SMART WATER

PROMOTING SMART AGRICULTURAL WATER MANAGEMENT IN BOSNIA AND HERZEGOVINA

"This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952396".

THE THIRD SUMMER SCHOOL

Adaptation to climate change of agricultural water management sector in Bosnia and Herzegovina

Impact of climate change on evapotranspiration, irrigation requirements and yield of crops grown in specific pedoclimatic conditions of Bosnia and Herzegovina

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CIHEAM – Bari, Italy

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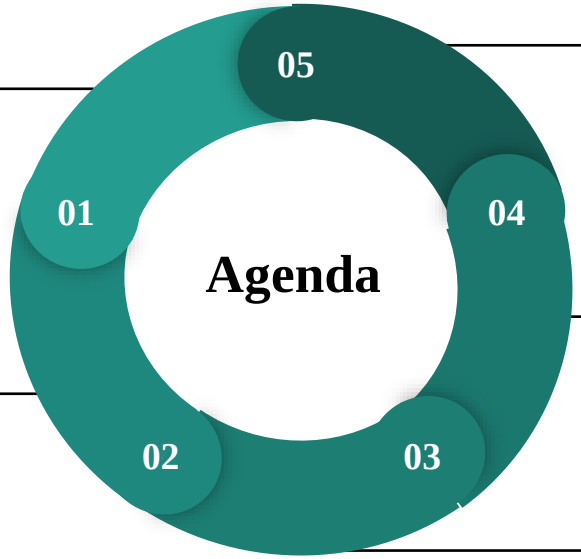
Introduction
Objectives
Research area

Literature review
Key points
Problem statement



Upcoming tasks

Results
Effects of climate change

Materials and methods
Data requirements
Formulas

Objectives

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- Assess the impact of climate change on agricultural water management and crop growth in specific pedoclimatic conditions of Bosnia and Herzegovina

Assess the trend of main weather parameters	Investigate impact of climate change	Propose adaptation measures
• Air temperature • Precipitation • Reference evapotranspiration	• Crop Evapotranspiration • Irrigation requirements • Crop yield • Water productivity	• More efficient agricultural water management

Study location

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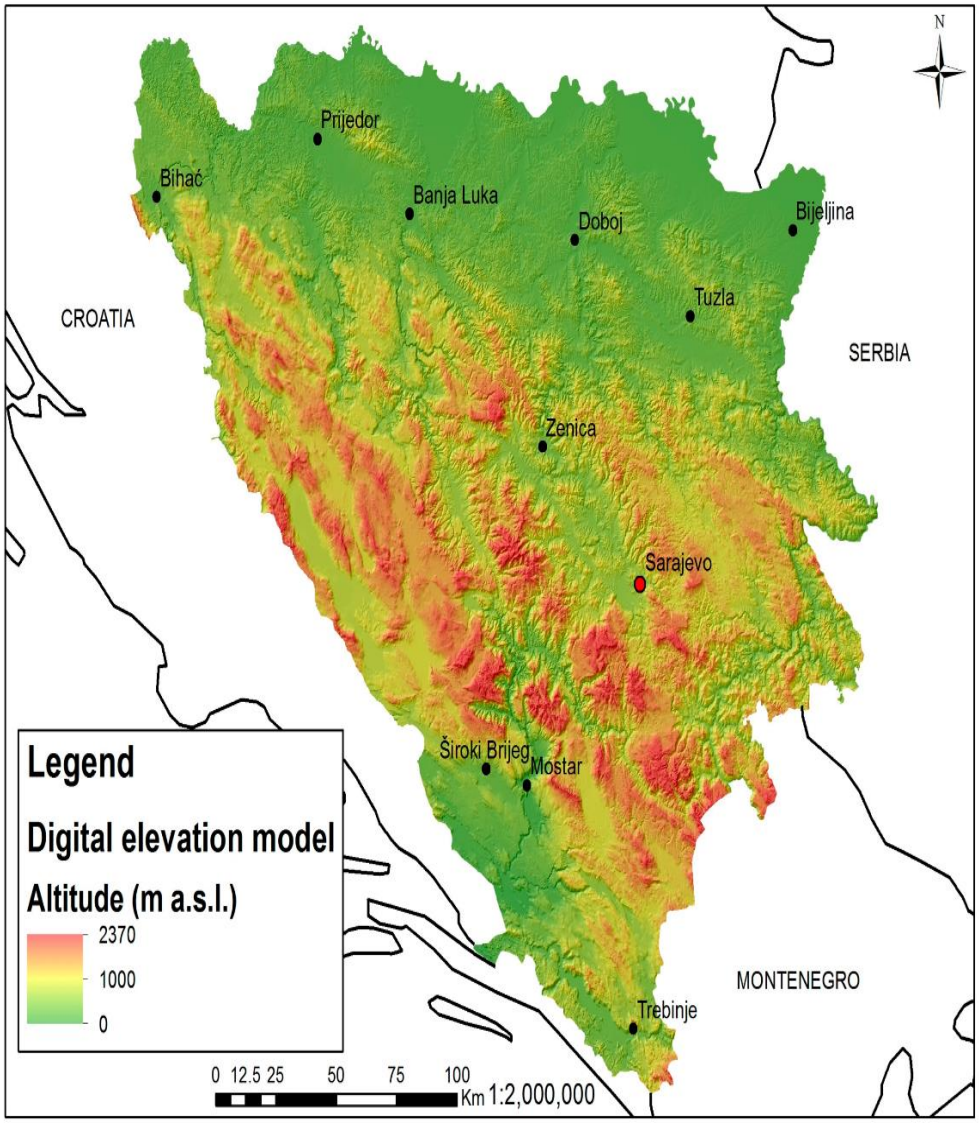
- Southeast Europe
- Mediterranean basin
- 51.209 km²
- 5% lowlands
- 24% hills
- 42% mountains
- 29% karst region
- 500 m a.s.l.



