensity of the cooling processes, facilitate the entering on the territory of Romania of some air waves with different physical characteristics, in this case, frosty and dry, that lead to great aberrations, disturbances from their normal regime [7].

The late rime is characteristic to benign and calm nights and it is formed by the sublimation of water vapors present in the air, in the objects with a temperature below 0^{o} C that become cold by nocturnal radiation [7]. The thickness of the ice blanket, formed by the rime, may go up to 1-3mm and even over 5mm. For the territory of Romania, the geographic position in the South East of the European Continent, at an interference area of the principal baric centers, that occur along the year (whose activity represents the engine that starts the entire cycle of atmospheric movement), leads in the temporary and spatial evolution of the climatic elements and phenomena to significant changes, with respect to the multiannual medium situations, taken as normal.

The fine ice crystals that form the rime are formed during the benign nights, when the radiative cooling leads to a decrease in air temperature and/or on the soil under 0^{o}C. The shape of the laid crystals is different, being present as bristles, blades, flakes, fans [8].

Together with the negative temperatures of the active surface, the conditions that favor rime appearance are given by the presence of weak or moderate wind that favors the turbulent mixture [7].

4. THE MOMENT OF OCCURENCE AND INTENSITY

Late rimes have 'an incubation period' shorter than the early ones, because they are produced during 2-3 consecutive days, and generally, are not widely spread in time, therefore we will not talk about the so called ”cooling waves of rime production waves”, as we could do for the early rimes.

The medium data of the last rime indicates territorial dissimilarities in their repartition. The earliest moment when the last spring rime can occur is around the 21st

of March, in the coastal/littoral region. The latest spring rime takes place in the mountainous regions, on 11 May, at high altitudes and at 1st May in the depressions[10]. Moreover, in the map regarding the minimum temperature distribution in Romania at 21st May 1952 the and number of days with late rime (Figure 1), it can be clearly seen that for the meteorological stations situated in mountain areas (Sibiu and Predeal), the rime may be produced in June too. In the other stations, the number of days decreases from March (c. 4,5) to Aprilie (c. 3) and sometimes May (c. 0,5), excepting Tulcea Meteorological Station (0,9 days in March and 1 day in April), duet o the temperature inversions occured in the Danube Delta during the transitional seasons.

