PRESENT ENVIRONMENT AND SUSTAINABLE DEVELOPMENT, VOL. 6, no. 2, 2012

# CONSIDERATIONS REGARDING THE CLIMATIC POTENTIAL FOR AGRICULTURAL ACTIVITIES IN DOBRUJA

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**Key words:** agro-climatic zone, Dobruja, hydric resources, thermal resources

**Abstract.** Knowing the activity of the climatic factors, their direction and intensity in action is of real use in perfecting the development of agricultural production, the improvement of territorial distribution, and the differentiated application of the culture systems and of the agro-phyto-technical measures, as well as in the scientific organization of production and agricultural labor. Dobruja as a whole belongs to the agro-climatic zone 1 – warm-dry – generally characterized as the region with most generous thermal resources, but also with the poorest water resources.

## Introduction

Dobruja belongs as a whole to the agro-climatic zone I – warm-dry – generally characterized as the region with the most generous thermal resources, but also with the poorest hydric resources.

Knowing the activity of the climatic factors, their direction and intensity in action is of real use in perfecting the development of agricultural production, the improvement of territorial distribution, and the differentiated application of the culture systems and of the agro-phyto-technical measures, as well as in the scientific organization of production and labor. The two major climatic elements, temperature and precipitations, though displaying some differentiations, do not influence in particular the level of the crops, at least in terms of the species cultivated not only in Dobruja, but also in the entire agro-climatic zone I (the

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south-east of the country). At the most, for some species of fruit trees and grapevine, sunnier positions can be identified or lacking cold currents in spring.

*Temperature*. The annual average varies between 10.4°C in the north-west of the region and 11.4°C in the south-east. In what regards the temperature, the littoral zone, meaning a strip of land measuring 10-15 km west of the seashore, benefits from the highest average temperature, over 11°C, but especially from higher atmospheric humidity. This latter element diminishes to some extent the scorchers at the end on June and beginning of July, favoring the normal maturation of autumn cereals, but also the fruit yielding processes (pollination and fecundation in maize and sunflower). Also, the same littoral strip benefits in autumn from the sea thermostatic effect, prolonging the vegetation season with 10-15 days and favoring thus the cultivation of maize and sunflower hybrids that last longer and are thus more productive. The same phenomenon protects the vegetable crops against the early autumn frost. All these spatial differences in regard to the thermal distribution do not exclude Dobruja from the great agro-climatic zone I, warm-dry, whose thermal parameters are between 3700-4300°C – the sum of temperatures above 0°C (fig. 1), and 1400-1750°C – the sum of actual temperatures above 10°C (fig. 2). At the level of the entire territory of Dobruja, this amplitude of the thermal resource permits, in spite of all these, a sufficient zonal differentiation, which in turn will materialize into distinct productivities of the respective territories.


Fig. 1 - The distribution of the sum of daily average temperatures over 0 °C, in Dobruja (1965-2005)

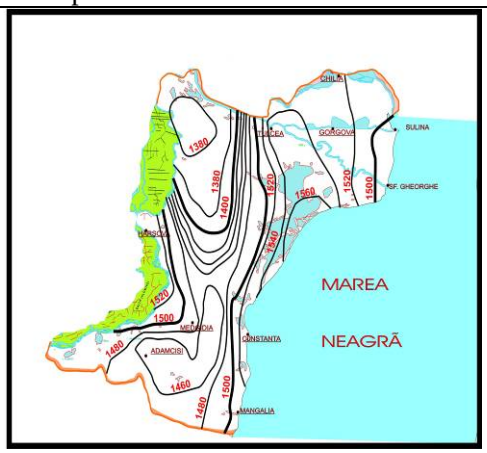


Fig. 2 - The distribution of the sum of daily average temperatures over 10 °C, in Dobruja (1965-2005)

