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CLIMATE TRENDS IN OLTENIA. CASE STUDY: CRAIOVA - BANU MĂRĂCINE

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Abstract

Climate is the result of the interaction of biotope factors. It is important for cultivated plants because it ensures the passage of the vegetation phases. Climate change may require the adaptation of cultivation technology, the change of varieties or the modification of the cultivation area. For this reason, the paper studies the evolution of the climate in Oltenia, a historical region located in the south-west of România. This region is important from an agricultural point of view (cereals, grapevine, vegetables). This study is based on weather records (e.g. hours of sunshine, annual rainfall, monthly precipitation, average monthly temperature, average annual temperature) over a long period of time, obtained from the Craiova weather station. In order to show the climate trend in Oltenia, the statistical indices of the data series were calculated (e.g. arithmetic mean, standard deviation, coefficient of variation). The thermic and water resources of a territory can be important for characterizing the existing climate. As a result, the values of these climatic factors were used to calculate two ecological indicators: the Martonne`s aridity index and the Lang`s humidity index. The obtained results were included in the tables and represented graphically and show the evolution of the climate in Oltenia over the last fifty years.

Key words: *climate, monitoring, trend, agroecology.*

INTRODUCTION

The climate is the result of the interaction of biotope factors. The change in the composition of the atmosphere, highlighted by the change of the concentration of some gases, such as carbon dioxide, disturbs the existing equilibrium. Studies on this topic show that climate change is not observed only at local level, but it affects the entire planet, with different intensities. For example, aridization phenomena have been reported in the area bordering the Black Sea, namely in the Republic of Moldova (Ivanov, 2017), in the Dobrogea region of Romania (Ionac et al., 2015), in Turkey (Deniz et al., 2011) or in Serbia (Ruml et al., 2016). The increase of the influence of the Mediterranean climate was highlighted in the Oltenia region (Romania) (Marinică et al., 2016).
The consequences of such evolutions manifest on many levels. From an economic point of view, the agriculture is one of the most affected sectors. For the horticultural sector, reductions in the content of substances responsible for the quality of wine production were reported, as well as a quantitative reduction in production (Fourment et al., 2013, 2020; Matei et al., 2009). In this regard, Marković et al., 2015, show that the grapes flavour accumulates in smaller quantities in the years when the average temperature in the growing season is higher compared to the multiannual average. The viticultural climate, as a whole, is evolving, with a tendency to increased temperatures in the northern viticultural area of Romania, for example (Bucur et al., 2016).
For other types of agricultural ecosystems, severe climatic risks have been identified (Roussos, 2020) caused by the early start of the vegetative stage of plants (Cojocaru, 2020).
In this context, there are studies that show that, as the temperature increases, evapotranspiration increases, the water deficit increases and the drought intensifies in irrigated areas (Vizitiu et al., 2019).

MATERIALS AND METHODS

The paper analyses the evolution of some climate indicators calculated based on the records from the Craiova weather station, where there is also located the Banu Mărăcine wine growing centre. The period under study is long enough to identify the climate trend in this horticultural area (1962-2019).

Specific indicators from meteorology, climatology (average annual temperature, annual amount of precipitation, duration of sunshine, etc.) and biogeography like Martonne aridity index, Lang index, Gams index, Dantin - Ravenga index, simple continentality index (Ivanov, 2017; Satmari, 2010; Vlăduț et al., 2017) were taken into account.

A series of statistical indices were calculated (arithmetic mean, rolling average, absolute amplitude, relative amplitude, root mean square deviation, standard deviation, coefficient of variation) and graphs were made that highlight the trend of the studied climatic factors. The Excel program ensured the fast and correct processing of the meteorological data. The interpretation of the obtained values and their correlation with the nature of the climate was made in accordance with the information from the literature (Patriche, 2009; Satmari, 2010; Vlăduț et al., 2017).

RESULTS AND DISCUSSIONS

The analysed time interval is large enough to ensure the characterization of the climate in Craiova - Banu Mărăcine and to indicate, at the same time, the dynamics and the trend. Figure 1 shows the evolution of the average annual temperature, the average temperature in July and the average temperature in January.