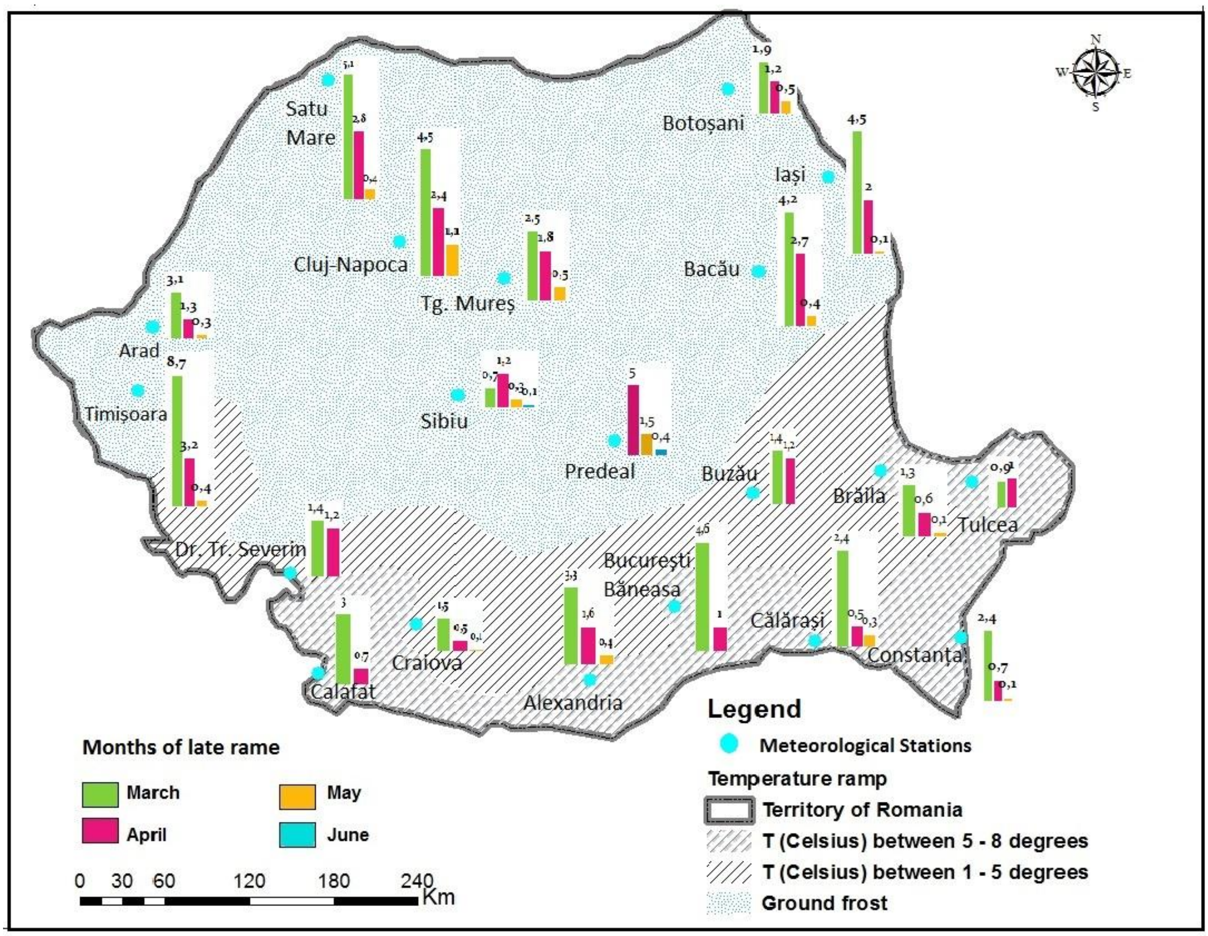

Figure 1. Minimum temperature distribution in Romania at 21st May 1952 (after Topor 1958, extract of Bogdan Octavia, 1999) and number of days with late rime in different meteorological stations

In the plain region, in the vicinity of Danube's water meadow, the latest rime appears, on average, between 1st and 11th April, and in the North of the Romanian Plain, after 11th April. This region is the only homogenous one as temperature on the ground regards, being characterized by temperature between 5-8 degrees. In the West Plain, the last rime occurs before the 21st April, and in the South part, before the 11th April [9].

In the Moldavian Plateau, in the North part, the average date of the last rime that took place is after 21st April and in the central and south part before 21st Aprilie. The situation in which ground frost is predominant appears in this part of Romania.

In the Transylvanian Plateau, the average date of the last rime is between the 21st April and 1st May. In the Sub – Carpathians (1-5 degrees Celsius in the southestern ones and ground frost in the easter ones), the average date of the last rime is between 21st April and 1st May, with a 10 day advance for the chutes that have foehn - like effects. Therefore, in the foehn – like regions of the Subcarpathians from the Curbature, the last rimes fall, on average, before 11th April [1, 9].

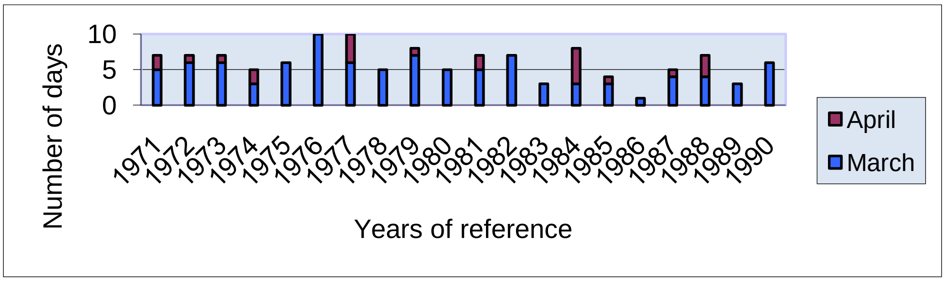

Figure 2. The frequency of number of days with late frost in M.S. Craiova (1971-1990)

