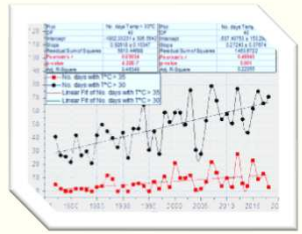
CLIMATE EVOLUTION AND TRENDS IN SOUTHERN ROMANIA AND IMPLICATIONS FOR VINE GROWING AND WINEMAKING

Mihaela BUCUR, Arina Oana ANTOCE George COJOCARU

University of Agronomical Sciences and Veterinary Medicine, Bucharest



INTRODUCTION

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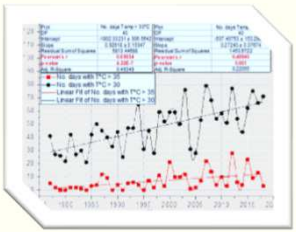
Grapevine is extremely sensitive to climate changes, therefore it is of great importance to follow the climate trends, in order to find solutions and adapt in due time



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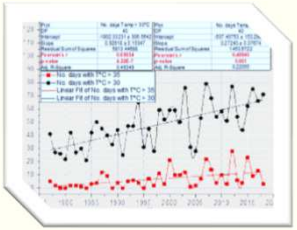
Thus, joining these efforts, the aim of this work was to investigate

- the **tendencies of 14 climatic parameters and 3 bioclimatic indexes**
- recorded in the vineyard of the University of Agronomic Sciences and Veterinary Medicine of Bucharest.

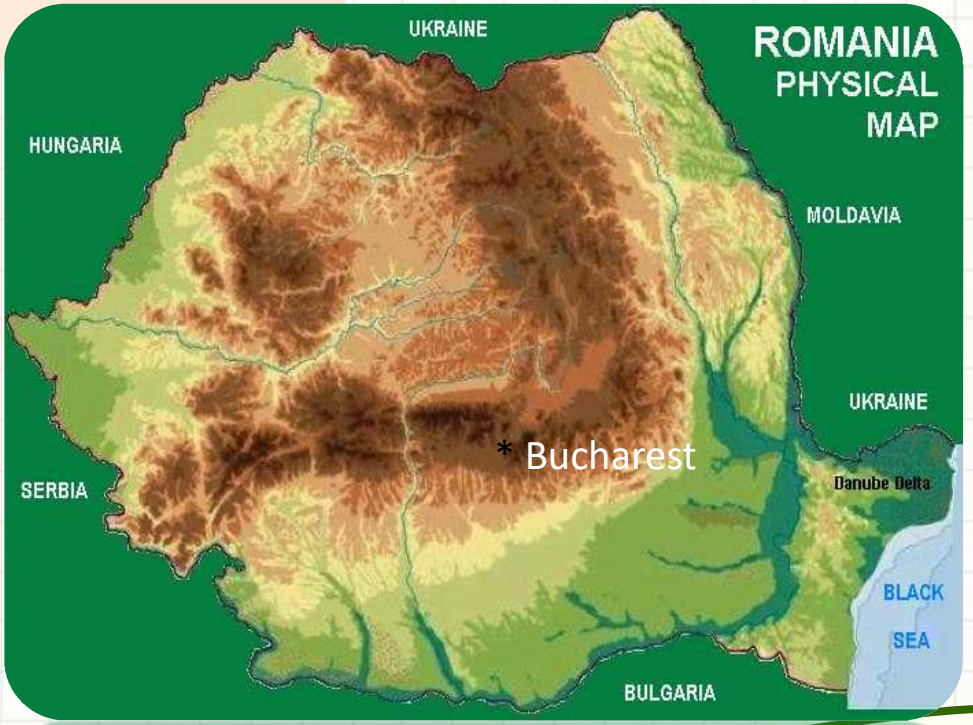
The climatic data allow the analysis of:

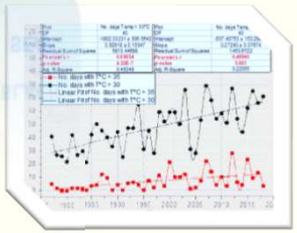
- *Climate evolution over a long period of time*
- *The characterization and quantification of global warming in the area of Bucharest…*



INTRODUCTION

…which is representative for the temperate continental climate of Southern Romania.