*Precipitations*. As shown before, Dobruja as a whole is sectioned from north to south by the isohyet of 400, which separates the same littoral zone from the rest

of the county territory. East of this line, the average annual precipitations are between 350-400 mm/year, while west of this line they are between 400-450 mm/year. Transversally, east of the mentioned isohyet, precipitations decrease from west to east, while west of this isohyet they increase from east to west. However, the spatial distribution of precipitations is not as linear as that of temperatures. The differences in regard to precipitations are small (20-30 mm) and they do not influence the zonal productivity as a whole, but they can have a beneficial effect when they occur in the most critical time for one crop or another. For example, in 2003 the autumn crops were practically compromised because of the total lack of precipitations during the first half of the year (1153 kg/ha for barley, but 2635 kg/ha for maize). The final conclusion on the distribution manner of the main climatic elements is that their territorial distribution in Dobruja permits the establishment of sufficiently distinctive productivity areas for the formation of differential ground rents based on the climatic favorability.

## 1. Material and method

For the analysis of the agro-climatic potential of Dobruja, the main climatic elements (air temperature, precipitation, air humidity) were taken into account based on the data resulted from the recordings of 18 weather stations and 23 rainfall stations, fig.3.

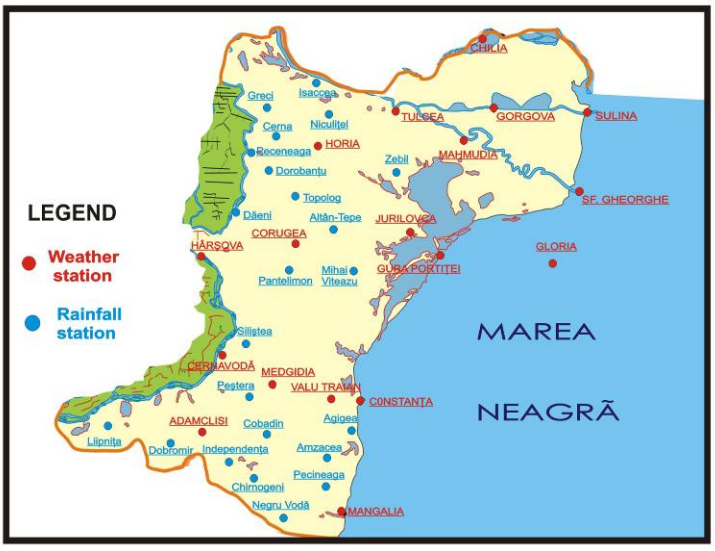


Fig. 3 - Location of weather stations and rainfall stations in Dobruja studied to assess the climatic potential

**2. Results and discussion**

In Dobruja, due to the existing soil and climate conditions, the main cultivated plants are wheat, maize and sunflower. Alongside these, crops such as rape, sugar beet, soy, grapevine, fruit trees, potato and others are cultivated on small fields. Based on the information already mentioned, we elaborated a study about the correlation between the existing climatic potential (especially temperature and rain) and the climatic demands of wheat, maize and sunflower.

***2.1. Sunflower***

*Climatic demands*

•*Temperature*. Sunflower is a mesothermal plant and it requires 2400-2800°C over the entire vegetation period, with daily temperatures above 0°C. Higher productions can be encountered in areas where the sum of temperatures over 0°C exceeds 2500°C. If the biological threshold of 7-10°C is taken into account (the sowing period for sunflower), then the sum of useful temperatures (daily degrees useful for growing) for the different types cultivated in the country is between 1450-1600°C. The temperature requirements of the plant are between *14-18°C* but they are different over the vegetation period. Thus, the minimum germination temperature is 3-5°C. When the leaves are formed, sunflower requires daily average temperatures of 15-18°C, while during the flower differentiation period, the most favorable temperatures are 18°C during the day and 8-9°C at night. When it blooms, sunflower requires moderate temperatures of 18-20°C. Temperatures above 30°C are very harmful because they lead to the loss of pollen vitality and thus to an increase in the percentage of dry seeds. High temperatures are more harmful when they are associated with dry winds and relatively low air humidity. This phenomenon occurred in the summer of 2007 on large surfaces in Dobruja when, because of very high temperatures associated with the lack of soil water and low air humidity, the sunflower crops suffered important losses. The plants remained small, with small calathidia, an extremely reduced number of seeds per calathidium, and very many dry seeds. The plants reached maturity very early (shortened vegetation period).