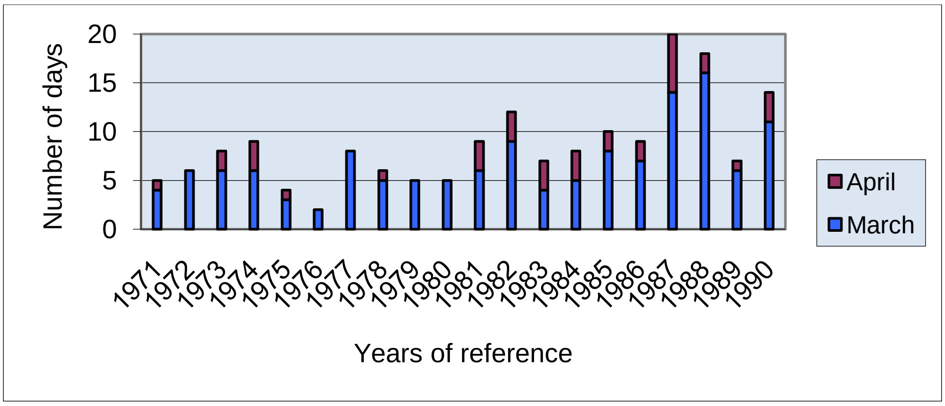

Figure 3. The frequency of number of days with late frost in M.S. Bechet (1971-1990)

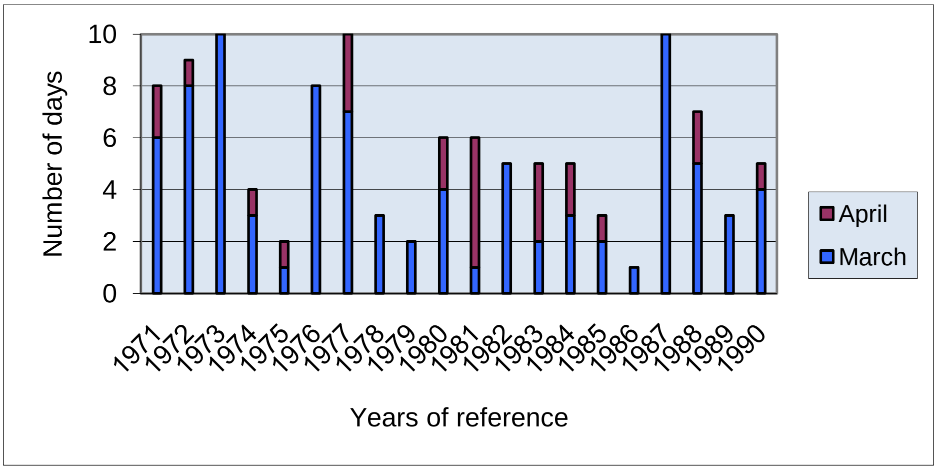

Figure 4. The frequency of number of days with late frost in M.S. Bâcleş (1971-1990)

In order to better enhace the placement in time of the rime occurred during the spring months, we have analyzed the frequency of number of days in three meterological stations south-western Oltenia. The months chosen were April and March, because May is an extreme moment of the rime occurrence and the data offered by the Regional Meteorological Centre, Craiova were little for a comparison between all the three months. The three diagrams (Figures 2-4) depicting the number of days with late rime have been created based on the available data[5], from three weather stations situated in low-lying areas of the region – Bâcleș, Craiova and Bechet. By comparing the results, one can observe the difference between the distribution of the number of days with late rime in April and March depending on the location of each of the stations. Most days when rime occurred in March are recorded at Bâcleș station (Figure 4), located in the Bălăciței Piedmont, at an altitude of over 250 meters, whereas Craiova (Figure 2) or Bechet (Figure 3) are situated below 250 meters. This situation can be explained by climatic differences, almost imperceptible on a small scale or at the level of annual average temperatures, but significant for a monthly analysis of hazardous phenomena.

Although the average number of days with rime in March decreases from Bâcleș to Bechet, with intermediate values registered in Craiova, the year 1986 is remarkable because late rime occurred only in March. This is not the case for the number of days with rime in April, which varies significantly and it is not homogenous from one station to the other for the same year. For example, at Bechet, the maximum number of days with rime in April was recorded in 1987, whereas for the other stations, the year is 1977, and for Bâcleș, 1987 is the year if the highest number of days with rime in March. Concerning the total number of days with rime during March and April, for Craiova and Bâcleș, this number does not exceed 10 days, while at Bechet, it can reach 20 days. Therefore, we can determine that, while at Bechet, frosts are less frequent in April, those happening in March last longer than in Craiova or Bâcleș, despite the lower altitude and warmer climate.

The importance of this data concerns the climatic study of hazards, because such phenomena force the vegetation to reduce its annual active life cycle, and are even more dangerous when they occur outside their normal interval, which is in the last ten days of March.