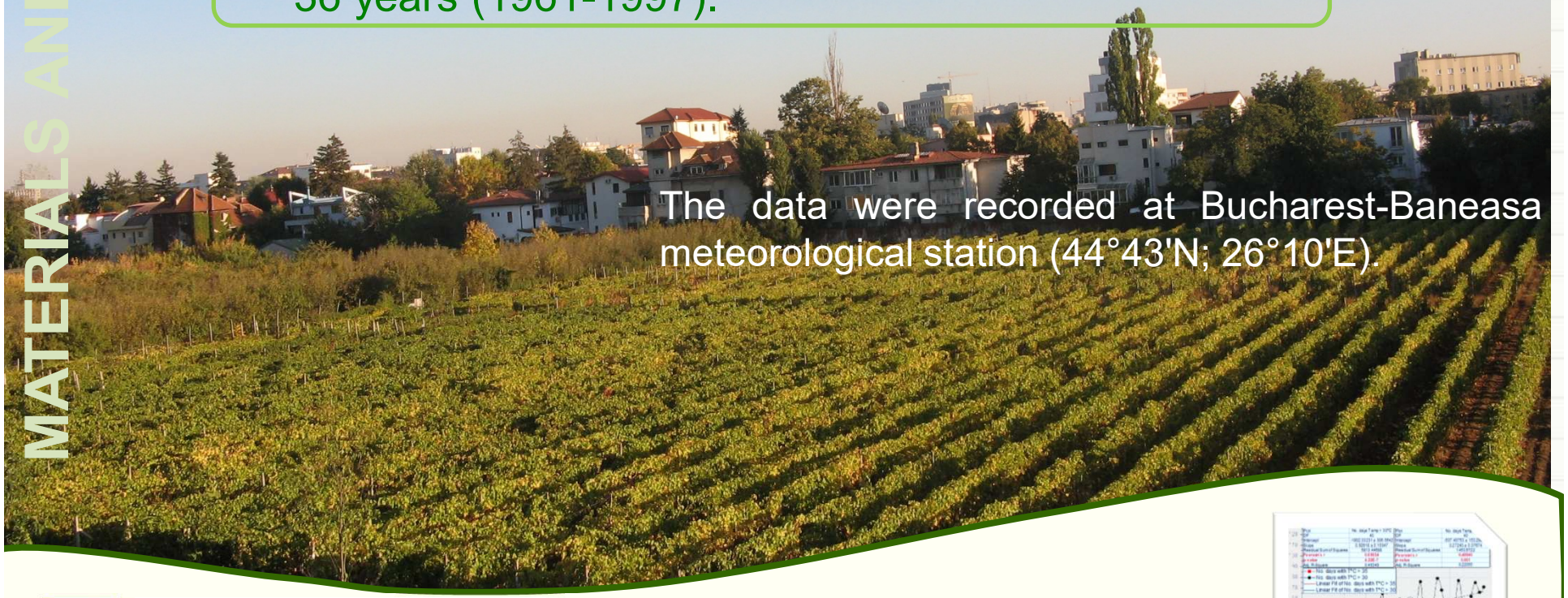


MATERIALS AND METHODS

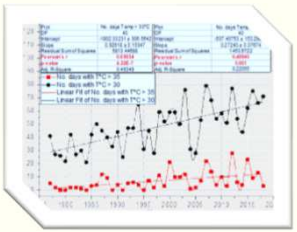
MATERIALS AND METHODS

The present analysis is based on

- ✓ the observation data recorded over a period of 21 years (1998-2018)
- ✓ compared with the reference period of the previous 36 years (1961-1997).



The data were recorded at Bucharest-Baneasa meteorological station (44°43'N; 26°10'E).



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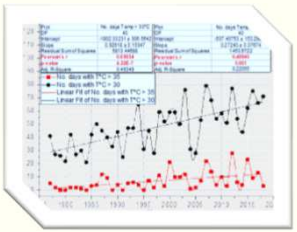
MATERIALS AND METHODS

The climatic data analysed are
- the average, minimum and maximum temperature,
- as well as the fallen precipitations.

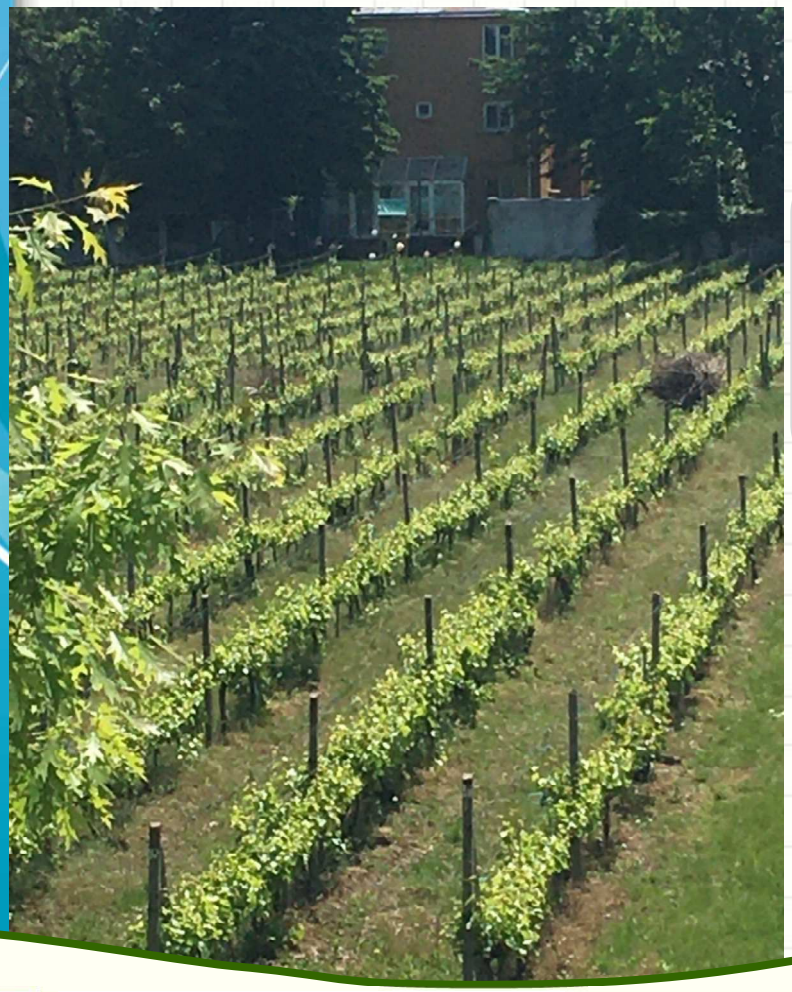
The temperature data were also used to calculate three well known bioclimatic indices:

- ✓ Winkler Index - WI (or growing degree-days index)
- ✓ Huglin heliothermal Index – HI (or heat sum /warmth index)
- ✓ Cool Night Index - CNI



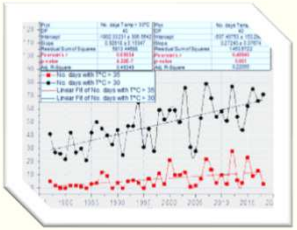
MATERIALS AND METHODS

Vine observations were made on the 1998-2018 period.