When the seeds are formed and filled, sunflower requires temperatures of 20-22°C. Higher temperatures lead to the reduction of the fat content and their quality is altered, meaning that the content of linoleic acid decreases and the content of oleic acid increases. As shown in fig. 4, the thermal conditions are met in this space, which makes Dobruja one of the main culture zones in Romania.

•*Humidity*. Even though sunflower has high water consumption, the transpiration coefficient being 290-705 depending on the environment conditions, it is still one of the most resistant plants (in terms of hydric requirements) due to its strongly developed roots and to the fact that the plants can withstand the temporary tissue dehydration caused by the drought. Sunflower's resistance to drought (a

frequent phenomenon in Dobruja) is also given by the plant porosity and the stem marrow which stores water.

The humidity requirements vary according to the vegetation stages. From emergence to inflorescence, sunflower consumes only 20% of the total water requirement during vegetation. From inflorescence to the beginning of blooming, it consumes approximately 30% of the total water quantity, then 14% during blooming. For the period during which sunflower forms and accumulates deposits of nutritive substances, it consumes 35% of the total water amount from the vegetation period (March-August) of the sunflower culture, in Dobruja(1965-2005).

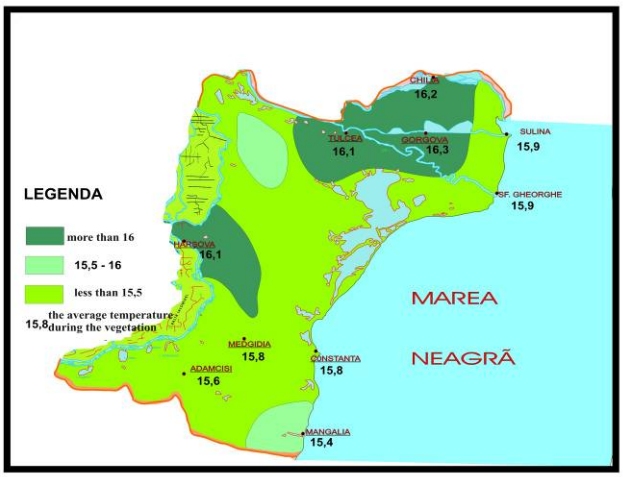


Fig. 4 - The distribution of the average temperature of the air (°C) from the vegetation period (March-August) of the sunflower culture, in Dobruja(1965-2005)

In order to realize high productivity, between blooming and maturity, the plant requires 150-200 mm of water. A final consumption of 400-450 mm is reached for the entire vegetation period (March-August). However, these conditions, as table 1 shows, are not met in Dobruja, which is why improvement works (irrigation) are necessary to supplement this deficit. The graph corresponding to the pluviometric deviations (depending on the vegetation period requirements, fig. 5) was realized based on table 1 and it was observed that the areas with the highest favorability degree are in the central-western part, where the deviations are below -190 mm. For sunflower, it was established that there is a strong correlation between the precipitation quantities in September-April, accumulated as water reserves in the soil. The deficit of humidity in the soil at

sowing time cannot be compensated by a larger quantity of precipitations during vegetation.

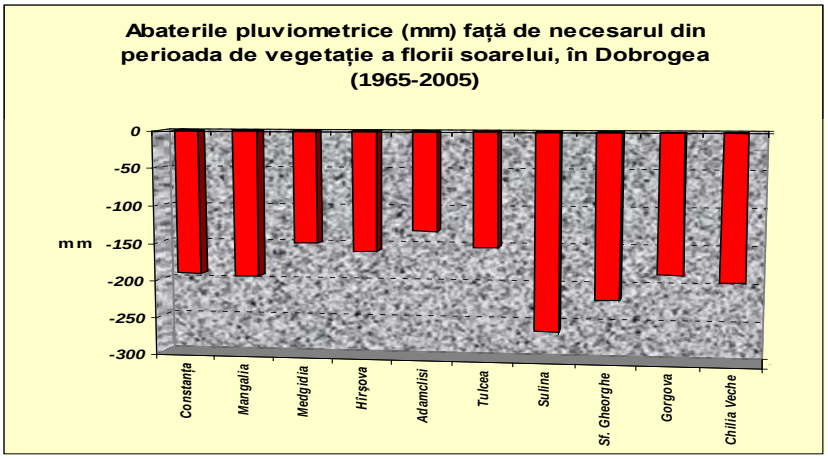


Fig. 5 - The pluviometric deviation (mm) of the necessary amount from the vegetation period of the sunflower, in Dobruja (1965-2005)