(Source: Zurovec et al., 2017)

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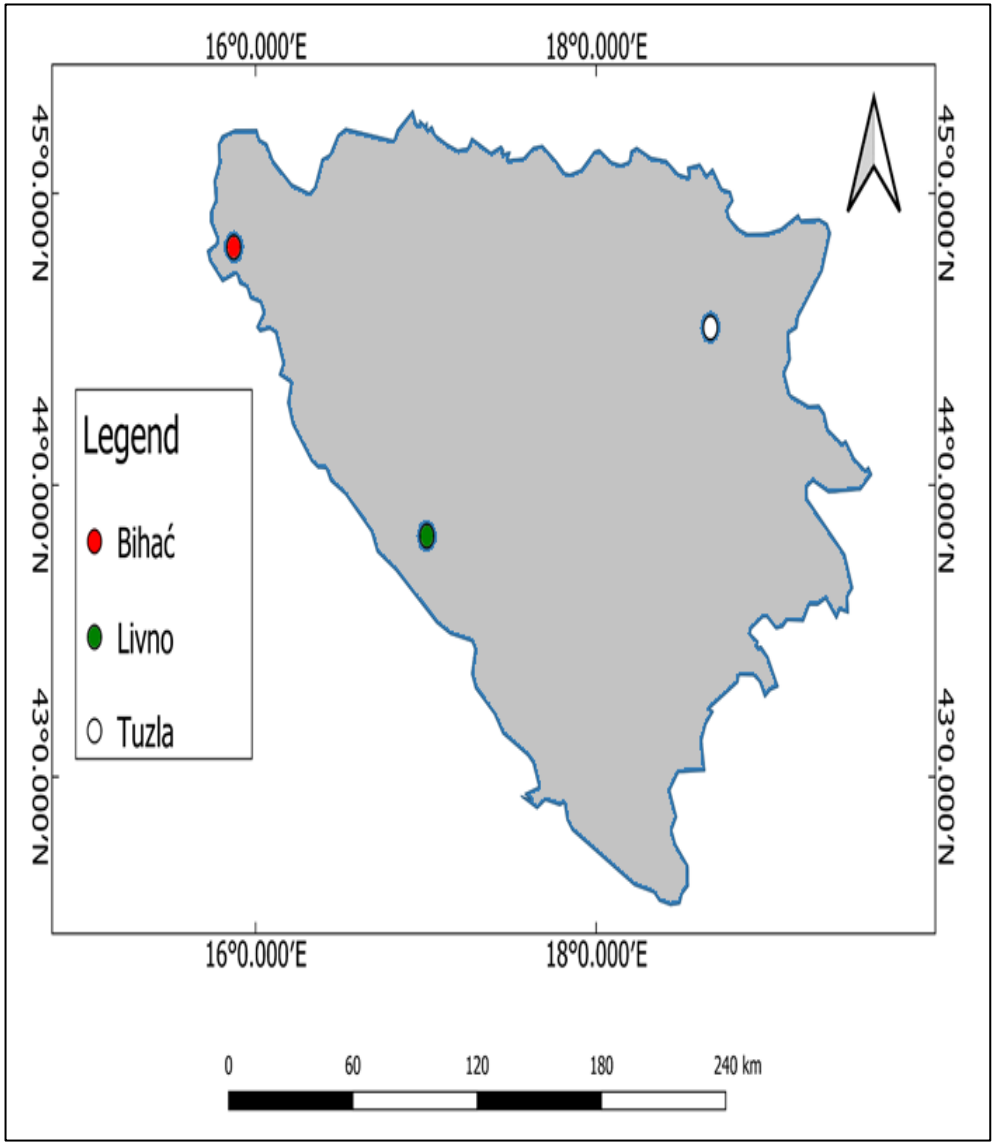
Bihac
Latitude: 44° 49' 0.98" N
Longitude: 15° 52' 14.99" E
Altitude: 230 m a.s.l
Warm oceanic climate