5. PHENOMENON DESCRIPTION (CASE STUDY – MAY 1952 AND 2011)

In the transition period from negative to positive temperatures, numerous cooling and rimes can occur, that have a risk character for the cultures at their ending vegetation period. Their destructive potential is gradual, depending on several factors: the occurrence period, cooling intensity, the types of cultures and affected plants, the stage they are at, and the form of relief. Normally, the rime appears at the same time with freezing, or a short amount of time later on. However there are cases when the rime appears before the frost takes place [1].

This situation was due to the fact that the Carpathians act as an orographic barrage, which deflected the cold air advections on both sides, concomitant with the change in the thermal characteristics of the air mass [7, 9]. On the other hand, the characteristics of the relief (with positive and negative forms), valley orientation and their altitude, marked the repartition of the rime. As a result they are thicker in the negative forms of relief, with temperature inversions and atmospheric calm, and thinner in the positive forms of relief, that are also exposed to air ventilation, from all the sides (Figure 5).

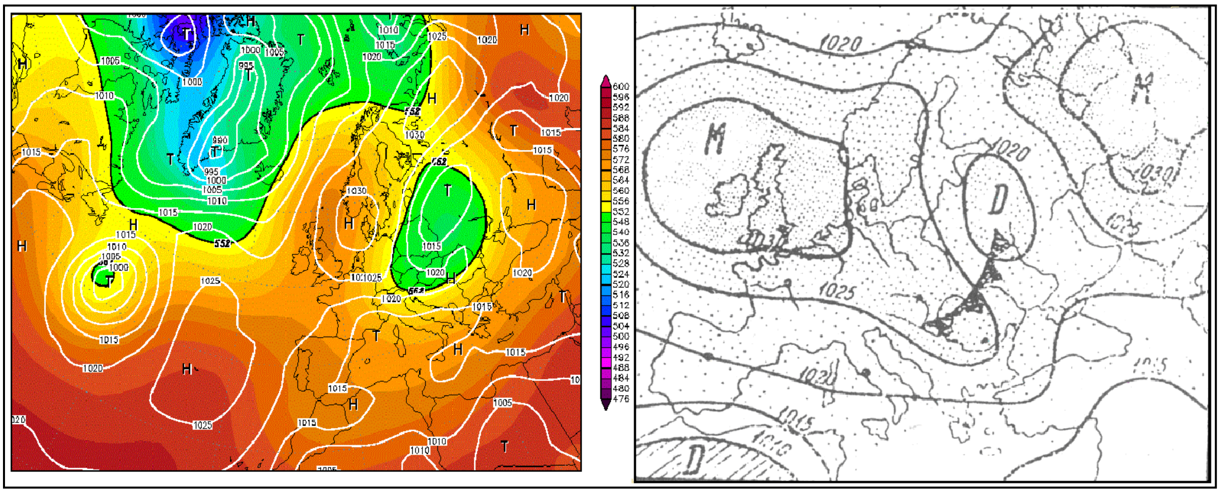

Figure 5. Distribution of atmospheric pressure at 850 *mb* and at ground level in Europe, 21 and 22 May 1952 (source: http://www.wetterzentrale by Toptarken and Topor, 1958, quoted by Bogdan Octavia, 1999).

The destructive record is held by the late rime from 21-22 May 1952 (Figure 5) that had a general character in Romania, slightly marking, referring to the forms of relief and to the altitude. Therefore, the rime from 21 May, is characteristic to mountain regions from 1500-1700 m and it signified a vertical aberration of 1000-1300 m, as it went down to 400-500 m in altitude. The aberration of 1000-1300m was not the only case, as it has a correspondent in time, meaning an aberration of approximately 40 extra days that found the agricultural regions in full season [9].

The genetic causes for spring rime production were highlighted through the distribution of minimum temperatures registered in the last month with rime – May.

The advections of arctic air masses are primary responsible for the production of spring rimes, (Figures 5 and 6) and are conducted in the direction of the Scandinavian anticyclone, in the NW-SE direction and marked by the two cold fronts that pass by the territory of Romania in the period of April-May in the colder years [7]. In this way, advective-radiative freezes are produced both on the soil and in the air, where an extremely low temperature occurs, locally reaching even -2^{o}C.