Tab. 1- Average monthly quantities corresponding to the vegetation period of sunflower (mm) in Dobruja( 1965-2005)

| **Station** | **III** | **IV** | **V** | **VI** | **VII** | **VIII** | **The Vegetation Periods** |
|---|---|---|---|---|---|---|---|
| Constanța | 30,9 | 31,1 | 36,1 | 45,3 | 32,3 | 33,3 | **209** |
| Mangalia | 28,9 | 34,6 | 33,7 | 38,9 | 34,6 | 35,8 | **206,5** |
| Medgidia | 24,8 | 32,7 | 47,8 | 54,5 | 49,1 | 42,4 | **251,3** |
| Hârşova | 25,5 | 29,6 | 47,2 | 51,7 | 49,2 | 38,4 | **241,6** |
| Adamclisi | 32,0 | 38,1 | 47,7 | 62,8 | 46,2 | 42,9 | **269,7** |
| Tulcea | 30,9 | 34,8 | 43,3 | 55,4 | 49,5 | 34,7 | **248,7** |
| Sulina | 14,8 | 18,2 | 24,8 | 27,1 | 25,5 | 28,9 | **139,3** |
| Sf. | 24,1 | 24,6 | 29,3 | 29,8 | 32,9 | 41,7 | **182,4** |
| Gorgova | 27,9 | 29,6 | 38,6 | 44,3 | 39,5 | 36,6 | **216,5** |
| Chilia | 19,1 | 29,6 | 34,0 | 48,2 | 35,6 | 40,5 | **207** |

Tab 2 - The average production obtained in sunflower in Romania and the county of Constanta in 2005

| *Year* | ***Romania*-kg/ha-** | **The Constanța County-kg/ha-** |
|---|---|---|
| ***2005*** | ***1381*** | ***1661*** |

* according to the Statistical Year Book of Romania, 2006

•*Light*. Sunflower is a plant with high demands for light, a condition met in the analyzed space, where sunshine during the vegetation period exceeds in all stations 1300 hours. The leaves heliotropism, very strong in sunflower, constitutes an element that justifies its high demands for light and light intensity. The plants are very sensitive to light when the first pair of true leaves emerge. If the leaves are shaded at this time, the stems elongate and the leaf surface diminishes. The elements mentioned above lead to the conclusion that Dobruja (especially the central-southern area) is a very favorable space for the cultivation of sunflower, the climatic resources also determining a superior productivity compared to the country average (table 2).


Fig. 6 - The ecological map of the sunflower in Dobruja (1965-2005)

As a conclusion, we can say that Dobruja is a space where sunflower finds both climatic and soil conditions that are favorable on almost 80% of its surface (with the exception of the Danube Delta, where dominant are flooded surfaces and

sandy soils, the littoral area with sandy soils and high anthropic degree, the Macin Mountains and the central-western side), fig. 6.

***2.2. Wheat.*** Wheat, the main plant in Dobruja, is one of the oldest crops in this region, a fact proven by the old and new archaeological discoveries in Constanta (Tomis), Mangalia (Callatis), Harsova (Carsium) and other ancient towns.

*Climatic requirements.* The vegetation period of autumn wheat, in the conditions of Dobruja, is generally between 270-300 days (sowing is done after October 1 and harvesting takes place at the end of June). In this long vegetation period, autumn wheat is affected by the climatic factors in a very large amplitude variation.