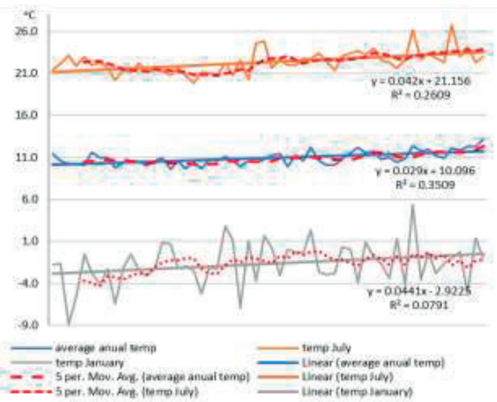

Figure 1. The temperature evolution in Craiova - Banu Mărăcine

Regarding the three series of values, the general evolution in time is highlighted, being noticed an upward trend. The data show a warming in the cold season (January) and in summer (July); the growth trend is lower at the annual level.

The dynamics of the hours of sunshine and annual rainfall recorded in the studied period is shown in Figure 2.

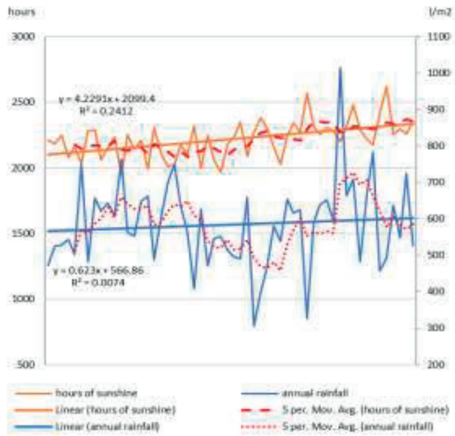

Figure 2. The evolution of sunshine hours and rainfall in Craiova - Banu Mărăcine

The trend is similar to that identified in the case of temperature. The data indicate a growth trend of helio-thermal resources, probably with a moderate general trend of increasing the annual amount of rainfall.

Taking into account all these data, it is advisable to consider the interaction of biotope factors, among which we can mention temperature and humidity, as important factors for the genesis and characterization of the climate.

As a result, Figure 3 shows the evolution of bioclimatic indicators calculated on the basis of the two factors mentioned above, namely the Martonne aridity index and the Lang index. They are important because they make a connection between the nature of the climate and the specific vegetation.

For Craiova, the trend shows slightly reduced values. This means a slow evolution of the climate, in the sense of moving from the warm temperate climate (Lang index: 100 - 60) to the lower limit of the semi-arid climate (Lang index: 60 - 40). It should be mentioned that in the time interval we are referring to, values characteristic for the steppe climate was also recorded (Lang index: 40 - 20) in a proportion of 8.9% of cases. All of them were reported mainly in the second part of the interval, starting with 1983.

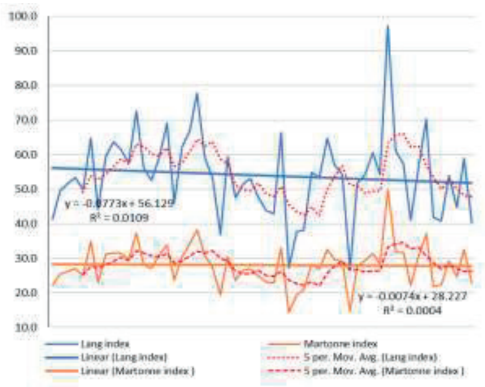

Figure 3. The evolution of the Lang and Martonne indices, in Craiova - Banu Mărăcine

The Martonne aridity index fluctuates from values that characterize the steppe and Mediterranean climate (Martonne index: 10 - 20) to values specific to the humid climate (Martonne index: 30 - 60).

The advantage of this indicator is that it ensures a more nuanced interpretation of the climate and its correlation with the type of vegetation. The data series that is dominant characterize the semi-humid climate (Martonne index: 20 - 30), closely followed by the values characteristic of the humid climate (Martonne index: min 30). As in the previous case, the semi-arid (Martonne index: 15 - 20) and arid (Martonne index: 10 - 15) years were reported when there are high helio-thermal resources amid low rainfall.

The cases were mainly reported in the second part of the considered interval, starting with 1983.