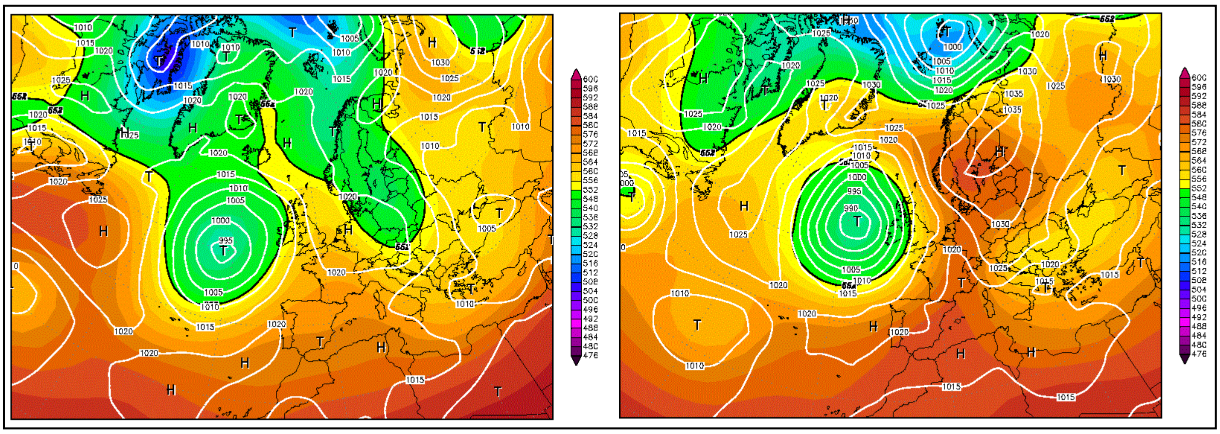

Figure 6. Geopetential distribution of 500 mb in Europe, 8 and 9 May 2011

Among other causes, there is the process that allowed, in the last years, the Scandinavian anticyclone to join with the one formed above Great Britain, from which a cold air ramification can reach to the Carpathians and afterwards to enclose all the south-west and the west part of the country [9], from here onwards the freeze and the rime have a general character.

The front trajectory and its decomposition above the West Plain and Apuseni Mountains can be observed during the few hours that are between the two moments of maximum cold air mass advection production from above the territory of Romania - that also led to the appearance of the latest rime.

In addition, the two years that represent examples when rime occurred (1953 and 2011) and not the only cases; in May 1999 and April 2001, there were advective-radiative situations that favored rime production with negative effects for agricultural vegetation [9].

6. GRAPHICAL MODELS OF RIME PREVENTION

The graphical methods were used in order to achieve an empirical prevention of the phenomenon, the analysis being based on the data regarding the average date of the rime to be produced, calculated on the data available on the Romanian Meteorological Annuaries. The diagram representing the correlation between the daily average minimum temperature in April and the day of the last frost (Figure 7) was made by correlating the minimum temperatures in April over a period of thirty years (1951-1981) from seven weather stations located in areas around the country that suffer slightly different climatic influences, and which have been chosen according to the data available from hydrological yearbooks and other scientific works.

Data used were extracted from the Meteorological Annuaries and the stations were chosen accordingly to the disponibility of the data and their uniform repartition within the territory of Romania. The Sopojnikova method, which is described in detail by climatologist Nicolae Topor[1], predates modern computerized methods used by weather stations nowadays to determine or estimate the occurrence of rime, by taking into account the fact that, in general, April is the month when most hazardous late rimes happen. The results of the calcula show that only for Câmpulung Moldovenesc, Timișoara and Galați Meteorological Stations the value of the correlation line is directly proportional with the number of days with late frost and the average daily temperature in April.

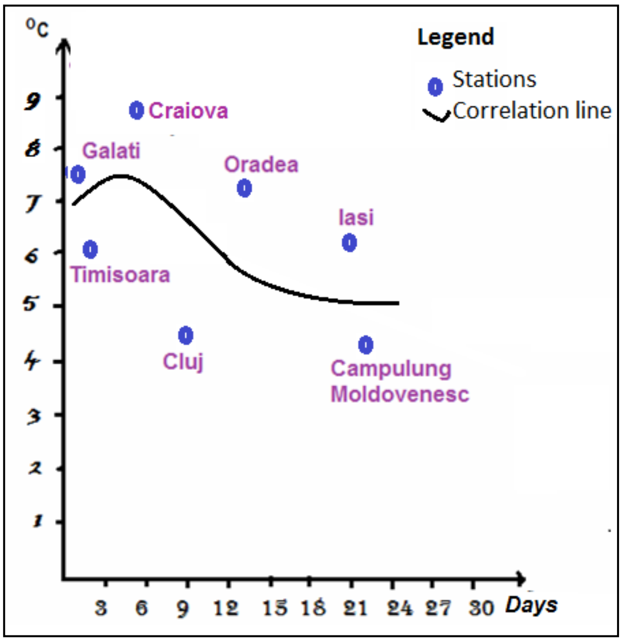

Figure 7. Correlation between average daily temperature in April and the average last frost date for seven wather stations (using Sopojnikova method)