• *Temperature*. Wheat yields high productions in areas where the temperature is low at the beginning of the vegetation period, moderate during the intense growing stage and high in the ripening period. During the vegetation period, (October-June), the optimal average temperature is between 7-10ºC, but it varies considerably in each development stage. Thus, germination in wheat begins at 1-2ºC, tillering and retardation (accumulation in cells of large quantities of sucrose, glucose, and fructose) at 8-10ºC, earing at 16-18ºC, blossoming and pollination at 16-20ºC. These conditions are met to a large extent, which makes the given territory one of the main culture zones at national level (Fig. 7).

• *Atmospheric precipitations.* Due to the fact that wheat vegetation period includes the richest months of the year in precipitations, this culture values better than others the natural fertility of the soil, the fertilizers used and the superior level of the agricultural works. By examining the territorial distribution of atmospheric precipitations in Dobruja over the entire vegetation period of wheat, it can be observed that the lowest level (250-300 mm) is recorded on a strip that includes the Black Sea littoral and the Danube Delta. The same quantity of precipitations falls around the town of Medgidia, as well as in the centre and north-west of the province (fig. 8).

On the largest part of the arable territory, precipitations fall in the vegetation period (300-350mm), except the south-western corner of the county of Constanta, the center and the north-western part of the county of Tulcea, where the values recorded are over 350 mm. we must mention that this last zone includes very rough fields, covered for the most part by forest vegetation with forest soils with poor fertility. The prolonged drought, accompanied by strong scorchers at the end of June, usually finds wheat in the full maturity phase or as it is being harvested. This makes autumn wheat a sure crop in Dobruja, compared to the spring cereals which reach maturity later and are thus more affected by the summer drought. Because the vegetation period of wheat includes the richest months in precipitations, this

crop values the natural fertility of the soil, the fertilizers, as well as the superior level of the agrotechnical works better than the other agricultural plants.

*The natural zones for the production of wheat in Dobruja.* The ecological studies of plants, the harvests obtained in different cultures in certain geographical areas show a tight connection between the natural conditions (especially climatic) and the accomplished productions. In an attempt to materialize the connection between the climatic resources and the wheat production, we extracted the average yield/ha in all the agricultural units in Dobruja between 2000 and 2005. Moderate average productions, on communes, were put on a map, depending on the categorization (according to the level of production).

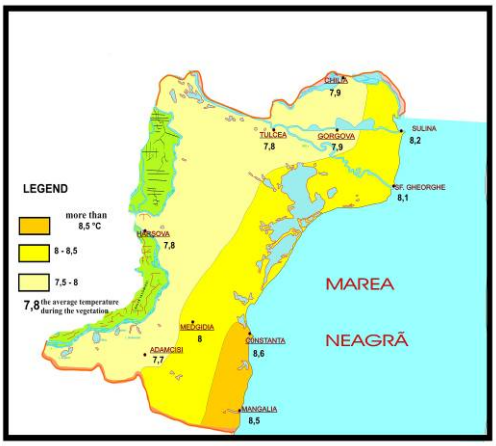


Fig. 7 - The distribution of the average temperature of the air (°C) from the vegetation period (October-June) of the wheat, in Dobruja (1965-2005)

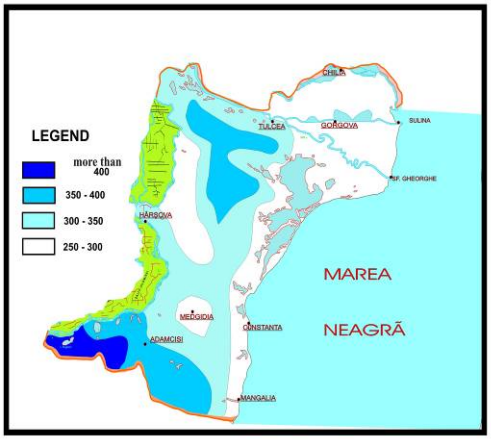


Fig. 8 - The distribution of the average precipitations (mm) during the vegetation period of the wheat, in Dobruja (1965-2005)

Thus, we noticed that the average productions oscillate within generous limits. This amplitude, between 1500 and 3500 kg/ha, is mostly explained by the natural zoning of this crop. Starting from this element, the territory of Dobruja can be divided into three natural ecological zones: zone I with the highest level of production, where the agricultural units obtain 2500-3500 kg/ha; zone II with an average production between 2000-2500 kg of wheat/ha, and zone III with the lowest production, between 1500-2000 kg/ha.