The plantation was established in 1994, with Feteasca regala variety, clone 21 Bl, grafted on Kober 5 BB rootstock, spaced by 2.2 m (inter-row) and 1.2 m (intra-row), with a density of 3787 plant·ha^{-1}.

The vines are trained as bilateral cordon with a spur pruning system and loading of 10 buds/m^2.



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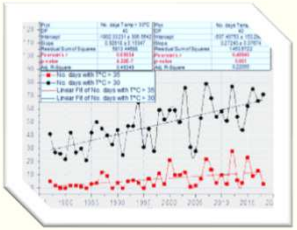
MATERIALS AND METHODS

- ✓ Total titratable acidity (g/l tartaric acid)
- ✓ Brix (% m/m)
- ✓ Yield (kg/vine)
- ✓ Average weight of a berry (g)

were determined
every year on 10th of September
during the past 21 years.



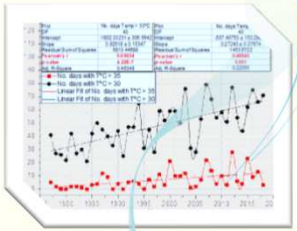
Trends of climate variables in Bucharest

Results

Table 1. The main climatic parameters and bioclimatic indices during the experimentation period (1998-2018) compared to the reference period (1961-1997)

Climatic and bioclimatic parameters indices	Average 1961-1997 ±SD	Average 1998-2018 ±SD	Difference (±)
Average annual temperature, °C	11.15±0.62[a]	11.89±0.61[b]	+0.74
Average temperature in the growing season (IV-X), °C	17.64±0.62[a]	18.38±0.74[b]	+0.74
Average temperature in summer (VI-VIII), °C	21.76±0.78[a]	22.97±1.01[b]	+1.21
Average temperature in the warmest month, °C	22.89±1.12[a]	24.27±1.17[b]	+1.38
Average annual			

20 parameters recorded or calculated



Results

Trends of climate variables in Bucharest

Climatic parameters and bioclimatic indices	Average 1961-1997 ±SD	Average 1998-2018 ±SD	Difference (±)	
Average maximum temp. in summer (VI-VIII), ºC	28.10±0.96*[a]	29.99±1.26[b]	+1.89	significant increase
Average maximum temp. in the warmest month, ºC	29.55±1.44*[a]	31.54±1.55[b]	+1.99	
Average minimum temp., in the growing season (IV-X), ºC	10.30±0.51*[a]	10.71±0.69[b]	+0.41	low increase
Average of absolute minimum temp., ºC	-15.87±3.61[a]	-18.76±4.27[b]	-2.89	significant decrease
Absolute minimum temperature, ºC	-23.7	-25.7	-2	

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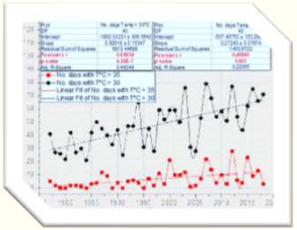
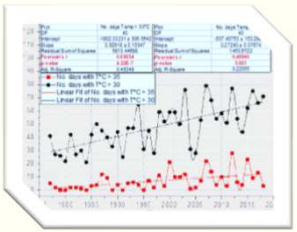


Trends of climate variables in Bucharest

Results

Climatic parameters and bioclimatic indices	Average 1961-1997 ±SD	Average 1998-2018 ±SD	Difference (±)	
Annual total precipitation, mm	613±125[a]	632±152[a]	+19.27	
Total precipitation in the growing season (IV-X), mm	398±116[a]	419±133[a]	+21.05	**insignificant changes**
Total precipitation in summer (VI-VIII), mm	195±67[a]	177±67[a]	-18.63	
Huglin index (HI)	2236±156*[a]	2416±149[b]	+180	
Winkler index (WI)	1632±142*[a]	1792±159[b]	+160	**clear increase**
Cool night index (CNI)	10.24±1.51*[a]	10.91±1.22[a]	+0.67	



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Results

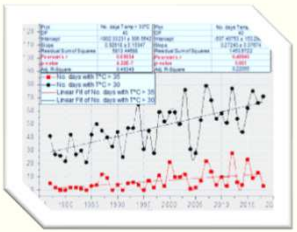
Trends of climate variables in Bucharest

