FROST AND THAW – RISK CLIMATIC PHENOMENA IN DOBROGEA

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ABSTRACT. – In meteorology it is considered that *frost* days are those days when the minimum temperature is below or equal to 0°C.
Thaw is characterized by warm weather during the cold period of the year, when air temperature rises to 0°C or exceeds this value. If the frost interval is accepted as existing from the first to the last day with minimum temperature below 0°C, in what regards the thaw period, there is no unanimous opinion. In this paper, the thaw interval was considered according to the researches, which accept that a new beginning for thaw can be considered after the frost has stabilized, that is, after the maximum temperature < 0°C is registered consecutively for a particular number of days. The end of thaw is considered the time when the daily average temperature is permanently over 0°C.
Frost and thaw are part of the phenomena whose action influences negatively different economical activities. These phenomena have very harmful effects in agriculture. Thus, late spring frost interrupts the vegetation period of plants, while early autumn frost leads to the loss of the crop. Thaw in turn, accompanied by the sudden melting of the snow layer, endangers the autumn cultivation or contributes to soil erosion. The constructors pay special attention to the alternation of frost and thaw as they affect the resistance of materials. Negative effects of these phenomena are also encountered in industry, transport etc.

Keywords: Dobrogea, frost, thaw, risk

1. INTRODUCTION

The risk factors and climatology aspects in Dobrogea (including frost and thaw), have been researched on papers written by D. Țâştea etc. (1967), I.F. Mihăilescu (1986, 1999, 2001), Bogdan Octavia (1978, 1996, 1999), S. Chiulache and Nicoleta Ionac (1995), Cr. Păltineanu etc. (2000), M. Lungu (2009).

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accompanied by the sudden melting of the snow layer, endangers the autumn cultivation or contributes to soil erosion.

The synoptic processes that favor the most frequent winter thaw in Dobrogea belong to the tropical and western circulation of oceanic type (Mihăilescu, 2001). Frost, on the other hand, is determined either by the general modifications (of dynamical origin) caused by sudden variations of the air masses: the passing of cold fronts, invasions of polar air etc (advection frost), or by anticyclonic situations with clear sky and atmospheric calm (radiation frost). The radiation frost is harmful in spring, when the vegetative cycle is resumed. But, for this to occur in this period of the year, several factors must be associated:

- A relatively low maximum temperature the previous day. This condition is fulfilled if a humid and unstable mass of air covers that particular region.
- A strongly deficient radiation during the night. As the atmosphere is unstable, the soil radiation at the beginning of the night cools the air mass at the basis and causes the air to descend. The resulting adiabatic compression leads to the disappearance of the clouds. The loss by infrared radiation becomes thus very strong and it makes the soil temperature go below or around 0°C.
- The lack of wind is necessary for this process; consequently, the cooling of the air close to the soil is not possible in the presence of wind, which mixes the different layers of the atmosphere and thus homogenizes the temperatures.
- The state of the soil can intensify or, on the contrary, diminish the radiative cooling of the air. The intensification is specific to the depression landscape, which favors the accumulation of the cold and dense air or of the porous and dry soil. The delay of the radiative cooling occurs either on a reclined landscape, which favors the oozing of the cold air, or on a soil that transmits well the accumulated heat. The wet and relatively set soils meet this last condition.
- Certain agricultural techniques that increase the risk for frost; tilled field or the presence of hedges, of wind protection etc, reduce the air turbulence and implicitly the homogenization of its temperature accentuating the risk for frost etc.

The analysis of these risk hydrometeors in Dobrogea is based on the data obtained from the observations accomplished at the weather station between 1965 and 2005 and its purpose is to characterize the climate of the regime and the probability for its occurrence and territorial distribution.

2. THE MAIN PARAMETERS THAT CHARACTERIZE THE FROST AND THAW IN DOBROGEA

2.1. Average duration of frost

In the cold period of the year, especially in winter, the thermal influence of the Black Sea, warmer than the land, is felt on the littoral at its strongest. This influence is emphasized by a number of characteristics of the air temperature in the cold period of the year, when frost and thaw occur. Thus, the annual average of frost increases from approximately two months at the Black Sea shore to about three months in the western extremity of the region, on the Danube bank and extends to three and a half months in the highlands (over 200 m) of the central-northern plateau of Dobrogea. Thus, the average interval without frost in Dobrogea is the largest in the country. This adds up to 225–230 days in the littoral area and the Danube Delta (Sulina 228 days, St. George 223 days, Mangalia 229 days), 200–225 in southern Dobrogea and below 200 days in central and north Dobrogea.