The correct distribution line would be the one in which to a lower average temperature in April would correspond a later date of last frost and to a higher average temperature in April would subsequently correspond an earlier date of last frost. This proves that late rime is indeed a risk phenomenon, as its occurrence does not necessarily depend on the climatical tendencies in a period of time, but the imprevisible at long time scale cold air advections are the elements responsible for them. On the other hand, Craiova Station is, probably, the most untypical of all that have been represented. There are more than 6 days of late frost during the April, whilst the average temperature is 9.2 degrees Celsius. This fact is due to the situation of the city in a sort of depressional area, in the meadow and on the terraces of Jiu River, being surrounded by the Getic Piedmont, Leu-Dioști (eastward) and Bălăcița (westward).

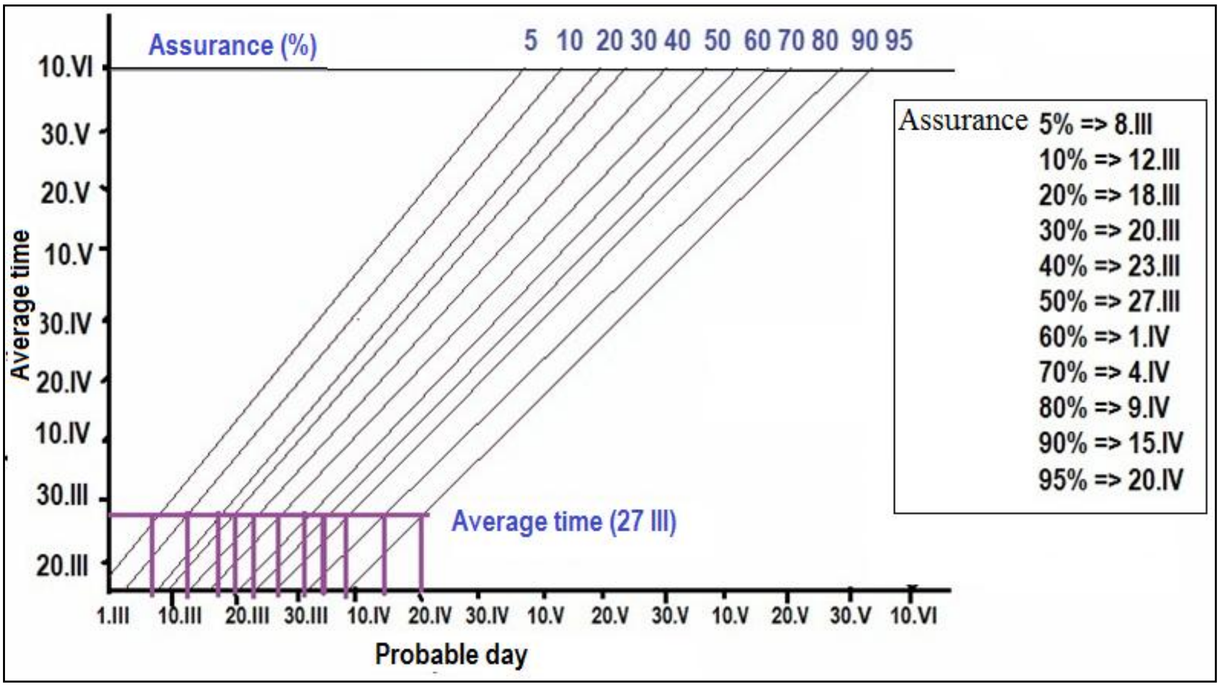

Figure 8. The nomogram for establishing the probable date of the last frost with various assurances (%) for the Meteorological Station of Craiova

The second empirical method employed to estimate the date of occurrence for the last frost is the ”Nomogram for establishing the probable date of the last frost with various assurances” (Figure 8), which we adapted for the values calculated for the Craiova Meteorological Station[1]. This station was chosen for two reasons: firstly, here were recorded both rimes from the years used in the comparison (1952 and 2011) and secondly, the sufficient numerical data from this station, offered by the Regional Meteorological Centre and completed from the Meteorological Annuaries, allowed us the possibility to calculate the assurances and, consequently, the average date of occurrence for the last rime with a precision of 1 in 30 years (thirty years of observations – 1951-1980). It can be noticed that the occurrences of late rimes with high assurances, of over 60%, all belong to April, and not March, and none took place in May. Thus, the late rimes of May 1952 and May 2011 can truly be considered exceptional hazards, particularly due to the effects on crops, which are, at that time, in an advanced state of vegetation.

