

Grapevine phenology and agroclimatic indices in Croatia under climate change



Višnjica Vučetić¹, Marko Vučetić¹, Branimir Omazić², Maja Telišman Prtenjak², Ivan Prša³ and Marko Karoglan⁴



¹ Croatian Meteorological and Hydrological Service, Grič 3, Zagreb, Croatia: vucetic@cirus.dhz.hr

² Department of Geophysics, Faculty of Science, University of Zagreb, Zagreb, Croatia

³ Institute of Viticulture and Enology, Croatian Centre for Agriculture, Food and Rural Affairs, Zagreb, Croatia

⁴ Faculty of Agronomy, University of Zagreb, Zagreb, Croatia



Introduction

- The cultivation of grapes and wine production in Croatia has a long tradition, thus it is important to establish how climate change affects on the phenological cycle of grapevines.
- There are two types of cultivation of grapes: continental varieties with armature in the continental part of Croatia and Mediterranean varieties without armature in the mid-Adriatic part of Croatia.

Objectives

- The aim is to determine whether the part of the country that is suitable for cultivation of grape continues to be favourable in the future.

Data and Methodology



- 37 meteorological stations were analysed in the period 1961-1990
- 75 meteorological stations were analysed in the period 1987-2016
- phenological stations were analysed in the period 1961-2016
- Linear trend analysis and Mann-Kendall test
- Huglin index (HI > 1600°C favourable grapevine growing):

$$HI = \sum_{i=1.4}^{30.9} \left[\frac{(T_{mean, i} - 10) + (T_{max, i} - 10)}{2} \right] k$$

- Growing degree-days (GDD):

$$GDD = \sum_{i=1.4}^{30.9} \left[\frac{T_{min, i} + T_{max, i}}{2} - 10 \right]$$

Pulliat classification

Period of maturity	Variety
First period	Chasselas White
Second period	Queen of Vineyard
Third period	Riesling Italico
	Istrian Malvoisie
Fourth period	Plavac mali
	Trbljan

φ	k
42.1° - 44.0°	1.03
44.1° - 46.0°	1.04
46.1° - 48.0°	1.05

Linear trend of phenophases

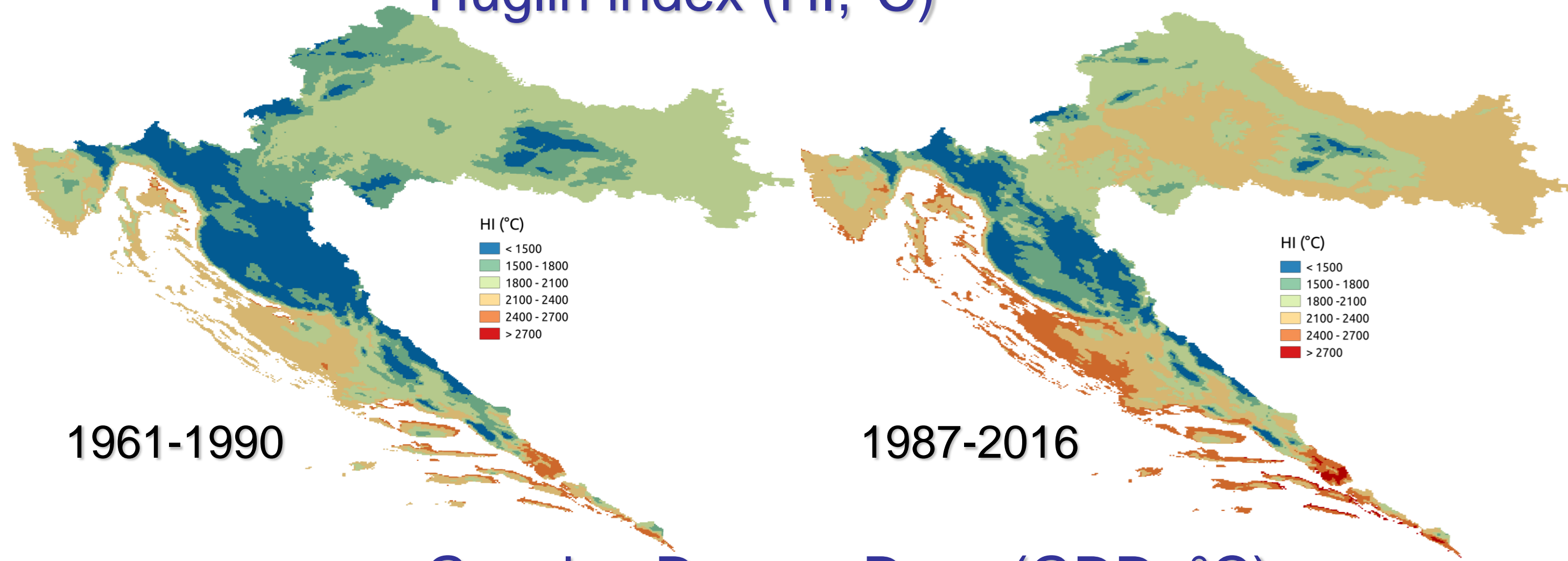
Pheno phases	BS	UL	BF	EF	BR	FR	RP
POŽEGA Trend (day/decade) in the period 1961-2016							
Chasselas White	0.2	-0.4	-0.8	-0.9	-0.5	-4.1	-3.7
DARUVAR							
Chasselas White	-2.7	-3.3	-3.1	-2.4	-0.7	-4.9	-3.8
Riesling Italico	-2.1	-2.1	-2.6	-1.9	1.8	-4.1	-3.1
KRIŽEVCI							
Chasselas White	-1.3	-1.9	-4.1	-2.9	-0.3	-5.0	-4.9
Riesling Italico	-1.6	-1.5	-2.2	-0.8	2.4	-4.8	-5.3
ČEPIĆ							
Istrian Malvoisie	-1.9	-0.4	-4.1	-2.5	-0.3	-5.3	-2.7
HVAR							
Plavac mali	-3.9	-3.0	-2.3	-1.5	2.3	-1.0	-1.3
Trbljan	-5.3	-3.6	-2.8	-2.3	0.8	-4.8	-3.1
LASTOVO							
Plavac mali	-0.5	-0.8	-0.8	-0.3	-2.2	-5.0	-1.5
OREBIĆ							
Plavac mali	-0.8	-1.0	-1.2	-1.3	2.6	0.2	-0.3
VELA LUKA							
Plavac mali	-2.2	-2.7	-2.4	-2.2	-0.5	1.9	-1.5
Vineyard Queen	-3.8	-3.8	-2.8	-2.7	-2.6	-4.1	-4.6
Blatina	-2.7	-2.9	-2.8	-2.2	0.3	2.8	-1.3

