Analyses of agroclimatic indices applied to Croatian grapevine growing regions in present and in the future climate

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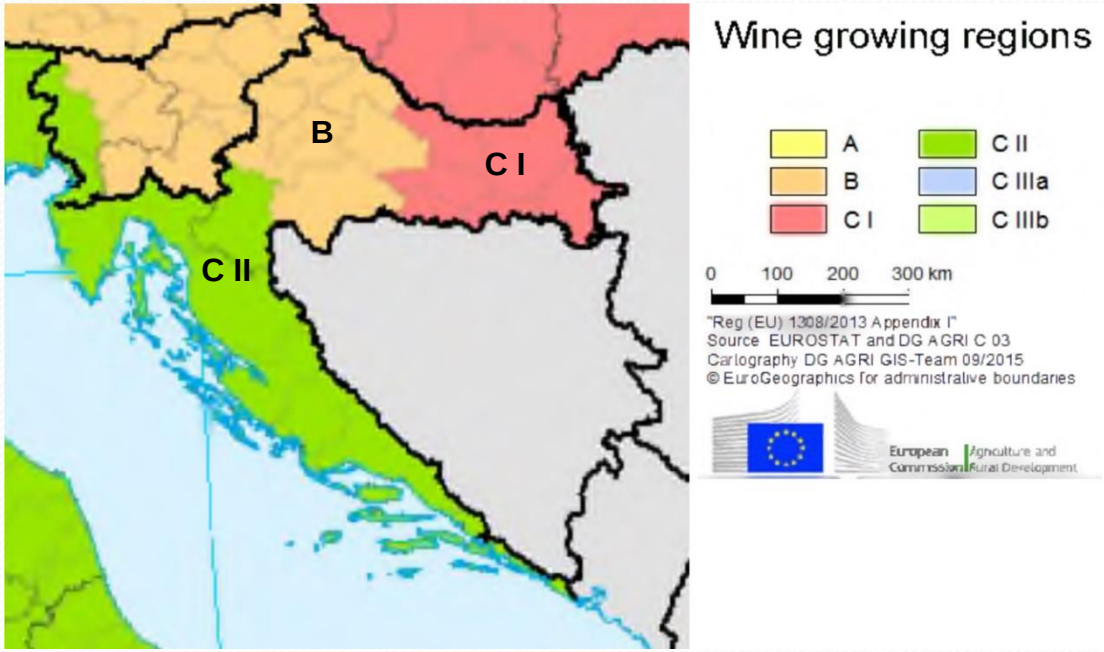
Motivation and aims

Vine is a climate sensitive crop, since its growth and development are strongly influenced by the prevailing atmospheric conditions in each region.

agroclimatic indices serve us as a "tool" in determining the geographic areas and their benefits for the cultivation of a certain grape variety

maps of wine-growing areas



Current vineyards zones in Croatia since 2013

Source: EUROSTAT and DG AGRI C.03
Cartography DG AGRI GIS-Team 09/2015 c
EuroGeographics for administrativeboundaries

Motivation and aim

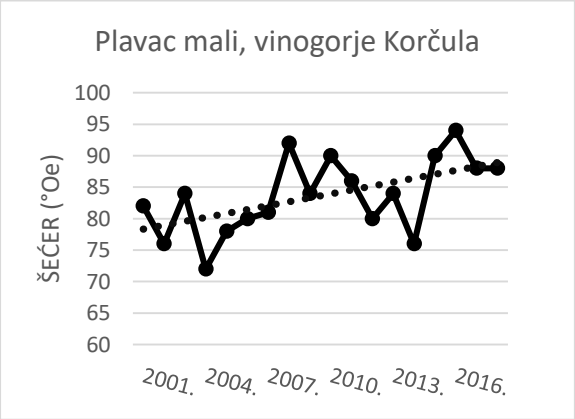
Changes in the last 10 years in grape juice:

- **sugar growth**
- **increase in (potential) alcohol levels**
- **reducing in the total acidity**

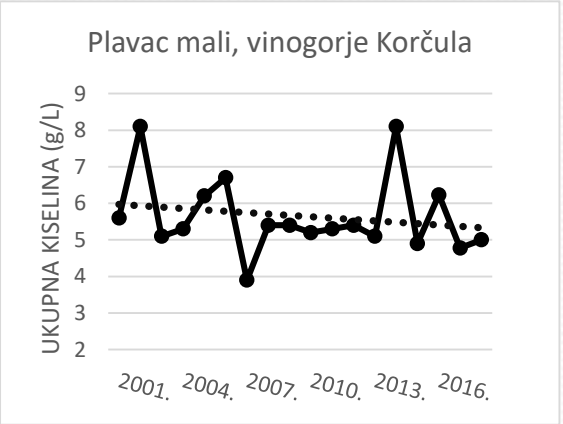
Production/export costs are not aligned with the vineyard zones (due to upper limits of suger and alcohol for each zone)

due to climate change

period 2000 - 2018



The sugar content (° Oe) in grape juice prior to harvest; plavac mali variety.