Minimum temperatures below -20°C recorded in Bucharest-Baneasa

✓ A restrictive factor for vine cultivation

1961-1997	1998-2018
1963: -23.7°C (18.01.1963)	1998: -20.3°C (25.12.1998)
1969: -21.7°C (05.02.1969)	2002: -25.7°C (26.12.2002)
1980: -21.5°C (15.01.1980)	2003: -20.0°C (14.02.2003)
1985: -22.6°C (14.02.1985)	2004: -20.8°C (13.02.2004)
1987: -21.7°C (31.01.1987)	2005: -23.7°C (08.02.2005)
1990: -20.4°C (22.01.1990)	2010: -24.6°C (26.01.2010)
1997: -20.0°C (18.12.1997)	2012: -24.3°C (29.01.2012)
-.	2015: -20.8°C (08.01.2015)
7 out of 36 years	2016: -22.0°C (20.01.2016)
-	2017: -20.2°C (24.01.2017)
	10 out of 21 years

frequency of minimal harmful temperatures for the vine increased in the last decades compared to the reference period (1961-1997)



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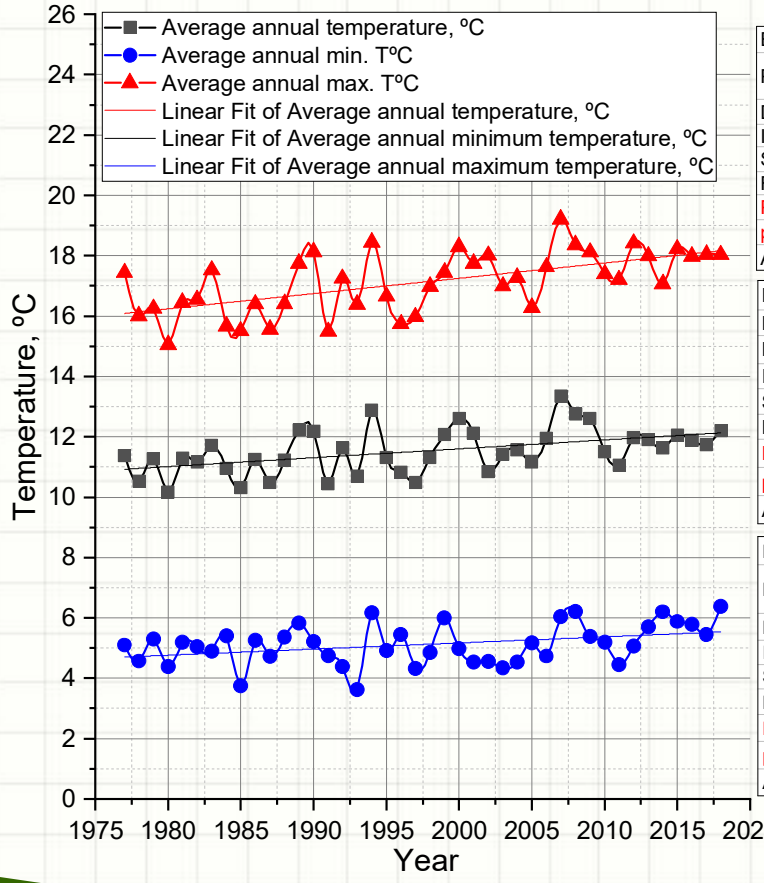
Trends of climate variables in Bucharest

Results

Evolution of the average temperature, minimum and maximum averages between 1977 and 2018

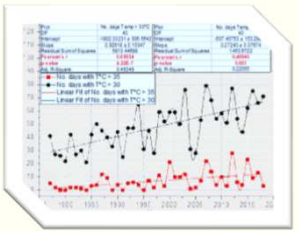


Equation	y = a + b*x
Plot	Average annual max. Tº C
DF	40
Intercept	-83.96532 ± 20.58212
Slope	0.05061 ± 0.0103
Residual Sum of Squar	26.20421
Pearson's r	0.61336
p-value	1.57E-5
Adj. R-Square	0.36062

Equation	y = a + b*x
Plot	Average annual TºC
DF	40
Intercept	-47.21661 ± 16.70896
Slope	0.02941 ± 0.00836
Residual Sum of Square	17.2699
Pearson's r	0.48587
p-value	0.00111
Adj. R-Square	0.21697

Equation	y = a + b*x
Plot	Average annual min. TºC
DF	40
Intercept	-35.38265 ± 15.723
Slope	0.02028 ± 0.00787
Residual Sum of Squares	15.29261
Pearson's r	0.37721
p-value	0.01
Adj. R-Square	0.12084