The average frost duration is about 135–140 days on the littoral (the lowest in the country) and 140–165 days on the larger area of Dobrogea (approximately 140 days in the Southern Dobrogea Plateau and the lower regions of the Central Dobrogea Plateau and over 165 days in the higher sectors of Casimcei Plateau and Northern Dobrogea Plateau). The number of frost days is under 80 on the littoral, 80–90 in southern and central Dobrogea and over 100 in north Dobrogea. The frost days (minimum temperature ≤0°C) are recorded between October–April, and more numerous in January and February. The first frost occurs in the first part of October in the western part of the region and in the first part of November in the eastern part, where it is a month late.

2.2. Date of frost occurrence

The dates of frost occurrence and disappearance are directly connected to the morphometrical characteristics and to the exterior climatic influences felt in Dobrogea. In the analyzed period (1965–2005), the first autumn frost, as average date, is delayed from west and north-west to east and south-east, as the influence of the Black Sea increases. The entire region is sectioned diagonally on north-east-south-west by the November 1, isoline which divides into two areas: the western area, where frost occurs between October 26 and November 1 (within which there is the Northern Dobrogea Massif where, because of high altitude, frost occurs even before October 26) and the eastern area where, under the influence of the sea, frost is delayed until November 11 (inside this area, the littoral area where frost occurs averagely after November 11), e.g. Mangalia November 15, Sulina – jetty November 12, fig. 1.

The earliest autumn frost can occur in the western area even from the second part of September (in Northern Dobrogea Plateau and Casimcei Plateau) and the third part of the same month for the rest. In the eastern area, frost is delayed by 10 days, and it occurs in the first and second part of October. The last spring frost takes place differently, as average date. The April 1 isoline delineates the eastern and southern part of Dobrogea with Pontic and sub-Mediterranean influences (where frost disappears before this date, at the earliest, e.g. Jurilovca and Sulina, March 30), from the rest of the territory (west and north), where the last frost continues to happen after this date: between April 1 and April 11 on most of the western territory, and after April 11 in the Northern Dobrogea Plateau, as a result of altitude increase, but also of the continental influences in the east and north-east (fig. 1).

The latest frost can occur at the beginning of the vegetation period, in the third part of April in the littoral and the first part of May in the western half of Dobrogea and the Northern Dobrogea Plateau.

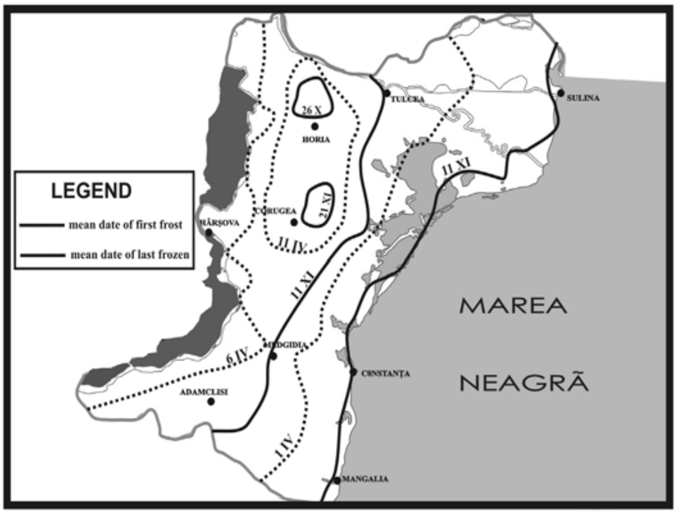

Fig. 1. ***Average dates for the first and last frost in Dobrogea (1965–2005)***

The moderating effect of the water surface on frost can also be observed in the littoral lakes. Such an example is given by the very close frequency of frost observed in St. George, located at a distance of 2 km from the Black Sea and Jurilovca, located at 20 km from the Black Sea, but on the bank of Lake Razim (Lungu, 2009).