The total acidy (g/L) in grape juice prior to harvest; plavac mali variety.

What is the distribution of agroclimatic indices in the future?

Do we have a justified division of vineyard zones now and in the future?

Methodology

Regional Climate Models

EURO-CORDEX
(a) CLMcom-CCLM4-8-17
(b) SMHI-RCA4
for Croatian domain

Greenhouse Gas (GHG) Emissions Scenarios:

moderate (RCP4.5) & high-end (RCP8.5)

Periods:
1971-2000
2011-2040,
2041-2070
2071-2099

RCMs are forced by GCMs

resolution: 0.11°

Used data:
Min T,
max T,
average T,
rh,
wind speed
total precipitation

SMHI-RCA4 is driven by 5 different GCMs:

- CNRM-CERFACS-CNRM-CM5
- ICHEC-EC-EARTH
- IPSL-IPSL-CM5A-MR
- MOHC-HadGEM2-ES
- MPI-M-MPI-ESM-LR

CLMcom-CCLM4-8-17 is driven by 4 different GCMs:

- CNRM-CERFACS-CNRM-CM5
- ICHEC-EC-EARTH
- MOHC-HadGEM2-ES
- MPI-M-MPI-ESM-LR

Methodology

agroclimatic indices

(1) Average temperature growing season
(2) Growing degree days (GDD)/Winkler index (WI)
(3) Huglin index
(4) Cool night index
(5) Dryness index

The spatio-temporal regression-kriging framework (as implemented in the gstat package via 3D kriging) has been used for the presentation of agroclimatic indices distributions

Methodology

Growing degree days (GDD)/ Winkler index (WI)

$$WI = \sum_{i=1.4.}^{31.10.} \frac{T_{max,i} + T_{min,i}}{2} - 10 \qquad [°C]$$

Region	WI (°C)
Region I	850-1390
Region II	1391-1670
Region III	1671-1940
Region IV	1941-2220
Region V	>2220

Huglin index (HUI)

$$HUI = \sum_{i=1.4.}^{30.9.} \left[\frac{\overline{T}_i - 10 + T_{max,i} - 10}{2} \right] \cdot k \qquad [°C]$$

φ (°)	k
40,1–42,0	1,02
42,1–44,0	1,03
44,1–46,0	1,04
46,1–48,0	1,05
48,1–50,0	1,06

Class	HUI (°C)
Very cool	≤ 1500
Cool	1501-1800
Temperate	1801-2100
Temperate warm	2101-2400
Warm	2401-2700
Very warm	> 2700

Provides information on the amount of accumulated heat during the growing season.

Methodology

defines water in the ground

Cool night index (CI)

$$CI = \frac{1}{N} \sum_{i=1.9.}^{30.9.} T_{min,i}$$

Class	CI (°C)
Very cool nights	< 12
Cool nights	12 – 14
Temperate nights	15 – 18
Warm nights	> 18

- The average of the Tmin during the night of the month of harvest
- Provides a relative measure of maturing possibilities of berries

Dryness index (DI)

$$DI = \sum_{1.4.}^{30.9.} W_0 + P_{mj} - T_{v,mj} - E_{s,mj} \qquad [mm]$$

$$T_v = ETP \cdot k$$

$$E_s = \frac{ETP}{N} \cdot (1 - k) \cdot JPm$$

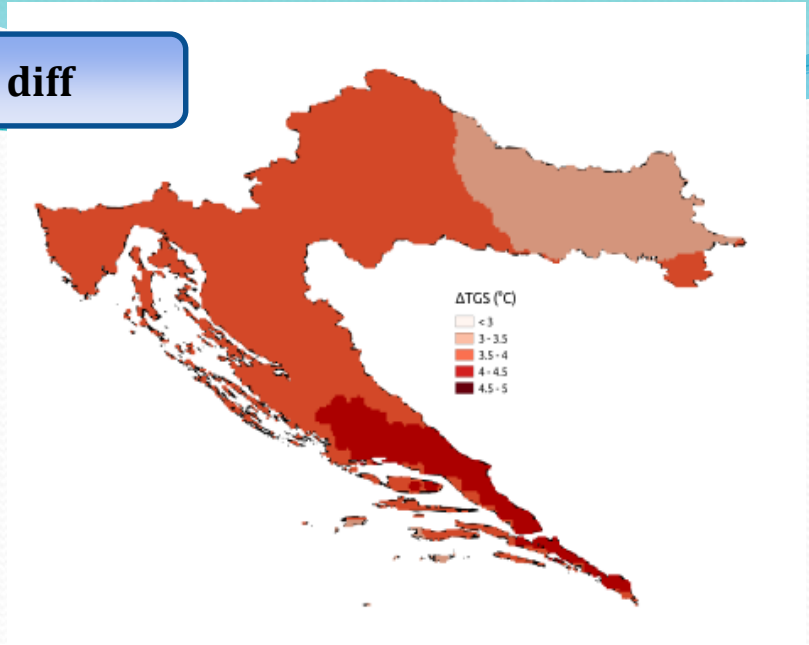
Class	DI (mm)
Very dry	< (-100)
Moderately dry	(-100) - 50
Sub-humid	50 - 150
Humid	> 50