Tuzla
Latitude: 44° 32' 18.31" N
Longitude: 18° 40' 1.52" E
Altitude: 245 m a.s.l
Temperate continental climate

Livno
Latitude: 43° 49' 37.02" N
Longitude: 17° 00' 26.86" E
Altitude: 724 m a.s.l
Temperate oceanic climate



Agriculture sector

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- **2.6 million ha** is agricultural land (**52%** of total land area)
- **48%** remains uncultivated
- **35%** located in mountainous areas
- Only **0.65%** currently irrigated

- Poor productivity and outdated technology
- Extensive farming techniques
- Small and scattered farms
- Limited market access
- Ineffective policies and regulations

- Total water use in 2012: **328,756,000 m³**

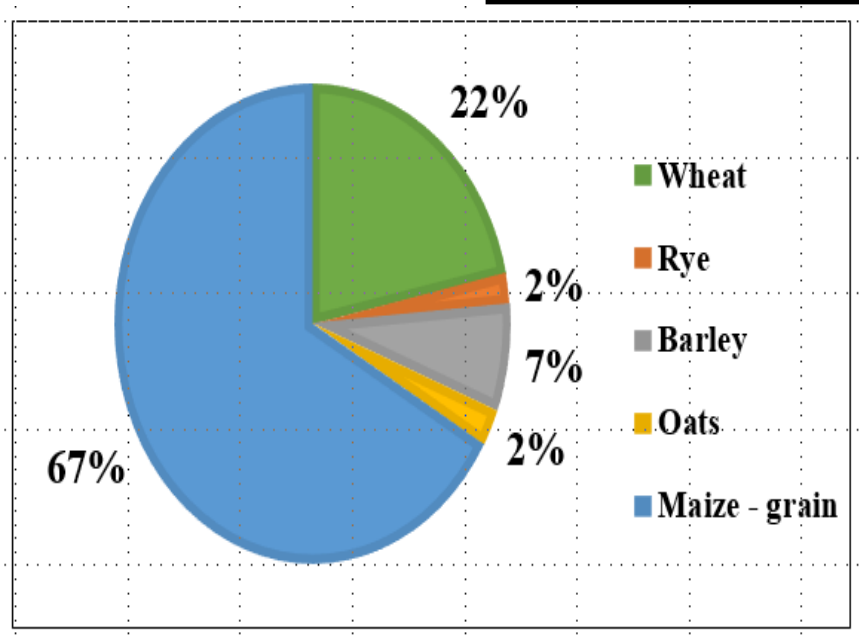
- Household consumption: **77.2%** of water supplied by public systems

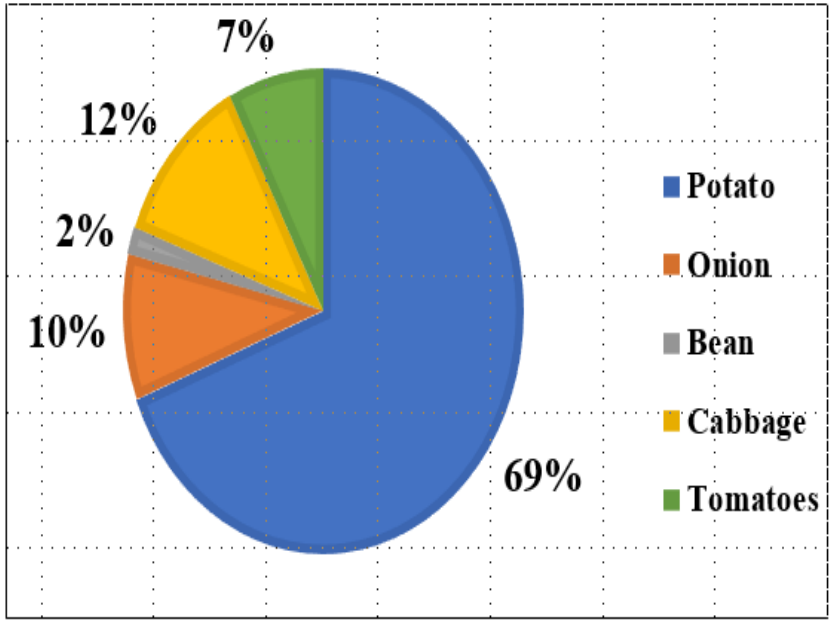
- Sources of water intake: - Subsurface sources: **46.7%**
  - Surface sources: **36.1%**
  - Rivers: **14.7%**
  - Reservoirs: **0.8%**
  - Lakes: **1.7%**