The strongest territorial contrast in terms of frost in observed on clear weather, when the transformation of the radiant energy into caloric energy expresses exactly the differences existing in the structure of the active surface. This results from the comparison between the recordings done in January at the meteorological stations in Constanta, Valu lui Traian, Medgidia and Harsova, which form by approximation a transversal profile between the eastern and western extremity of Dobrogea.

The moderating effect of the seawater can be felt on the littoral even on cloudy days, when the lowest frequency of the minimal negative temperatures occurs in comparison to the stations inside Dobrogea. In Constanta, on clear weather, the frequency of minimum air temperatures (values between -10 and -20°C) is over 2 times smaller than in Harsova, located on the Danube bank. Minimum air temperatures of -10°C – -20°C are connected to the winter anticyclones. They are usually associated in Constanta to higher daily values of the global radiation (150–200 kcal/cm^2 /min), which are the most frequent on clear weather. On cloudy days, the most obvious territorial contrast moves towards minimum temperatures between 0–10°C, also associated, most frequently to values of the global radiation of 150–200 cal/cm^2 /min.

2.3. Frost intervals

A general reduction of the intervals with frost is observed in the littoral area. At the points located in the western extremity of Dobrogea or at higher altitudes, the following are noticed: a reduction of the short intervals with 1–5 days of frost and an increase in the number of intervals lasting 11–15 days or more. The intervals with the longest time of frost (over 2 months) are recorded at the western limit of Dobrogea and in the highest part of the landscape.

2.4. The average annual duration of thaw

The distribution of thaw, which is preceded by a period of stable frost, is also characterized by an increased frequency at the same time with the increase of the distance from the sea and of landscape altitude. In the south of Dobrogea, in Mangalia, the average annual duration of thaw is only 16 days, compared to 21–23 days (recorded in the other meteorological stations on the littoral). The small thaw time period in Mangalia is explained by the reduced intensity of stable frost, given the accentuated thermal influence of the Black Sea, which reaches the highest depths and has the largest supply of warmth along the Romanian littoral. Inside Dobrogea, the average thaw duration is between 33 and 36 days, with a maximum of over 45 days in the high part of the landscape.

2.5. The earliest / latest thaw that precedes frost

The influence of the sea is very important for the occurrence of the earliest and latest thaw that precedes the frost (Lungu, 2009). Thus, in the first 30 km from the shore, the earliest thaw took place in the first half of the second decade of December, compared to the end of November in the rest of the territory. Also, the last thaw occurred at the end of March, on the littoral and in the first decade of April, in the highest part of the landscape. The most numerous thaw periods are accompanied by low values of the global radiation (50–100 cal/cm^2 /min) which characterizes the days when the sky is cloudy (nebulosity 8–10). The dominance of the advective processes in the occurrence of thaw is obvious, unlike frost, which is of radiative and advective-radiative origin, and whose frequency increases to high values of the global radiation in winter (150–200 cal/cm^2 /min).

2.6. Frequency of thaw

The maximum frequency of thaw between 1965 and 2005 was observed in February. In this month, like in March, there is the most obvious difference between the reduced frequency of thaw in the littoral sector and the increased frequency of thaw (given the prolongation of frost) in the highland areas. The frequency of thaw increases from the littoral with the distance from the sea and the landscape altitude, especially in the small intervals of 1–5 and 6–10 days. However, the littoral sector witnesses the highest frequency of long intervals with thaw of over 20 days. Here, with the strong caloric influence of the seawater, the freezing point is reached harder in comparison with the rest of Dobrogea. An example to illustrate the influence of local thermal inversions is the higher frequency of frost in the weather station in Valu lui Traian, located at 30 km from the sea, but at an altitude measuring 20 m more, on a terrace of the same valley. In conclusion, the territorial distribution and the frost and thaw regime in Dobrogea, determined by the moderating thermal influence of the Black Sea is characterized by a strong reduction of the average and extreme duration in the littoral sector.

Inside Dobrogea, in the western part and also on the high plateau landscape, short thaw periods and long frost periods occur more often. The local thermal inversions diminish the sea influence, favoring the increase in the frequency of frost, especially in the valleys, even though these are relatively close to the littoral, given their physical and geographical position.