Legend:
 BS: Beginning of sprouting BR: Beginning of ripening
 UL: Leaf unfolding FR: Full ripening
 BF: Beginning of flowering RP: Fruits ripe for picking
 EF: End of flowering Significant level p < 0.05

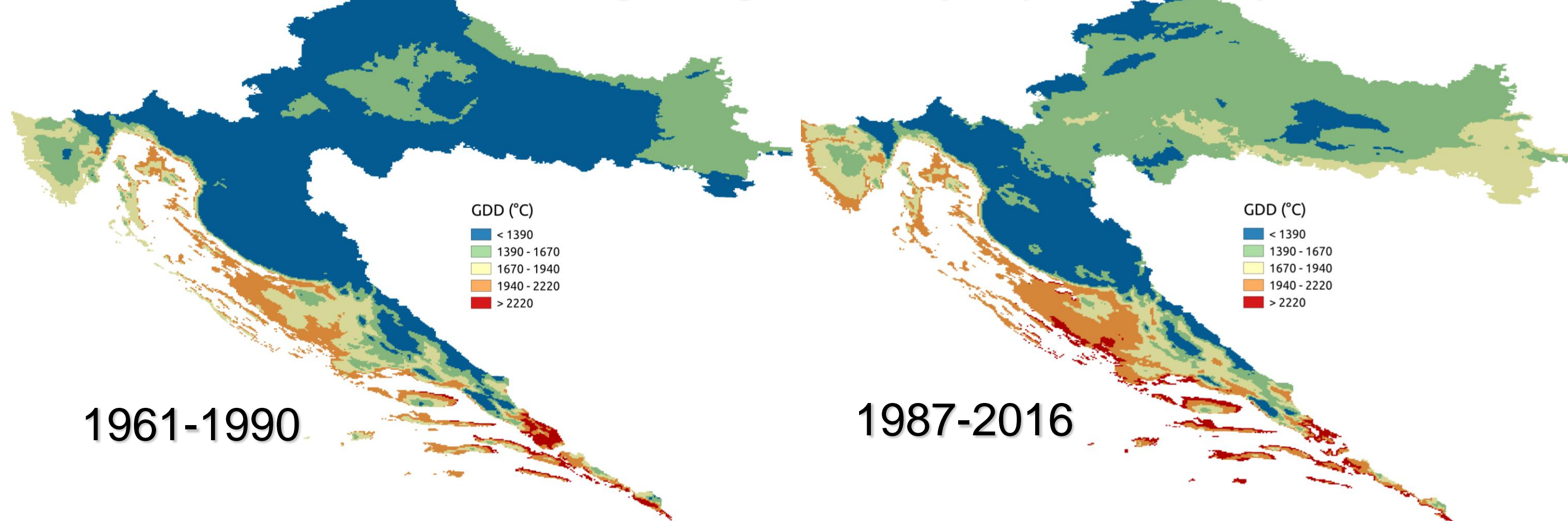
Linear trend analysis shows that dates of leaf unfolding, beginning of first flowers and end of the flowering occurred earlier by 1-4 days/decade. The negative trend of ripening and harvesting is more pronounced in continental part of Croatia (4-5 days/decade) than in the mid-Adriatic area.

Results

Huglin index (HI, °C)



Growing Degree-Days (GDD, °C)



In the period 1961-1990 HI was up to 2500°C and GDD up to 2300°C for the mid-Adriatic, up to 2050°C and 1500°C respectively for the continental area and below 1600°C and 1000°C for mountainous area. In the last 30 years, the increase of HI and GDD is evident in the whole Croatia (up to 300°C).

Conclusion

In the extremely hot years at the beginning of the 21st century earlier and later continental varieties ripened practically at the same time. The grapes had a very high sugar content, which resulted in wines with high alcohol content. Thus, in the near future in the continental part it could become possible to grow thermally more demanding red grape varieties, while earlier varieties could be cultivated in mountainous.

Acknowledgments: The research was realized within the project VITiculture and CLimate Change in Croatia (VITCLIC) from Croatian Science Foundation.