The extra deviations to the accomplished mean in the respective area can be explained, apart from the low thermal and pluviometric favorability, by the use of larger quantities of fertilizers, a wiser choice for previous plant, a better structure of the cultivated soils etc. At the same time, the minus deviations are explained by

the insufficient exploitation of the materials and by the inadequacy in the application of production technology etc.

The most favorable zone for wheat was, between 1965 and 2005, the south-east of Dobruja (Navodari, Mangalia), with a width of 20-40 km (fig. 9). In its western part, this zone includes the following localities: Independența, Negreşti, Cobadin, Medgidia and Castelu. The average productions obtained here were 2500-3500 kg/ha. In the agricultural area corresponding to Cobadin, Comana, Tataru, Agigea, Amzacea and others, the average wheat productions were 3500-4500 kg/ha. This area also includes an "island" from the central part of Dobruja, made up the Fântânele, Râmnic, Cogealac, Nalbant and Nicolae Bălcescu. This area, as we concluded from the study of climatic requirements, has the highest climatic favorability, determined largely by its proximity to the sea.

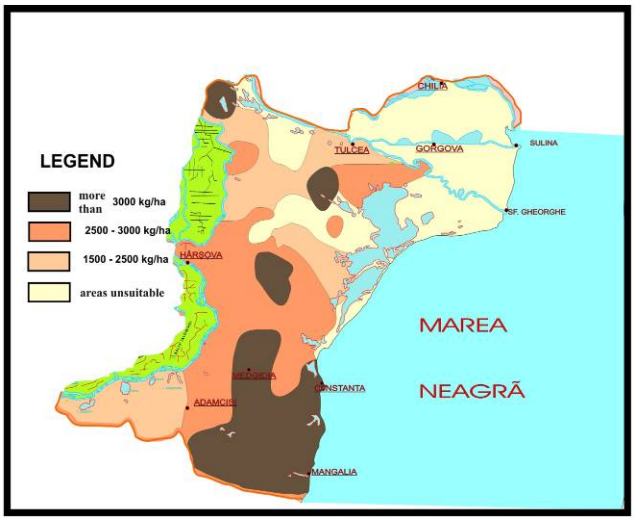


Fig. 9 - The production zones of wheat, in Dobruja (1965-2005)

Thus, the southern Black Sea littoral is characterized by a moderate climate with long and warm autumns and winters with high temperatures, which favors in autumn a prolonged vegetation of wheat, which determines stronger tillering and roots. Air temperature in winter is higher than in the other areas, which contributes to a rich vegetative growth. This is helped by the relatively higher air humidity, which makes the plants suffer less from the drought during dry periods and which also protects wheat against shriveling when the seeds mature.

The influence of the maritime climate is manifested on a limited area, whose width does not exceed 10-15 km. This is because the Black Sea represents a relatively small body of water and the hot and dry summer winds, as well as the

cold and dry winter winds, blow with intensity reducing significantly the moderating effect of the water mass. This is why the influence of the maritime climate is almost inexistent in the northern part of the Black Sea littoral, especially in the proximity of the lagoon complex Razim-Sinoe. Also, in the mentioned area, the leached and brown chernozem with high natural fertility that give high production.

In the pedological and climatic *favorability zone I* for wheat cultivation, especially Topraisar Plateau and Cobadin-Negru Voda, a more abundant pluviometric regime is encountered (with an annual average of 450-500 mm and even over 500 mm and with a uniform distribution of precipitations in the wheat vegetation period). On the agricultural fields in the proximity of Medgidia, the high productions are generally explained by the irrigation system. Actually, all the areas with high productivity (over 3000 kg/ha) are equipped with irrigations.