- defines water in the soil

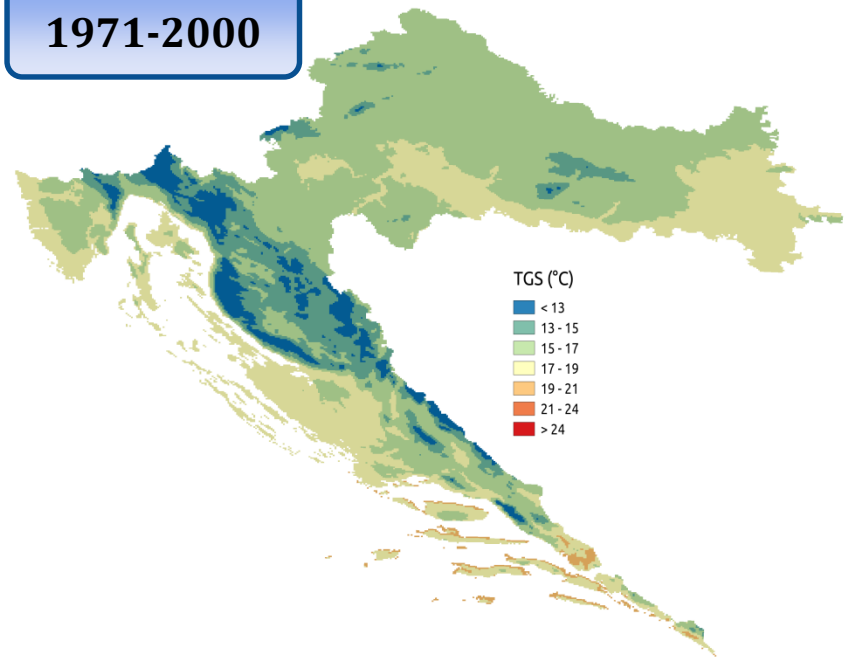
Results

Average temperature growing season (TGS) median & diff

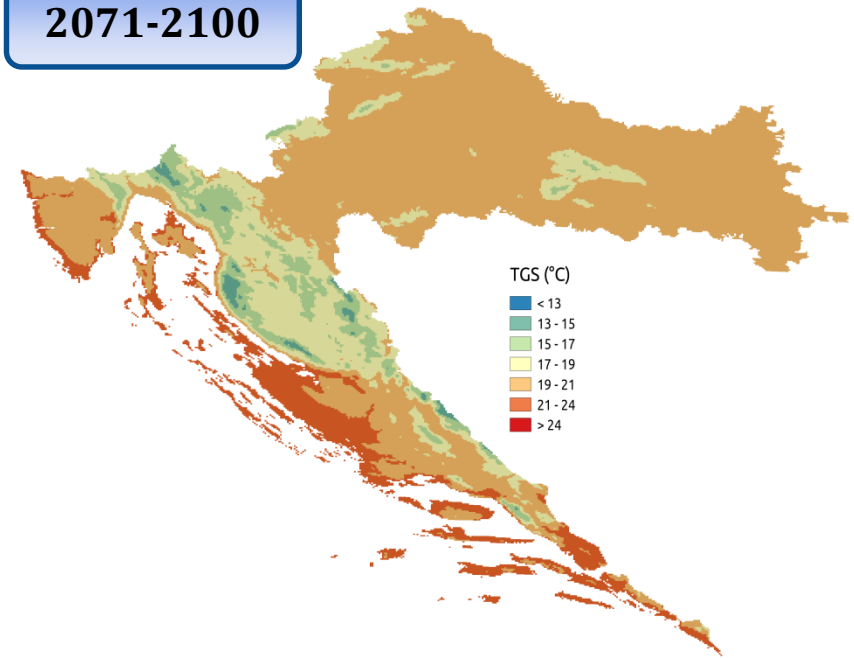
diff



1971-2000



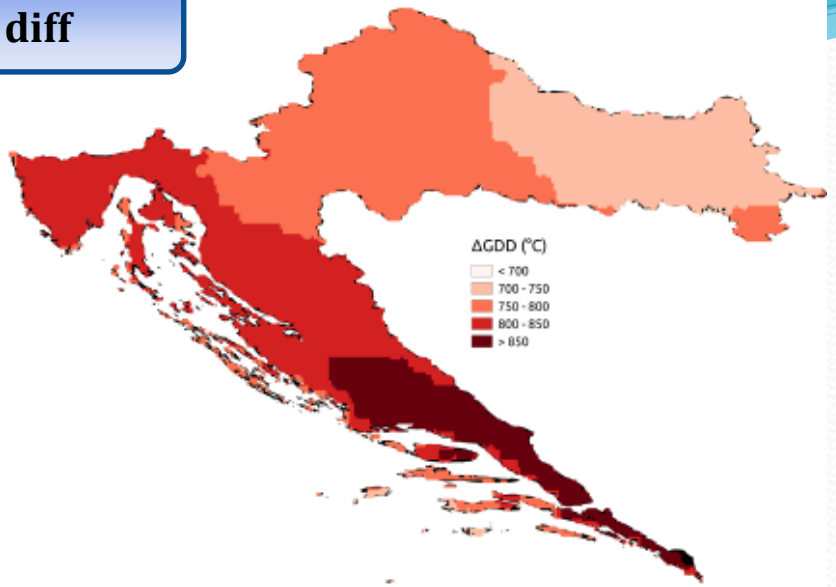
2071-2100



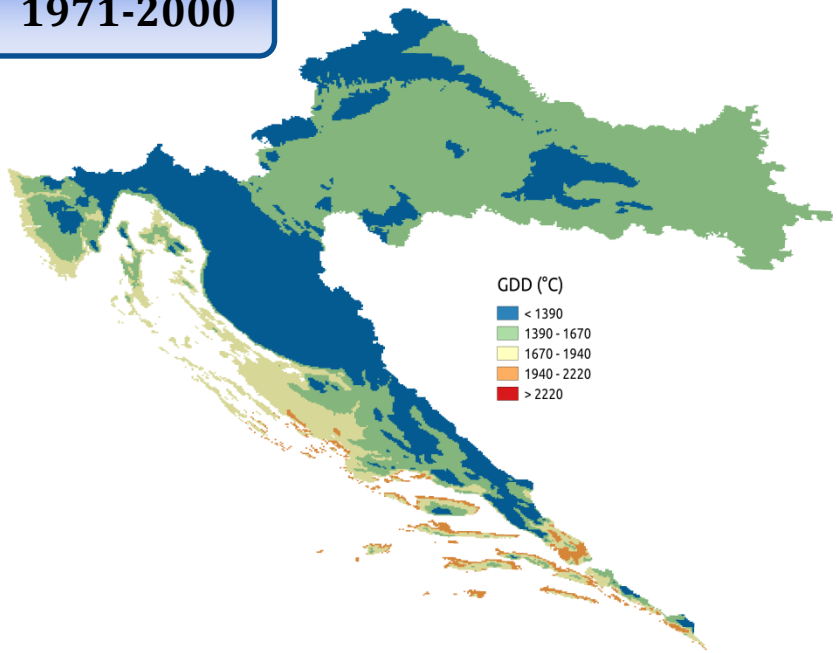