By analyzing the two diagrams, one can observe the fact that late rime, as a hazardous climatic phenomenon, cannot be associated with early April frosts because if the average date of occurrence is the 27th of March, the period in which the phenomenon can normally happen can be extended by 10 days. Regarding the Sopojnikova method, it proves its usefulness when correlating the average temperature of April with that of the last frost, knowing the average date of the beginning of the growing season, which is deduced from the histological phenogram the of each weather station.

7. THE RISKS OF LATE RIME IN THE AGRICULTURAL SECTOR

During a calendar year, when rime appears, it finds the cultures at the beginning of their vegetation period [10]. In order to evaluate the impact of the rime on the plantes, as a risk phenomenon, there are some risk aspects that need to be explained, that concern human communities and the grocery associations they connect with, in order for damages to take place. Therefore, the damages measure the economic value of the effects of a certain risk. In the table below, we tried to highlight and evaluate the negative effects as a result of the phenomenon, both during autumn, as well as in spring time, which reflect on vegetation and reaches the human by the damages to the cultivated lands, lowering the crops, or leading to the complete compromise of the plants cultivated [8]. Rimes are harmful in spring, when the vegetative cycle starts and in autumn, as the agricultural cultures, the orchards, the grape cultures, and the vegetable cultures, which had not been harvested before, are affected.

In Figure 9, the effects produced by the rime on the vegetables and the damages produced on local communities are synthesized.

Negative effects on phenologic processes	Agricultural damages (some examples from the literature of topic)	Material damages
Aberration to the inside of vegetation period, with regard to the medium date of the last freezing [8].	Culture resistance to hydro - climatic extremes is frequently overcome[8].	Some of the damaged thermopile plants are: beans, that freezes at 0 °C; tomatoes, at -0,5 °C...-1 °C; Peppers cannot live under temperatures lower than -2 °C.
The rime that is laid on leaves and branches of the trees, cultures and vegetables, determines temperatures to lower [11].	Cotton culture (thermopile plant) is done when latest rime occurs, especially in Bărăgan [12]. The destroyed cotton is usually replanted, prolonging its vegetation period in autumn, when it can be surprised again by the early rime.	Sun flower crop was compromised, by harming the vegetative edges of the plant (resulting in the degradation of next culture quality, by deforming the plants' ramifications, thus looking as bushes with small flower heads [1].
Water freezes in intercellular spaces. Cellular juice concentration increases. Flaky colloidal spaces. Partially or totally destroyed cells [8].	In the depression coridor of Târgu Jiu the freeze and rime phenomena are associated with the spring drought [13].	The frost in April-May 1952 took place when the sheep had their fur freshly cut and go on the mountain fields in Buzău and Vrancea counties without having assured any food or necessary shelter [1].

Figure 9. Table of the risk evaluation from the literature of topic

8. CONCLUSIONS

The risk represented by rime comes from the human dimension it possesses in the risk climatic phenomena for agriculture, in terms of rime constituting a danger for plants, especially when it is accompanied by intense cooling and stagnation or a regress of the fenological phases, with negative effects on population alimentation. The damages produced by rime are not among the worst, but they cannot be neglected. The most damaging rimes are the ones that appear in very late springs (May), when the vegetation cycle is at its start. Partially compromising the development of the plants in the first stages (bud, blossom, fertilization), the rimes sometimes determine considerable decreases of the production, both quantitatively and qualitatively.

The average dates for rime occurrence can be determined with a highly increased precision, if other climatic parameters are taken into consideration (monthly or daily minimum temperatures, the duration of the period without frost, synoptic conditions), but this stays enclosed in the category of risk climatic phenomena because of the late date it occurs, the multitude of preparing factors that generate it, and the negative effects reflected in agriculture and animal breeding.

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