3. CONCLUSIONS

Frosts and thaw are typical for the cold period of the year. The farther the distance from the ocean (sea), the higher the frequency and duration of the phenomenon due to the diminishing moderation effect of the water. Those have been extremely harmful in agriculture during 1965–2005, when the late spring frosts caused the interruption of the vegetation period of plants, while the early ones in fall caused the disparegement of the crops. On the other hand, the defrosts accompanied by the sudden defrost of snow, have endangered the autumn crops, contributing to the accelerated erosion of the soils. For example, in the central and southern part of Dobrogea (in Constanța county), frost and thaw have greatly damaged the agricultural field, causing the destruction of no less than 11502 ha in 41 years, which represents aproximately 41% of the total calamitated surface by climatic risk (table 1), which demonstrates the great impact of those hidrometeors on Dobrogea economy.

Tabel 1. ***The size and structure of the calamitated surfaces based on risk factors in Constanța (1965–2005)***

Location	**Average calamitated area (average of 41 years)**	**From the:**							
		Hail and torrential rain		**Floods**		**Frost and thaw**		**Other factors**	
		Ha	**% of area calamitated**	**Ha**	**% of area calamitated**	**Ha.**	**% din supr. calam.**	**Ha.**	**% of area calamitated**
Agigea	150	–	–	–	–	158	100	–	–
Albeşti	620	241	38,2	–	–	136	21,6	252	40,1
Amzacea	1048	737	70,3	6	0,6	395	29,1	–	–
Ciocîrlia	630	99	15,7	–	–	260	41,3	271	43
Stejaru	–	–	–	–	–	–	–	–	–
Cobadin	192	144	51,6	–	–	135	48,4	–	–
Mangalia	279	144	51,6	–	–	135	48,4	–	–
M. Kogălniceanu	1694	1098	64,8	–	–	507	30,1	89	5,1
Nazarcea	393	2	0,5	–	–	309	76,6	82	20,9
Negru Vodă	1741	992	57	–	–	188	10,8	561	32,2
Topraisar	222	–	–	–	–	222	100	–	–
ZONA I	**6986**	**3313**	**47,4**	**6**	**0,1**	**2412**	**34,5**	**1255**	**18**
Cogealac	1921	1509	78,5	13	0,7	599	20,9	–	–
Dorobanțu	1204	802	66,6	–	–	102	8,5	300	24,9
Murfatlar	695	8	1,2	–	–	687	98,8	–	–
N. Bălcescu	1164	772	66,3	–	–	348	29,9	44	3,8
Poarta Alba	591	331	56	80	13,5	150	25,4	30	5,1
Săcele	832	334	40,1	–	–	326	39,2	172	20,7
Târguşor	1912	1003	52,5	197	10,3	697	36,4	15	0,8
Tortomanu	964	245	25,4	292	30,3	427	44,3	–	–
Vegas	–	–	–	–	–	–	–	–	–
Medgidia	1391	247	17,8	–	–	1144	82,2	–	–
ZONA II	**10674**	**5251**	**49,1**	**582**	**5,5**	**4280**	**40,1**	**561**	**5**
Independența	176	–	–	–	–	–	–	176	100
Peştera	868	40	4,6	93	10,7	435	50,1	300	34
Pietreni	2227	1323	59,4	331	14,9	573	25,7	–	–
Stupina	764	102	13,4	–	–	662	86,6	–	–
Vulture	619	–	–	–	–	–	–	619	100
Crucea	804	–	–	–	–	804	100	–	–
Hârşova	463	463	100	–	–	–	–	–	–
Saraiu	–	–	–	–	–	–	–	–	–
ZONA III	**5921**	**1928**	**32,6**	**424**	**7,1**	**2474**	**41,8**	**195**	**18,5**
Adamclisi	209	–	–	–	–	–	–	209	100
Băneasa	673	482	71,6	–	–	191	28,4	–	–
Cernavodă	1278	144	11,3	11,3	0,8	1021	79,8	–	–
Ostrov	2324	1185	51	7	0,3	1124	48,4	8	0,3
ZONA IV	4484	1811	40,7	120	2,7	2336	52,1	217	4,8
TOTAL JUDEȚ	**28066**	**12303**	**43,8**	**1132**	**4,1**	**11502**	**41**	**3128**	**11,1**

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