Results

Winkler index (WI)
median & diff

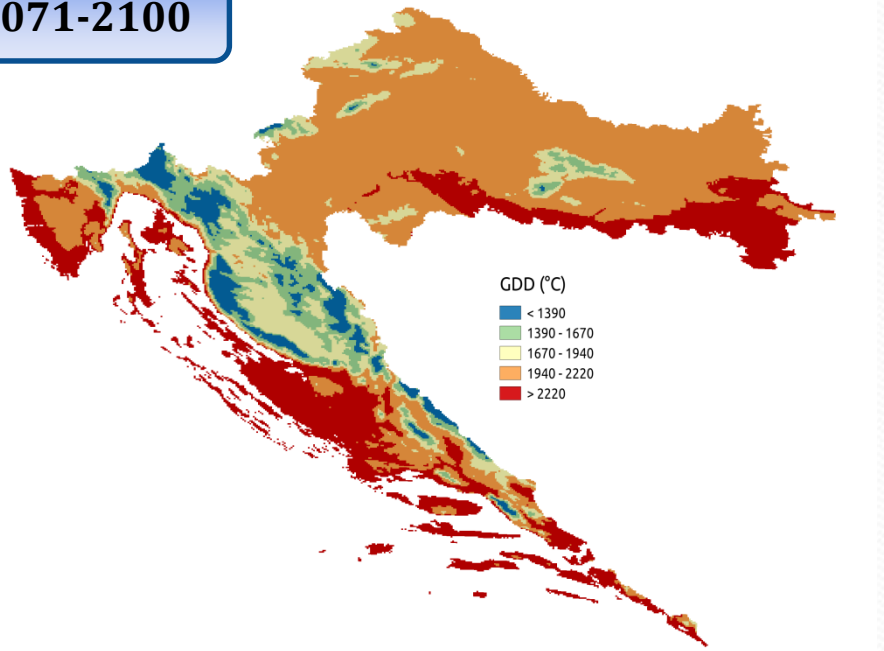
diff



1971-2000



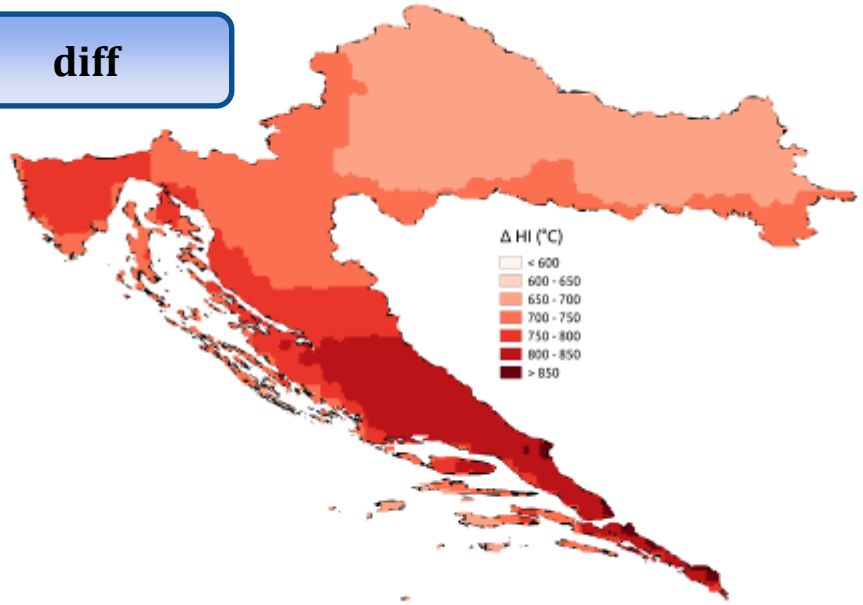
2071-2100



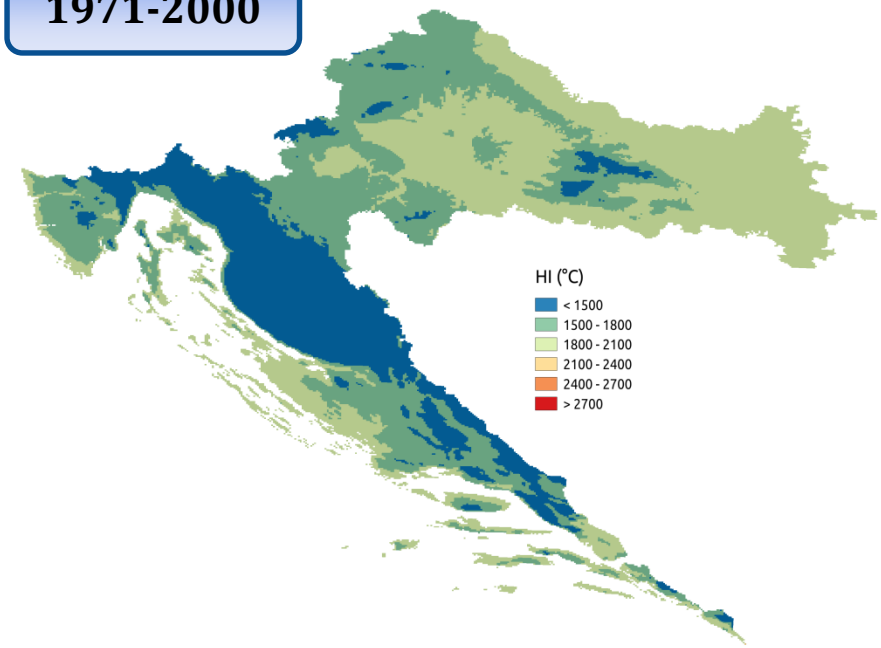
Results

Huglin index median & diff