A moderate positive Pearson correlation supports the increasing trend



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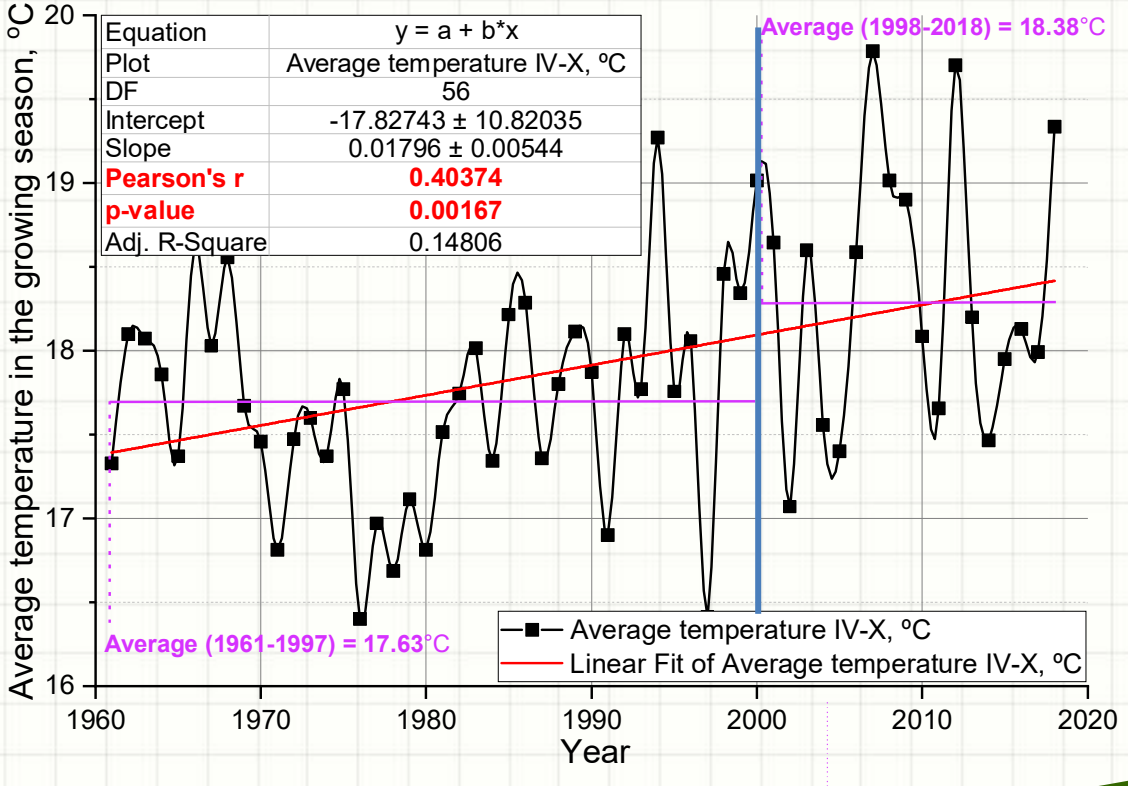
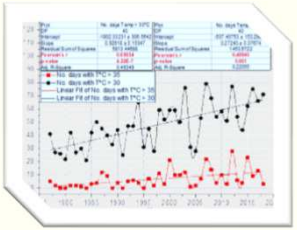
Trends of climate variables in Bucharest

Results

Evolution of the average temperatures in the growing season over the entire period 1961 and 2018



There is an increase of +0.75°C in the studied period (1998-2018) as compared to the reference period (1961-1997)



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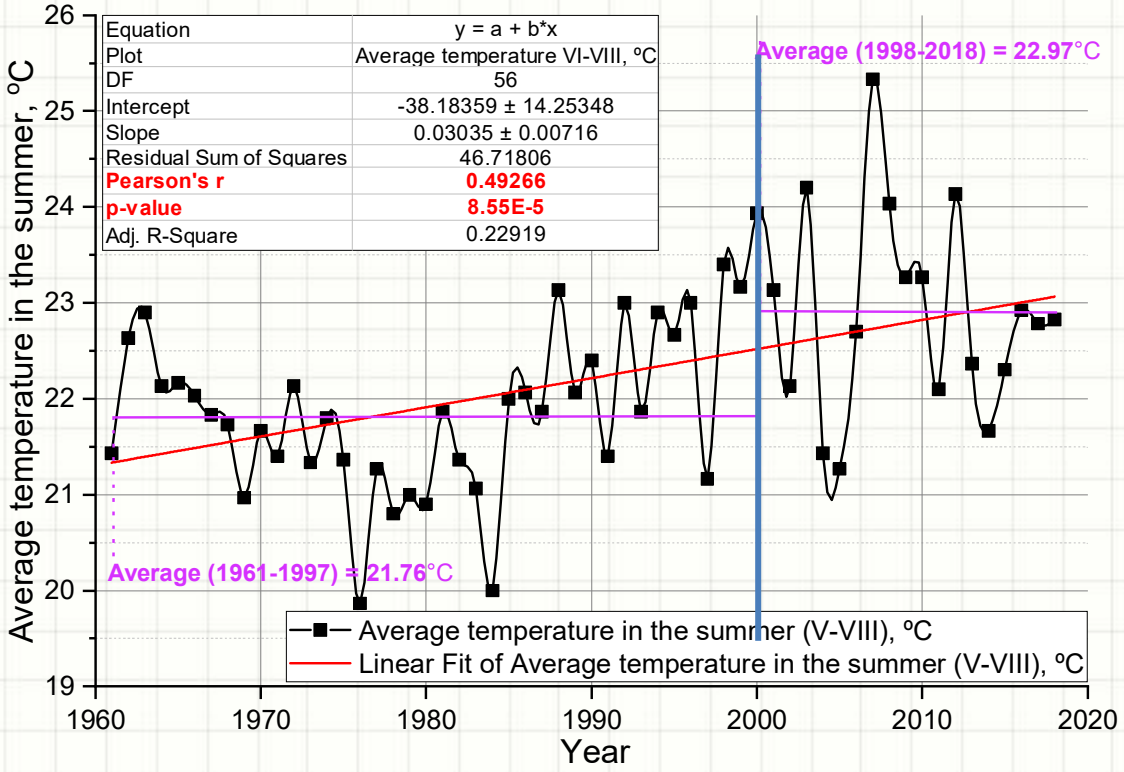
Trends of climate variables in Bucharest

Results

Evolution of the average temperatures in the summer (months VI-VIII) in Bucharest (1961-2018)



The most significant changes important for viticulture happen during summer (months VI-VIII), which show a difference of +1.21°C between period (1998-2018) and the reference period (1961-1997)