Area harvested (ha)	Production (t)	Yield (t/ha)
Maize		
191,902	963,854	5.02
Wheat		
66,785	266,959	3.97
Potato		
35,384	363,433	10.27

Source: FAOSTAT, 2023

Cereal and vegetable production (t)





Source: Statistical yearbook – BiH, 2022

Literature review – key points

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- Increase in extreme precipitation, air temperature and potential evapotranspiration
- ET_o has been increasing at a rate of **20.59 mm** per decade
- Precipitation has decreased by **30-40 mm**
- Projected **increasing aridity** during the growing season from 2001 to 2030
- The adaptive capacity is low
- The most vulnerable municipalities are located in the northern parts
- Lowland regions are classified as highly vulnerable
- The least vulnerable municipalities are found in the east and southeast of BiH
- **Detailed analysis on regional changes is lacking**

Problem statement

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- Climate change will moderately impact agricultural production in BiH by the end of century
- Bosnia and Herzegovina faces more extreme events, droughts, and high temperatures due to climate change
- Future irrigation needs will rise while water availability for agriculture will decline
- Agriculture in Bosnia and Herzegovina needs structural adjustments to adapt to climate change
- **Limited models obstruct accurate assessment of climate impact on agriculture, forestry and population**

Materials and methods

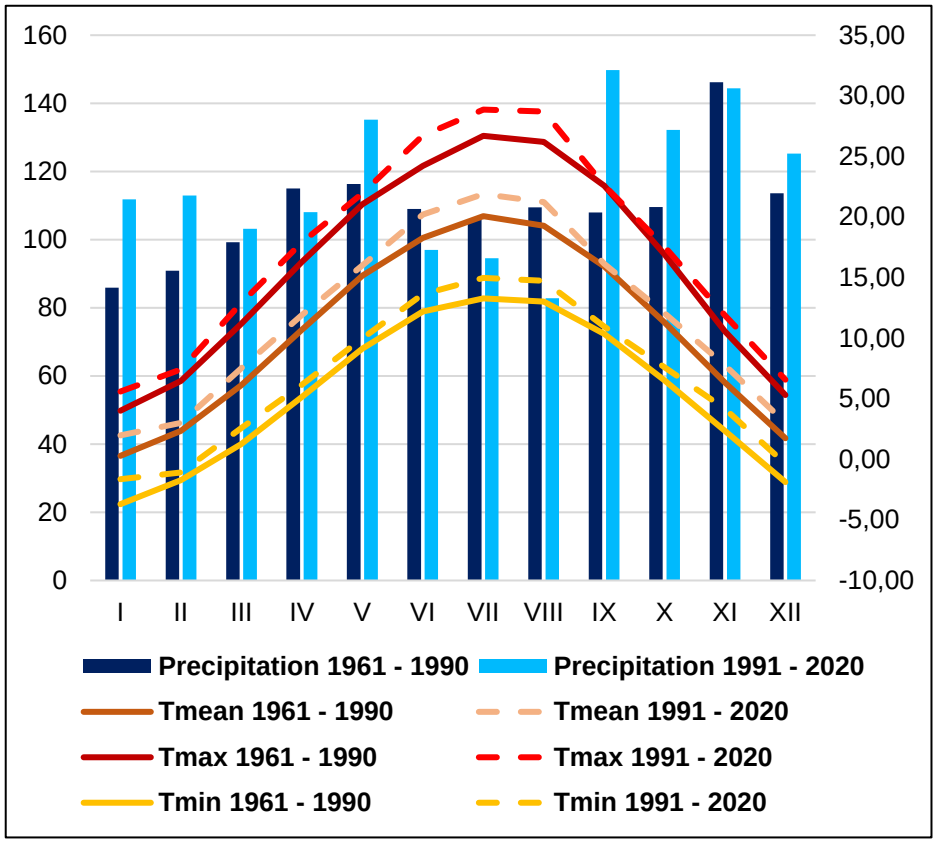
Trend analysis	Formula
Linear regression	$\beta 0 + \beta 1 Xi + \varepsilon i$
Quadratic polynomial regression	$\beta 0 + \beta 1 Xi + \beta 2 Xi^2 + \varepsilon i$
Cubic polynomial regression	$\beta 0 + \beta 1 Xi + \beta 2 Xi^2 + \beta 3 xi^3 + \varepsilon i$
Moving average	$\frac{x1 + x2 + \cdots xn}{n}$