*The second favorability zone* (2500-3000 kg/ha) for wheat occupies a larger surface (fig. 8). This zone includes Pestera, the central part of Dobruja (from the Danube to the sea), but also a strip of land close to the marine lakes in the county of Tulcea. It is characterized by plane lands or slightly waved in the south and center of the province, as well as fragmented on the right bank of the Danube. The brown chernozem is dominant, but there are also light brown steppe soils and carbonate brown chernozem, while chernozems in different stages of leaching are found in the depressions. The degree of climate continentality in this area is stronger in the west than in the east. Thus, the annual mean of precipitations is between 400-450 mm, while the relative air humidity is similar to that in Baragan Plain. The particularly high wind intensity of north winds accentuates even more the continental character of the climate.

*Zone III*, with average productions of 1500-2500 kg/ha, overlaps the south-west part of Dobruja (Rasova-Băneasa-Ostrov), as well as the Măcin–Babadag Massif.

***3.3. Maize.*** Maize (Zea mays L.) is one of the most valuable plants cultivated in Dobruja because of its high productivity and multiple uses in people's alimentation, in husbandry and industry. Its particular importance is also given by other advantages of its cultivation: it gives high productions, the harvests are more reliable than other plants as it withstands drought and has few diseases and pests. Maize loves the heat, its temperature demands being obvious from the stage of germination, which takes place at minimum 8-10°C. These conditions are met over the entire surface of Dobruja, in April (germination time – all meteorological stations recorded values above 8°C (Constanța 10°C, Sulina 9.6°C, Tulcea 10.6°C etc.). In May, the temperature must be above 13°C and 18°C when the panicle emerges. After that, till the occurrence of the tassel and during fecundation, it requires 22°C. When the seeds are formed, the temperature can decrease to 19°C,

and during their maturation, even to 15°C. Thus, in the vegetation period (April-September) an average temperature of 16-19°C is needed. This thermal condition is met on the entire surface (fig. 10). Temperatures lower than those indicated for the vegetation stages mentioned above lead to the delay of vegetation and the accentuated decrease of production. At 5°C, plant growth stops and frost (even light) destroys the leaves. Even though it has a reduced specific consumption, needing only 300 units of water for one unit of dry substance, maize has considerable humidity requirements, rewarding with increased productions the surplus of water from rain of irrigations. In Dobruja, even though the pluviometric conditions are not met for the most part, the large surfaces cultivated with maize can be explained by the fact that this plant can easily withstand the drought occurred during the first vegetation stages, when the humidity demands are low. The most serious production reductions are recorded in maize when it lacks water in the first 1-2 weeks from the occurrence of the male inflorescence and maturity, a period which lasts for about 5-8 weeks (depending on the hybrid). This is when maize has the highest water consumption (500% of the entire water consumption during the vegetation period). Maize has increased demands for light and does not tolerate prolonged shading.

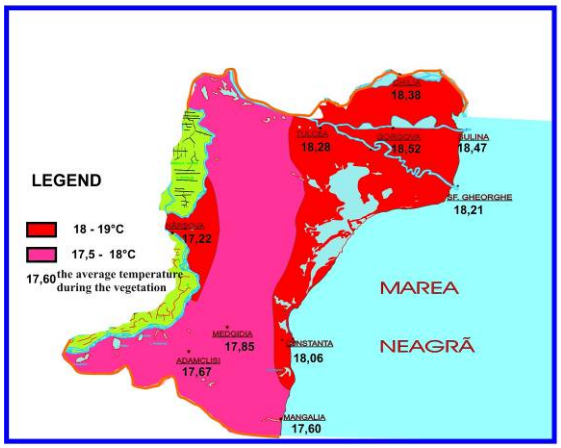


Fig. 10 - The territorial distribution of the average temperature of the air (°C) from the vegetation period of the corn (April-September), in Dobruja (1965-2005).

**Conclusions**

Dobruja region stands out through its specific meteorological conditions, defined by the physical- geographical characteristics of the territory.

The final conclusion on the distribution manner of the main climatic elements is that their territorial distribution in Dobruja permits the establishment of sufficiently distinctive productivity areas for the formation of differential ground rents based on the climatic favorability.

**Acknowledgements**

Cordial thanks to prof. Apostol Liviu, and prof. Sterie Ciulache, climatologists renowned specialists for helpful advice and logistical support provided and Agricultural and Rural Development of the Constanta County Council, for valuable information provided.

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