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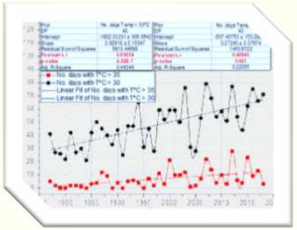
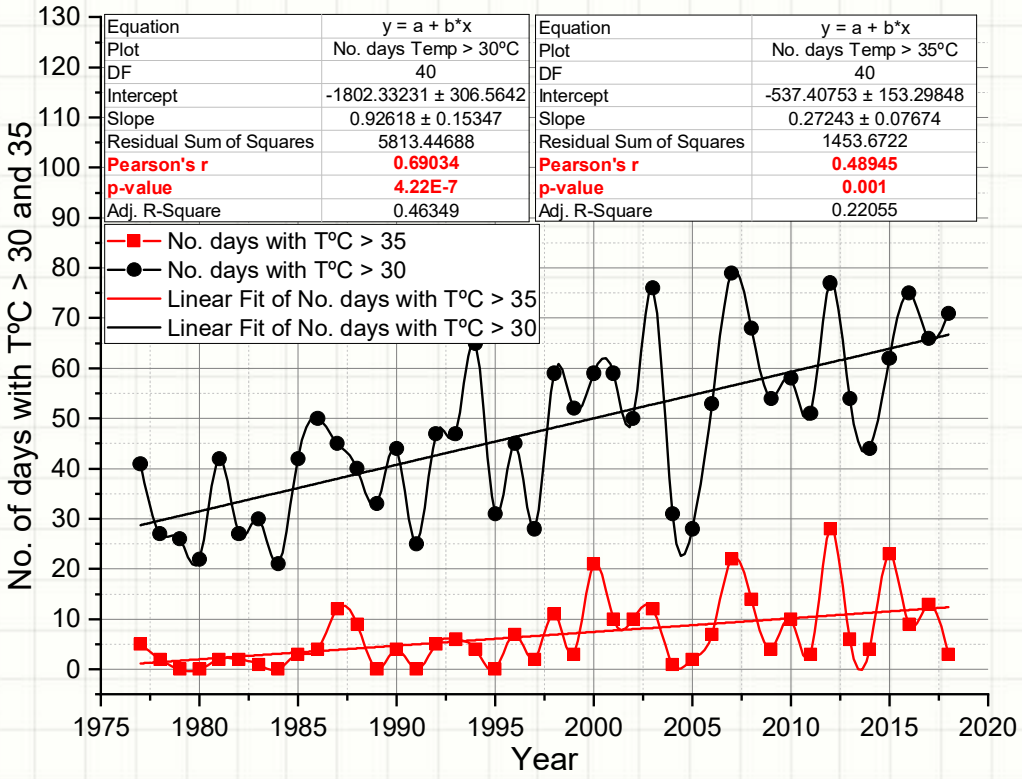


Trends of climate variables in Bucharest

Results

Number of the days with temperatures above 30°C and above 35°C in Bucharest (1977-2018)



Most importantly, in recent decades there has been a significant increase in the number of hot days (T > 30 °C) and very hot days (T >35 °C)

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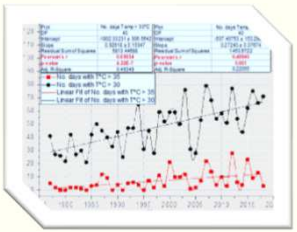
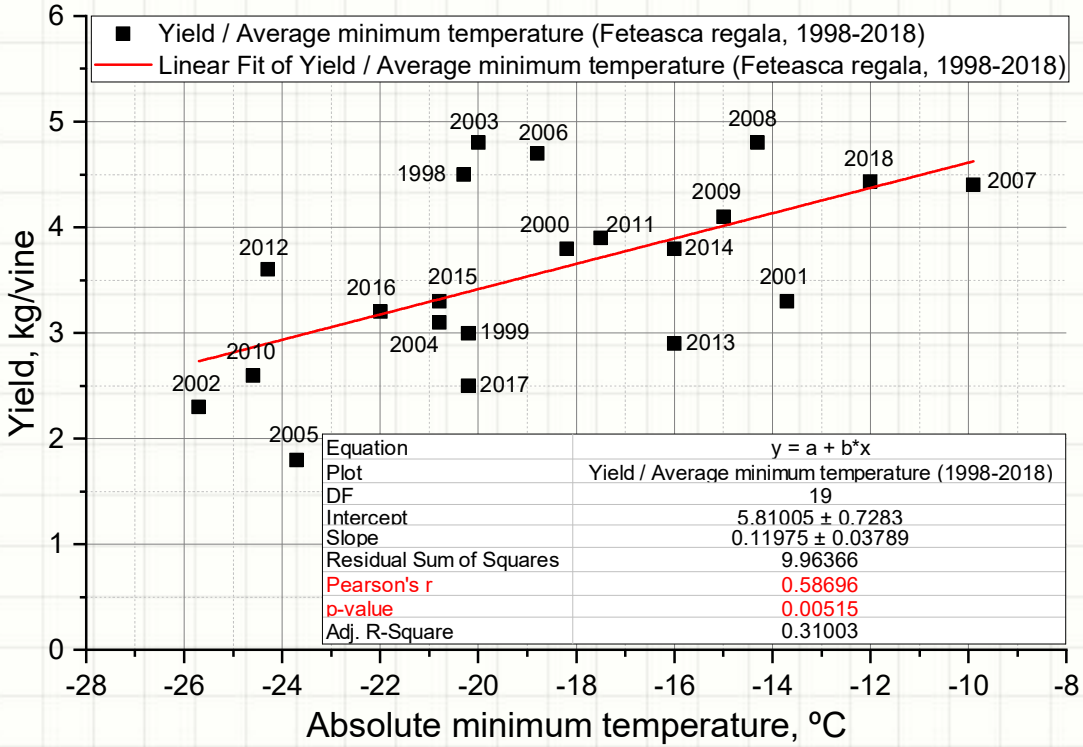