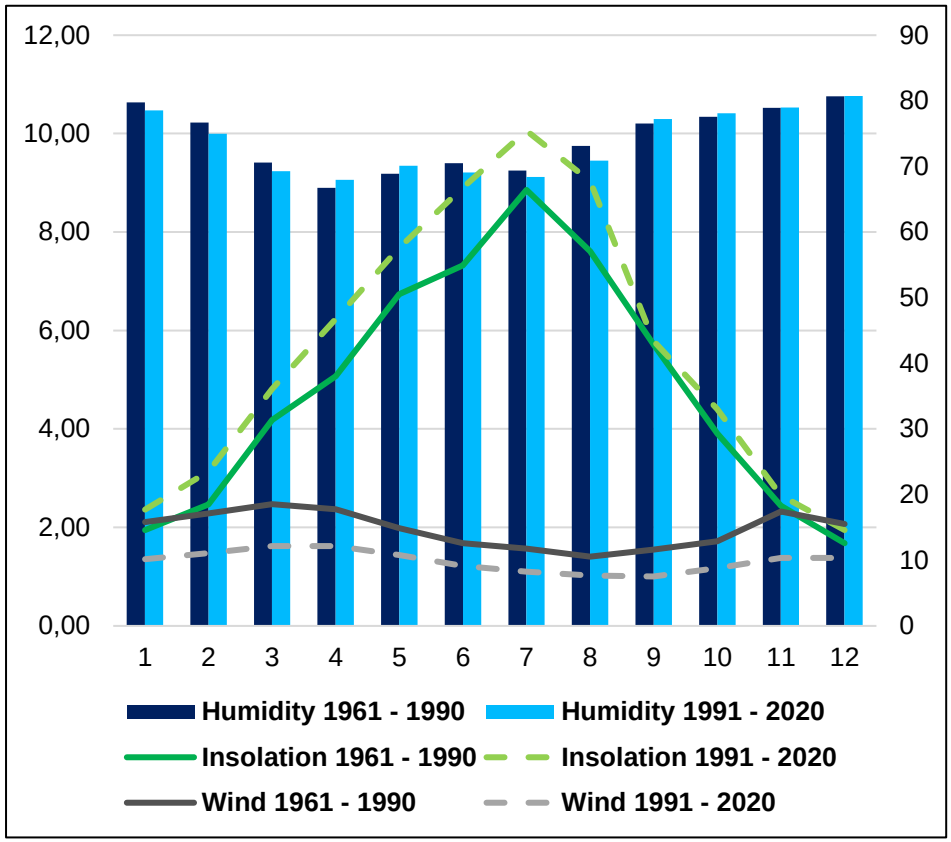
Quality of analysis	Formula
Coefficient of determination	$1 - \frac{\Sigma\,(\hat{y}_i - \bar{y})^2}{\Sigma\,(\hat{y}_i - \bar{y})^2}$
Mean squared error	$\frac{1}{n}\,\Sigma\lvert\hat{y}_i - \bar{y}\rvert$
Mean absolute deviation	$\frac{1}{n}\sum_{i=n}^{n}\lvert xi - m(X)\rvert$
Mean absolute percentage error	$\frac{1}{n}\sum_{t=1}^{n}\left\lvert\frac{At - Ft}{At}\right\rvert$