In addition, two more indices used for such studies were calculated, namely: the Gams index and the Dantin-Ravenga index (Figure 4). The Gams Index has a tendency to change values upwards and maintain zonal favourability for thermophilic species. There are rare cases (3.6%) in which the value of this index falls below 2 but they are common cases when they exceed 3 (50%).

The Dantin - Ravenga index also marks an upward trend, with higher values, which indicates a tendency of aridity of the area.

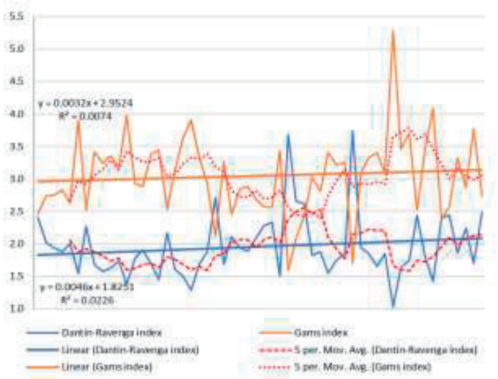

Figure 4. The evolution of the Gams and Dantin - Ravenga indices, in Craiova - Banu Mărăcine

Although the dominant one, in this case, is represented by the values that characterize the humid climate (Dantin-Ravenga index: 0 - 2), there is a trend of the last 25 years oriented towards the prevalence of higher values, specific to the semi-arid climate (Dantin-Ravenga index:> 2) and arid climate (Dantin - Ravenga index:> 3).

Summarizing the previous information provided by these indicators, in the form of average values of the analysed period, we can characterize the current climate; some indicators are also of viticultural importance (Table 1).

Table 1. The climate characteristics in Craiova - Banu Mărăcine

Indicator	Value	Characterization
Average annual temperature (°C)	10.9	Characteristic for temperate climate
Average monthly temperature July (°C)	22.4	Favourable area for obtaining wines with a controlled designation of origin
Average monthly temperature January (°C)	-1.7	-
Hours of sunshine	2219.9	Favourability for viticulture
Annual rainfall (l/m^2)	583.7	Favourability for viticulture
Lang index	53.9	Semi-arid climate
Martonne index	28.0	Semi-temperate climate, forest-steppe vegetation
Gams index	3.04	Climate favourable for thermophilic species
Dantin – Ravenga Index	1.96	Humid climate but at the limit of the semi-arid climate

For further characterization of the data, the variation indicators of the data series were calculated (Table 2).

If we refer to the relative amplitude, we find a similarity of the data to three out of the four climatic parameters. For annual rainfall, the variability is about four times higher than that of temperatures and hours of sunshine.

Table 2. The statistical indicators of the data series

Climate parameter / Statistical indicator	Average annual temperature (°C)	Average monthly temperature (°C) July	Annual rainfall (l/m^2)	The sum of the hours of sunshine (hours)
Absolute amplitude	3.50	6.96	707.84	679.8
Relative amplitude (%)	32.05	31.16	121.27	30.62
Alternative	0.64	1.82	14197.56	19724.30
Standard deviation	0.80	1.35	119.15	140.44
Coefficient of variation (%)	7.30	6.03	20.41	6.33

In fact, the coefficients of variation have close values, if we refer to the average annual temperature, the average temperature of July and the hours of sunshine, while, for humidity, the coefficient of variation has a value of about three times higher.

For this reason, we appreciate that in Craiova - Banu Mărăcine, the volume of annual rainfall varies within much wider limits than the temperature and hours of sunshine.

CONCLUSIONS

The analysis highlighted the dynamics of climate indicators in the studied area and the amplification of helio-thermal and water resources, but in a different way. The trend of the period is more pronounced, if we refer to temperature and hours of sunshine and it is lower, if we consider the volume of rainfall.

The dispersion indices show the temporal variation of the climatic elements, which in Craiova - Banu Mărăcine is higher in the case of rainfall, compared to the temperature and the sum of the hours of sunshine.

The interaction of biotope factors, expressed through the Lang, Martonne, Gams and Dantin - Ravenga indices, confirms the trend of climate aridization. In this context, there are climate challenges to which farmers will have to find adaptation solutions, in the short term, as well as in the medium and long term.

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