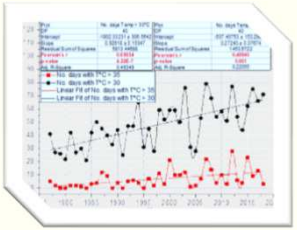
2. Behaviour of Fetească regală variety (1998-2018)

Results

The negative effect of winter temperatures on grape yield



The grape yield recorded large variations from one year to another (from the minimum of 1.8 to a maximum 4.8 kg/vine), mainly due to the frequency of minimum harmful temperatures for vines in winter.



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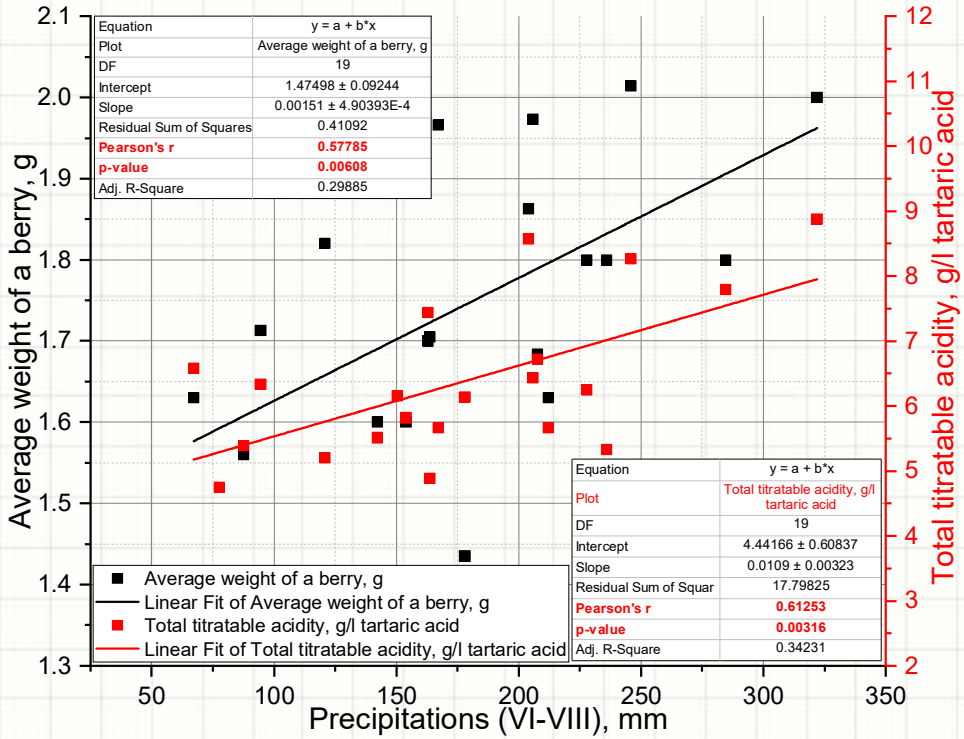
2. Behaviour of Fetească regală variety (1998-2018)

Results

The effect of the precipitations in the summer season on the average weight of a berry and titratable acidity



The increase in total titratable acidity is correlated to the increase in precipitations (minimum 4.74 g/l and a maximum of 8.88 g/l tartaric acid).

The average weight of a berry is increased too with the precipitations during summer. Average berry weight ranged from 1.40 to 2.02 grams.