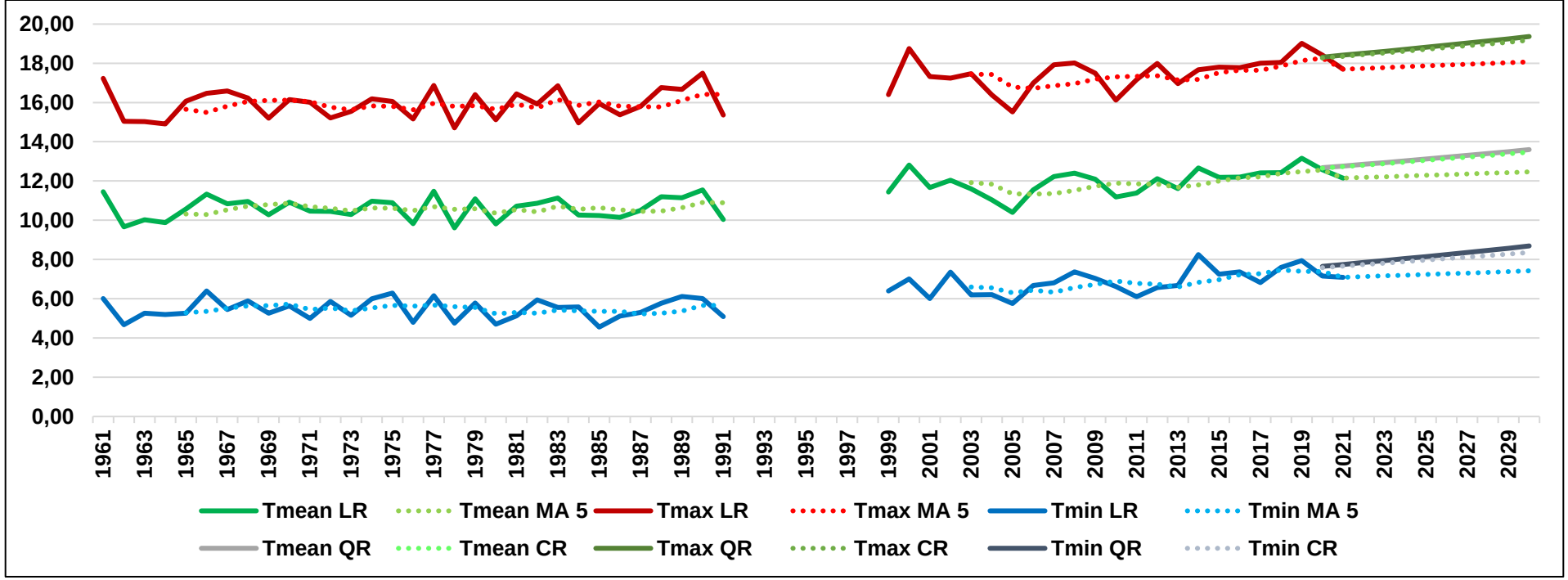
Parameter	Formula
ET_o	Penman - Monteith
ET_c	$ET_c = Kc \times ETo$
GDD	$GDD = \frac{T_{max} + Tm_{in}}{2} - Tbase$
NIR	$NIR = ETc - Pe_{ff}$
YR	$\left(1 - \frac{Y_a}{Y_m}\right) = K_y \left(1 - \frac{ET_{c,adj}}{ET_c}\right)$

