

## FROST AND THAW - CLIMATIC RISK TO CROPS IN SOUTHERN DOBRUDJA

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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.*

**Key words:** *Dobrudja, frost, thaw, risk*

### INTRODUCTION

The risk factors and climatology aspects in Dobrudja (including frost and thaw), have been researched on papers written by D. ȚĂȘTEA etc. (1967), I.F. MIHĂILESCU (1986, 1999, 2001), BOGDAN OCTAVIA (1978, 1996, 1999), S. CHIULACHE AND NICOLETA IONAC (1995), CR. PALTINEANU etc. (2000), M. LUNGU (2009).

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 synoptic processes that favor the most frequent winter thaw in Dobrudja belong to the tropical and western circulation of oceanic type (LUNGU, 2009). 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.

### MATERIAL AND METHODS

The analysis of frost and thaw in Dobrudja is based on the data obtained from the observations accomplished in six meteorological stations between 1965 and 2005 (figure 1). Its purpose is the climatic characterization of the regime, of the occurrence probability (in the representative landscape points, with relatively complete recordings) and of its territorial distribution.

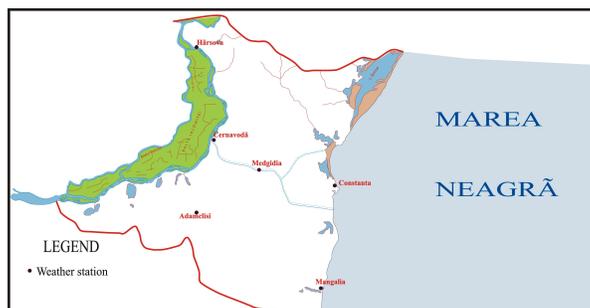


Figure 1: Repartition weather stations in southern Dobrudja

### RESULTS AND DISCUSSIONS

Frost and thaw are among the phenomena which adversely affect different economic activities. They have particularly harmful effects on agriculture. Thus, late spring frosts causing interruption to plant vegetation period and the early winter crops leading to compromise. In turn, thaw, accompanied by sudden melting of snow, jeopardize autumn sowing or contribute to accelerating soil erosion.

For climate risk assessment should be started from climatological data series of minimum air temperature in a given location. An observation period of 41 years (1965-2005) is sufficient to allow the analysis to be made at a time scale of a decade, which is appropriate in practical terms because of uncertainty in determining the occurrence of phenological stages. The main parameters characterizing the frost and thaw in South Dobrudja are: **The average duration of freezing.** Days with frost (minimum temperature  $\leq 0^{\circ}\text{C}$ , recorded between October to April, being most numerous in January and February.

The first frost occurs on average in the last decade of October in the western half of the region and the first decade of November, in the east, which is delayed by one month. In the cold season and especially in winter, the thermal influence of the Black Sea water, warmer than the earth's surface, is felt most strongly on the seaside. This influence is evidenced by a series of characteristics of air temperature regime of the cold season, frost and thaw being part of them.

Thus, the average annual frost period increases from approx. 2 months on the Black Sea, to approx. 3 months in the western region, the Danube. The largest average duration of frost-free interval in our country is in South Dobrudja, the coastal area totaling 225-230 days (229 days Mangalia), and in Central and West 200-225 days (215 days Adamclisi).

The average duration of the freezing is within the range of 135-140 days per season (lowest in the country) and 140-150 days in most of South Dobrudja Plateau.

**Annual average duration thaw.** Thaw distribution, which are preceded by a period of stable ice, are also characterized by a concomitant increase in frequency with increasing distance from the seaside and high altitude of relief, in Southern Dobrudja, in Mangalia, annual average length is only 16 thaw days, compared with 21-23 days as recorded in other coastal meteorological stations in the sector. Short duration of Mangalia's thaw is explained by the reduced intensity of frost accented stable under thermal influence of the Black Sea, reaching the highest depths and has the largest reserves of heat along the Romanian coast. In South Dobrudja, average thaw duration is between 33 and 36 days, with a maximum of 40 days in high relief from the southwest.

**Frost frequency.** For easier comparison, the variation frequency of frost at the meteorological stations within the South Dobrudja was presented simultaneously with meteorological stations in the coastal sector, situated at altitudes close as possible.

Moderator effect of the water surface over the frost it's also in areas where large lakes are found in (Tatlageacul Mare, Techirgiol, Mangalia).