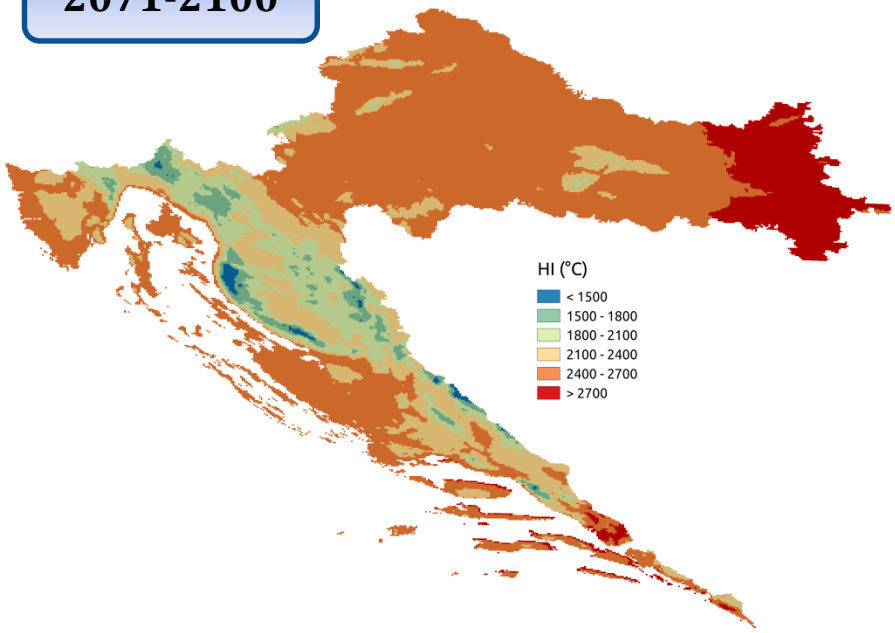
diff



1971-2000



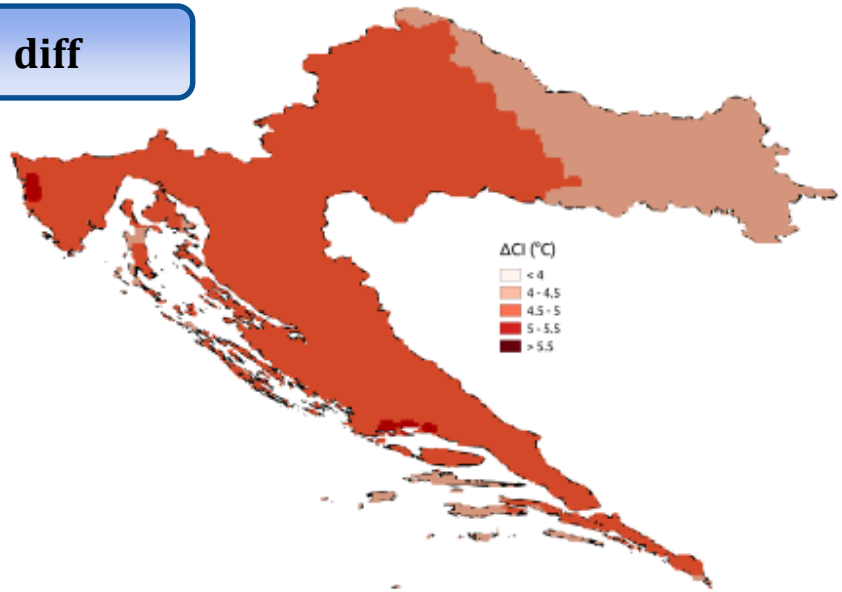
2071-2100



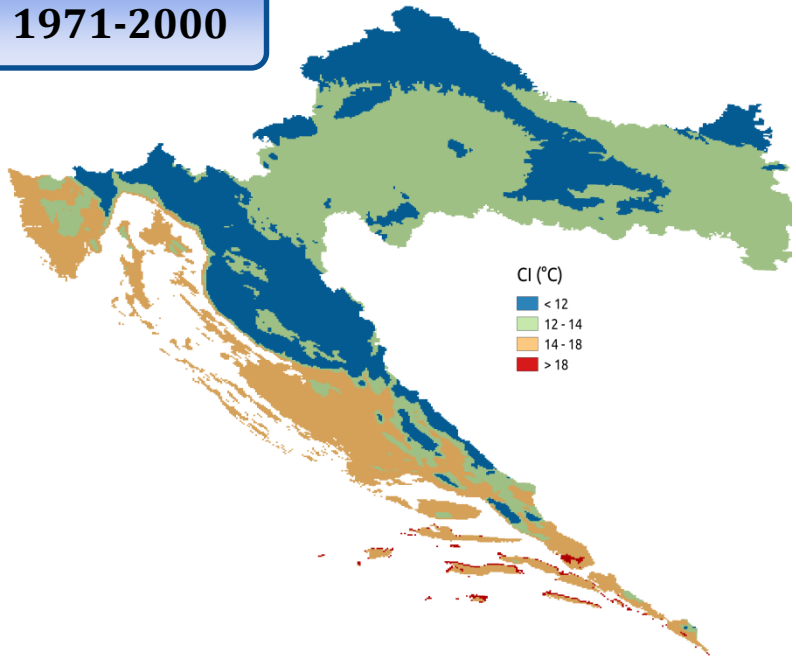
Results

Cool night index (CI) median & diff

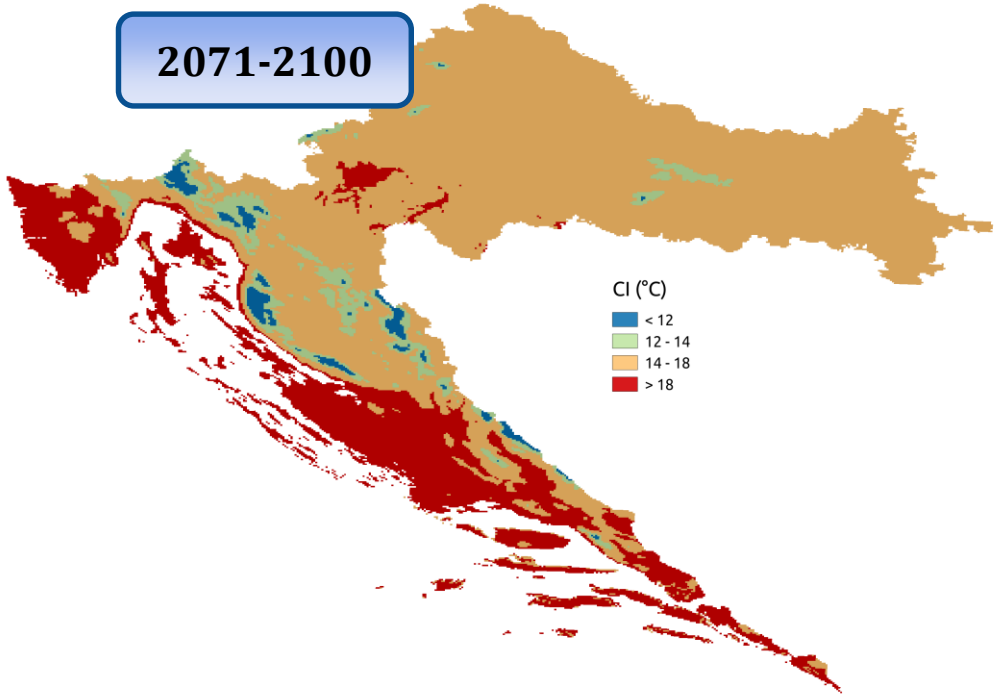
diff



1971-2000



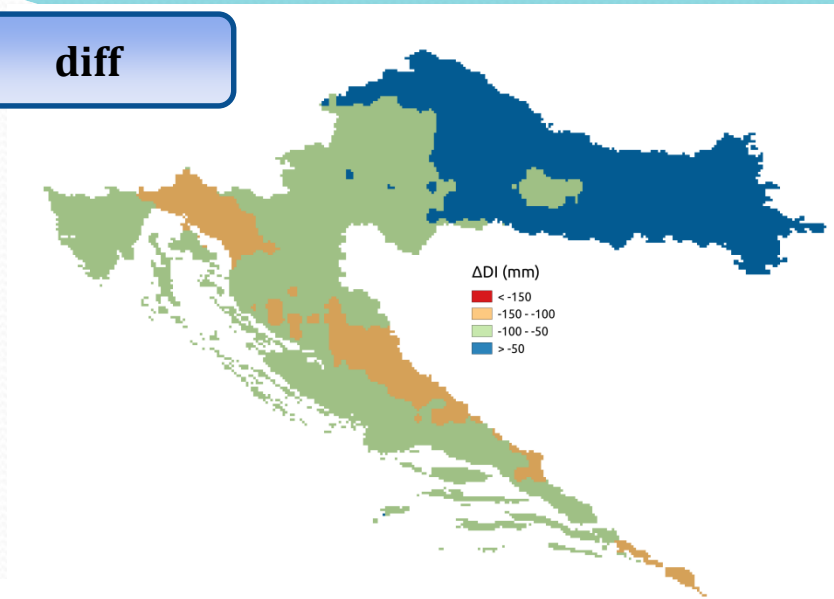