Results

Average monthly weather data – Bihać



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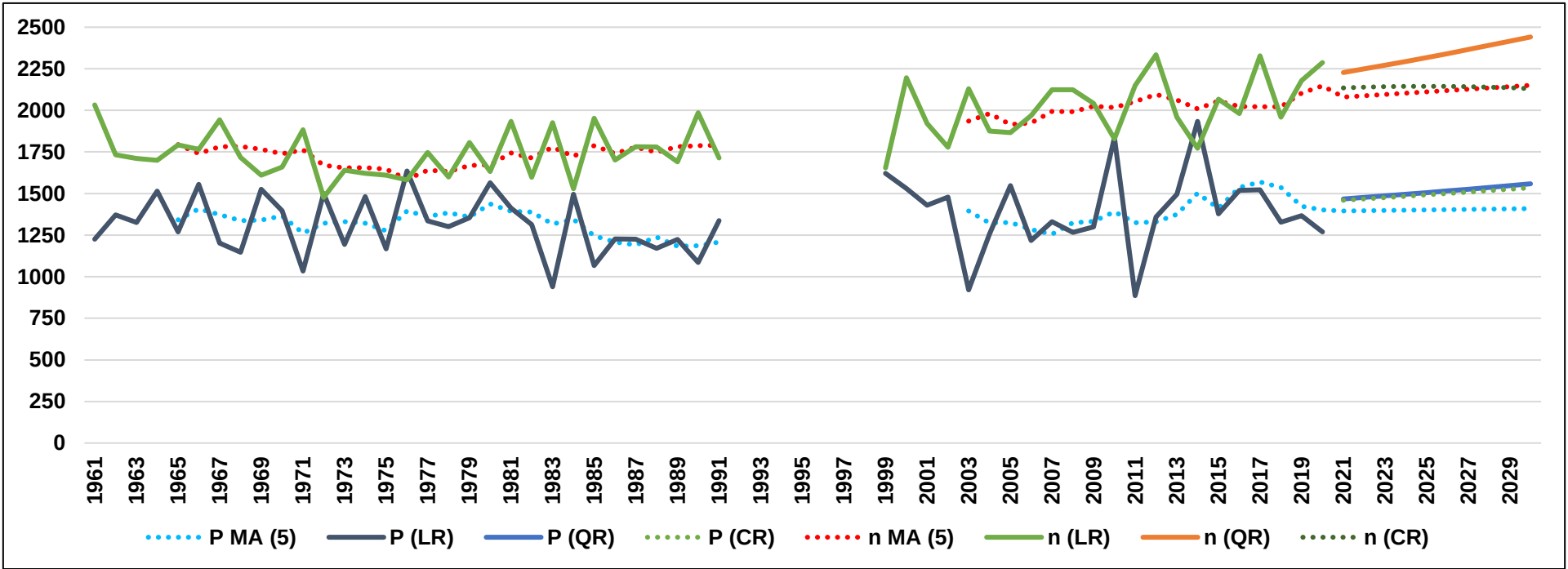
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