Territorial contrast most pronounced in the production of frost is observed during sunny weather, when the radiating heat energy transformation expresses faithfully the existing differences in the structure of the active surface. This follows from the comparison of records made in January at weather stations Constanta, Valu lui Traian, Medgidia and Hârşova, forming an approximate profile cross between eastern and western extremity of South Dobrudja. Moderator effect of seawater is felt on coastal even during covered days when there is the lowest frequency of adverse minimum temperatures compared to the inner stations. In Constanta, during sunny weather, the minimum frequency of air temperatures, with values between  $-10$  and  $-20$  ° C over 2 times lower than Hârşova, located on the Danube, the minimum air temperatures of  $-10$  ° C -  $-20$  ° C are related to winter anticyclone. They are associated, usually in Constanta, with larger daily values of global radiation of 150-200 kcal/cm<sup>2</sup> / min., which are most common in sunny weather.

On cloudy days, most pronounced territorial contrast moves to minimum temperatures ranging between  $0$  -  $10$  ° C, also associated most frequently with the values of global radiation 150-200 cal/cm<sup>2</sup> / min.

**Thaw frequency.** Maximum frequency of thaw during 1965-2005 periods was observed in February. In this month, as in March, the gap is most pronounced among lower frequency of thaw in coastal sector and increased frequency of thaw (due to extension of frosts) high from the relief.

Thaw frequency increases from the seaside, with increasing distance from the seashore and the altitude relief, especially for small ranges, 1-5 and 6-10 days. In contrast, the seaside meets the highest frequency of long intervals with thaws over 20 days; here, under the caloric influence given by the sea water, freezing is harder to achieve compared to the rest of

Dobrudja. An example of the influence of local thermal inversions is the high frequency of frost from meteorological station Valu lui Traian, located at the distance of approx. 16 km of coast, on the bottom of the valley Carasu compared with meteorological station of Medgidia, located just 30 km from coast, but at an altitude of about 20 m higher, on a terrace of the same valley. In conclusion, territorial distribution and frost, thaw and rime regime within Dobrudja, caused by the thermal moderating influence of the Black Sea, is characterized by a pronounced reduction in the average and upper limit duration.

In South Dobrudja, in the west and on the high plateau relief the frequency of short term thaws and long term frost increases.

Local thermal inversions diminish sea influence, favoring increased frost frequency, especially on bottom valleys even if they, but their physical and geographical position are relatively close to coast.

Table 1  
Size and structure of disaster areas on risk factors in South Dobrudja ( 1995 – 2005)

Location	Average the affected area (average of 10 years)	Din care:							
		Hail and torrential rain		Flooding		Frost and thaw		Other factors	
		ha	% of the affected area	ha	% of the affected area	ha	% of the affected area	ha.	% of the affected area
Agigea	150	-	-	-	-	158	100	-	-
Albești	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
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	-	-
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
Târgușor	1912	1003	52,5	197	10,3	697	36,4	15	0,8
Tortomanu	964	245	25,4	292	30,3	427	44,3	-	-
Medgidia	1391	247	17,8	-	-	1144	82,2	-	-
Peștera	868	40	4,6	93	10,7	435	50,1	300	34
Pietre ni	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	-	-
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
<b>Total South Dobrudja</b>	<b>28066</b>	<b>12303</b>	<b>43,8</b>	<b>1132</b>	<b>4,1</b>	<b>11502</b>	<b>41</b>	<b>312</b> <b>8</b>	<b>11,1</b>

The most dangerous frosts, thaws and rimes are those that occur outside their season, during transition seasons from winter to summer and vice versa, when there is an alternation of cold air advections from the north with the warm air ones from the south until the predominantly type of movement is established for that season. In the meantime, they can take on the aspect of climate risk that may endanger the crops, vegetables , fruit trees and vines in early stages of development, or to their end, creating chilblains, sometimes quite serious taking into account their resistance to frost which can affect peoples crops.

If spring frosts, temperatures recorded in meteorological shelter is not good enough as a reference for plants. A thermometer placed in the same conditions, but the exposed parts of plants, unprotected radiation provides information closer to reality than the thermometer in the weather shelter.

In South Dobrudja, between 1995-2005, frosts and thaws have brought great harm to agriculture, leading to the calamity of no less than 11,502 hectares, representing approx. 41% of the total area of climate risks disaster (table 1), which highlights the special impact on the economy of these hydrometeors in Dobrudja.

### **CONCLUSIONS**

Under certain conditions, the frost and thaw are climatic risk for agriculture South Dobrudja. Mention of these conditions:

- When they take place outside their season with 2 -3 weeks in early autumn or late spring compared with average data (frost);
- When the region is exposed to direct cold air advection;
- When the air is very cold, coming from the arctic;
- When they have mixed origins (Advection - radiative);
- When frost is recorded both on land and in air;
- When the oceanic type of tropical and zonal circulation takes place;

This study shows that the coastline is less affected by frost and thaw (average duration is about two months / 16 days) compared with the central and south-west part (about three months a year / 21-23 days) Therefore scale damage on agricultural land increases as the distance to seaside increases (eg 1144 ha. Medgidia calamity in the central town area, 135 ha. Mangalia)

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