2071-2100



Results

Dryness index (DI)
median & diff

diff



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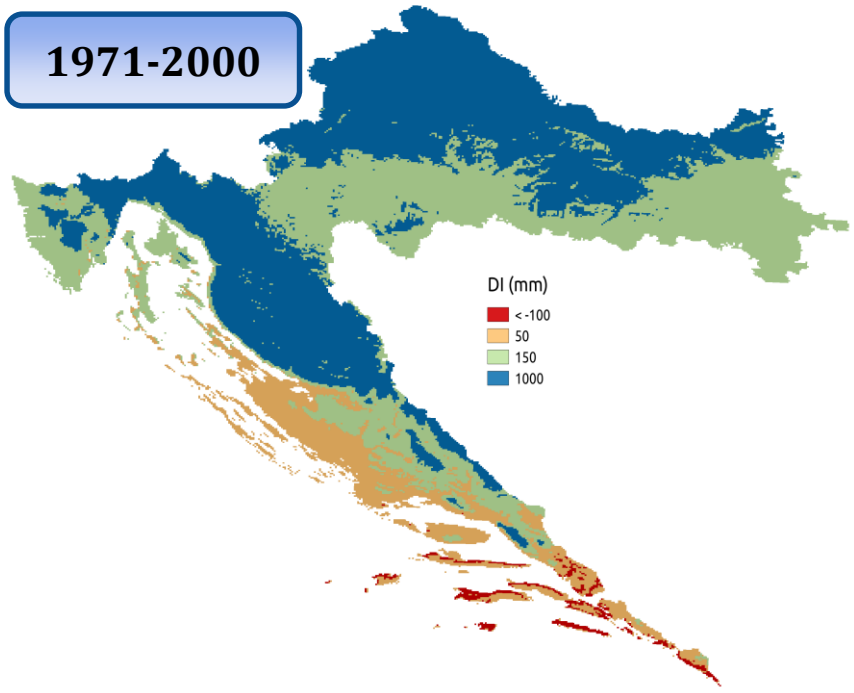
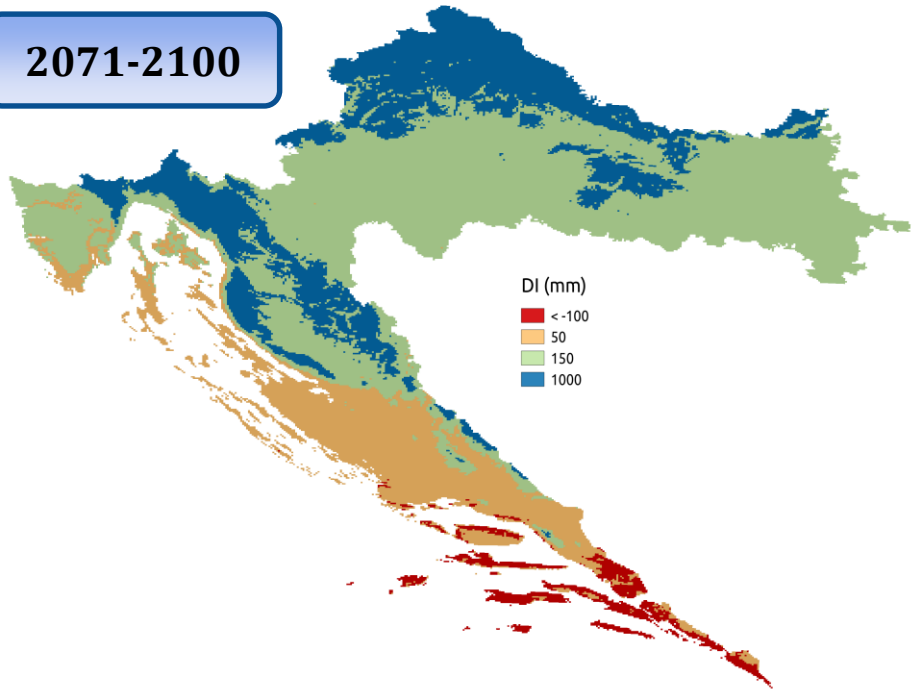


2071-2100



Summary

- **due to climate change, agroclimatic indices (based on the temperature) will increase in the future climate;**
- **Dryness index pointed to a further reduction in moisture in the future climate;**
- **the existing zoning of wine-growing areas is not adequate for the whole of Croatian territory;**
- **it is necessary to implement a new zoning of wine-growing areas -> taking into account the combination of climate data, pedological data, water balance calculations and political/administrative division of the regions.**

Thanks to VITCLIC project

Thank you for your attention!