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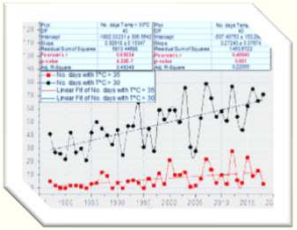
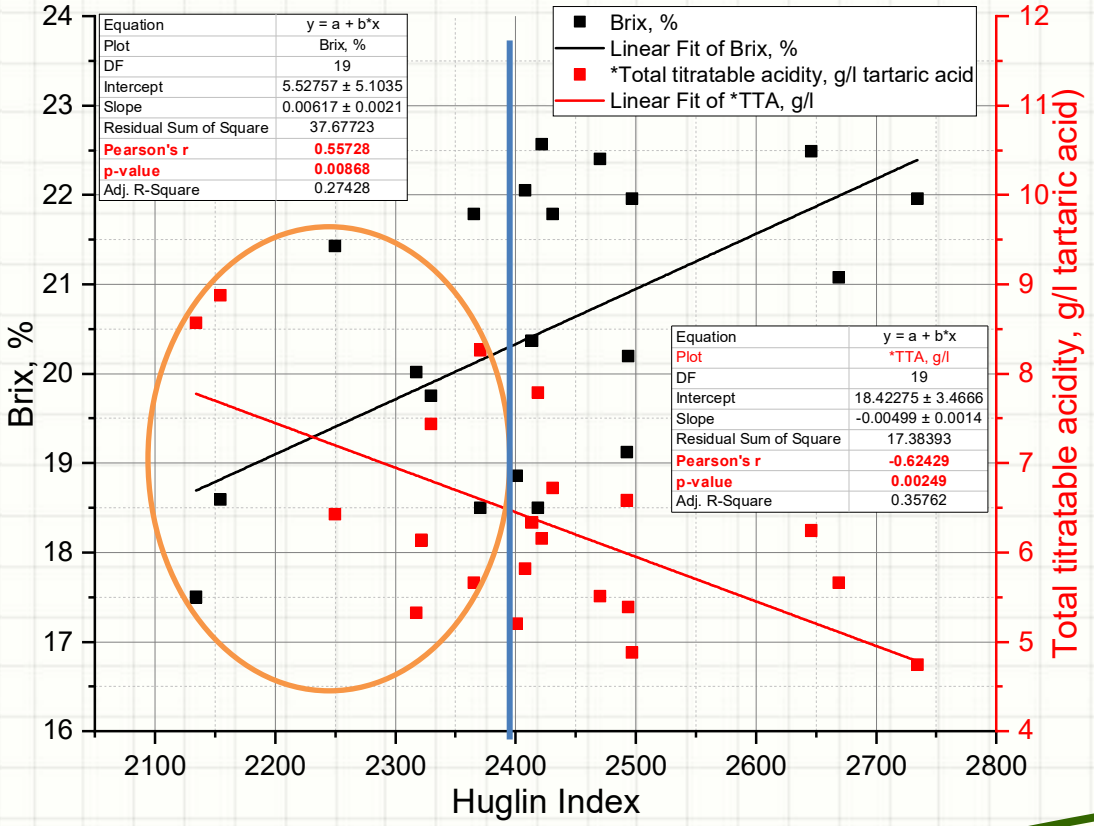


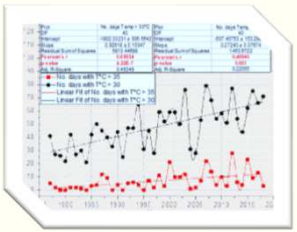
2. Behaviour of Fetească regală variety (1998-2018)

Results

The greatest influence on the grape quality parameters was found to be described by Huglin index



When the Huglin index is less than 2400 units (warm temperate climate), the total titratable acidity is generally higher than 5.5 g/l and often over 6.0 g/l tartaric acid while Brix is generally lower than 22%, which lead to harmonious light-bodied wines, with less than 13% vol. alcohol, typical for Fetească regală variety.



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Results

2. Behaviour of Fetească regală variety (1998-2018)

Multiple regression shows which climate parameters have the most effect on grape quality and are useful for prediction of sugar accumulation (Brix) and total titratable acidity

Multiple regression parameters	Brix, % (Y) Adj. R^2 = 0.56 (p-value = 0.00512)		TTA, g/l (Y) Adj. R^2 = 0.74 (p-value = 1.65E-4)	
	Value	SE	Value	SE
Intercept	18.7266	10.0287	6.4278	5.5530
X1 – **precipitations** (mm)	0.0015	0.0018	1.4984	0.3273
X2 - **Average temperature in the warmest month** (ºC)	-2.2712	0.5912	8.14E-4	9.72E-4
X3 - **Maximum temperature in the warmest month** (ºC)	1.2230	0.5195	-1.0984	0.28767
X4– **Number of days with T > 30ºC**	0.0025	0.0453	-0.0280	0.0251
X5 - **Number of days with T > 35ºC**	0.0658	0.0484	-0.0537	0.0268
X6 - **Huglin Index**	0.0069	0.0037	-7.23E-5	0.0021

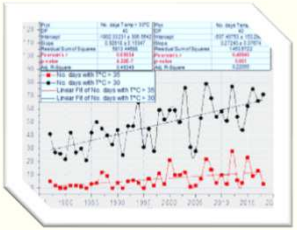
The equation used for the prediction is as follows:

$$Y = b_0 + b_1 \cdot X_1 + b_2 \cdot X_2 + b_3 \cdot X_3 + b_4 \cdot X_4 + b_5 \cdot X_5 + b_6 \cdot X_6$$

CONCLUSION

- ✓ As already proven by some other authors, the climate change is undeniable and its influences on the grape quality and implicitly on wines are clearly manifested.

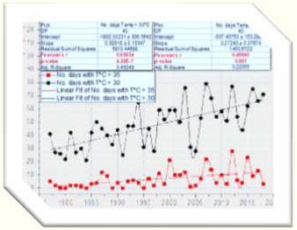
- ✓ **In Bucharest too, our study proved that the climate is changing from the warm temperate (IH +1 class) to the warm climate (IH +2 class).**



CONCLUSION

CONCLUSION

- ✓ There is a tendency toward and excessive number of days with temperatures over 30 and 35°C, a lower absolute minimum temperature and more frequent winter days with temperatures below -20°C.
- ✓ In order to produce balanced wines, the oenologists are forced to compensate for these climate changes.
- ✓ While the simple early harvesting is a temporary solution, other solutions would be more viable for the longer term (replacement of early varieties with late ripening ones or relocation to higher elevation).



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REFERENCE

Detailed results are published in
Bucur et al., 2019, *The climate change influences and trends on the grapevine growing in Southern Romania: A long-term study*, BIO Web of Conferences 15, 01008, 2019
https://doi.org/10.1051/bioconf/20191501008

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