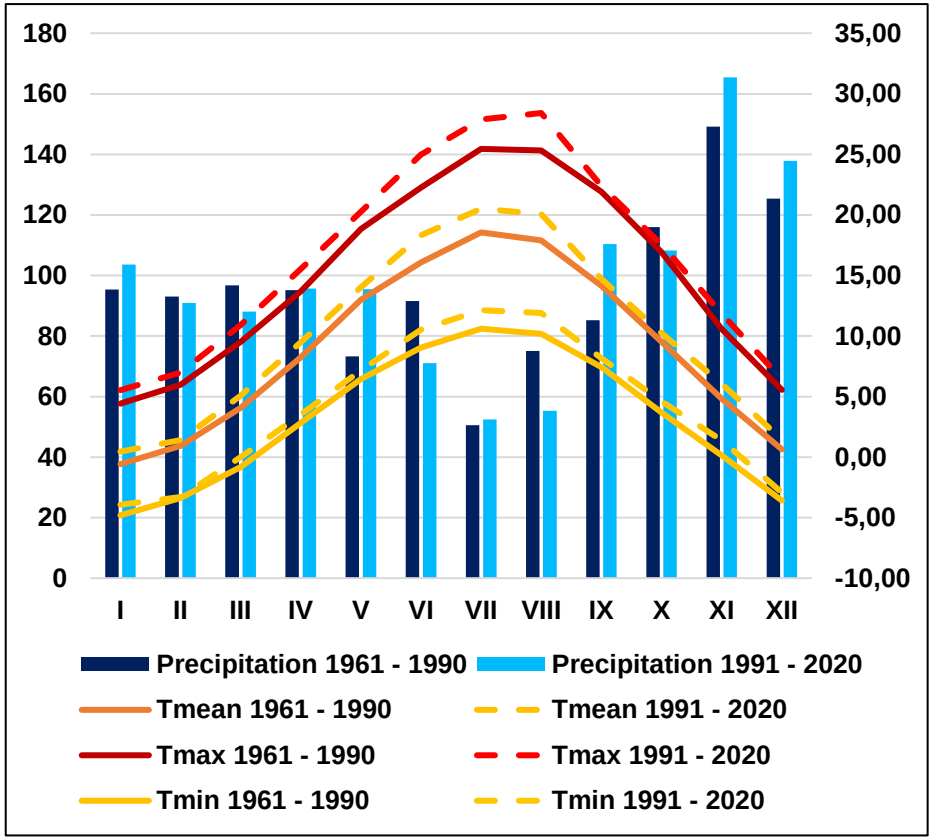
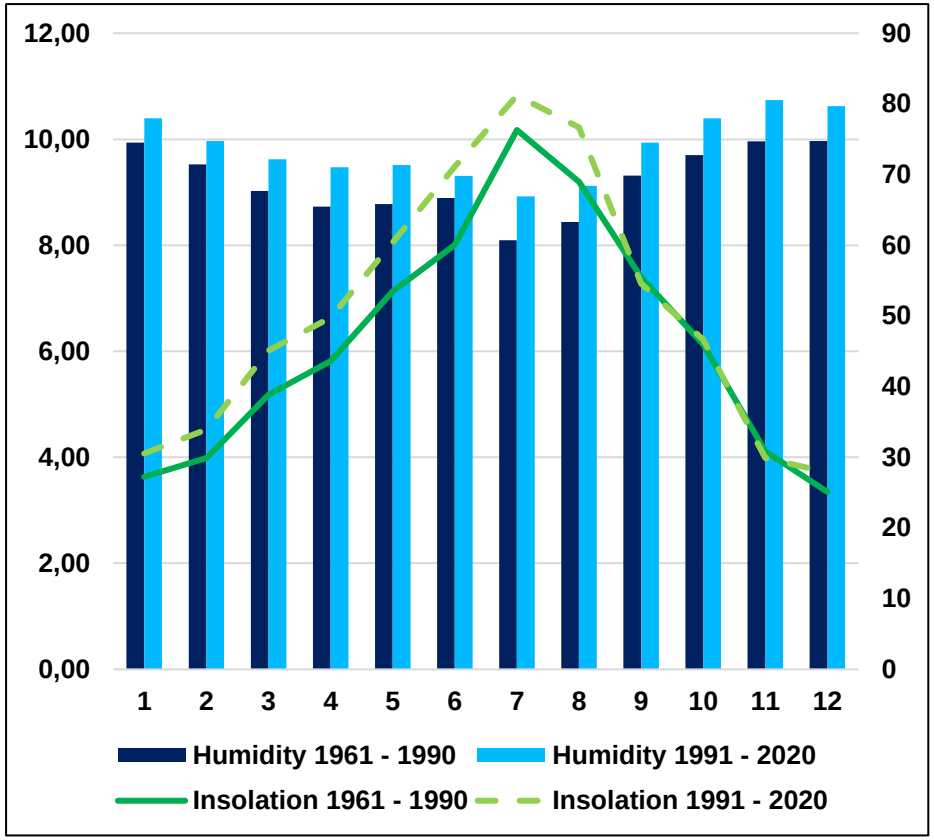
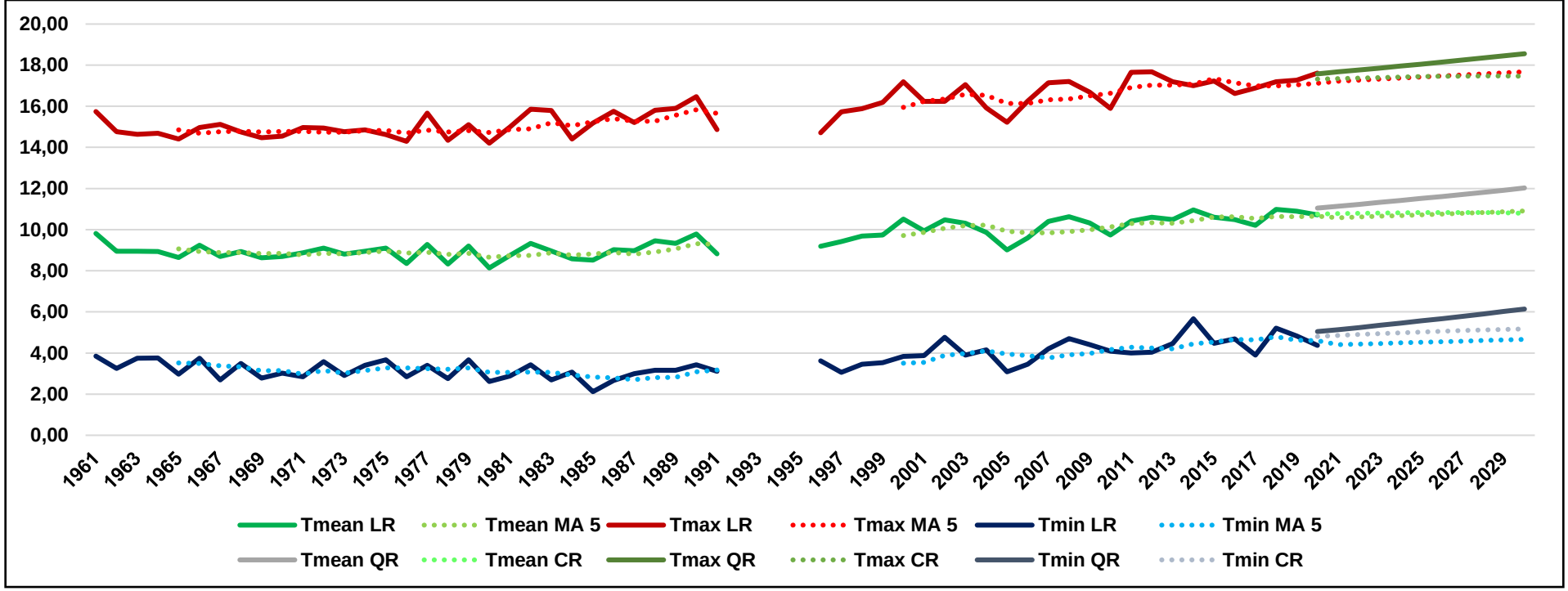
Average monthly weather data – Livno



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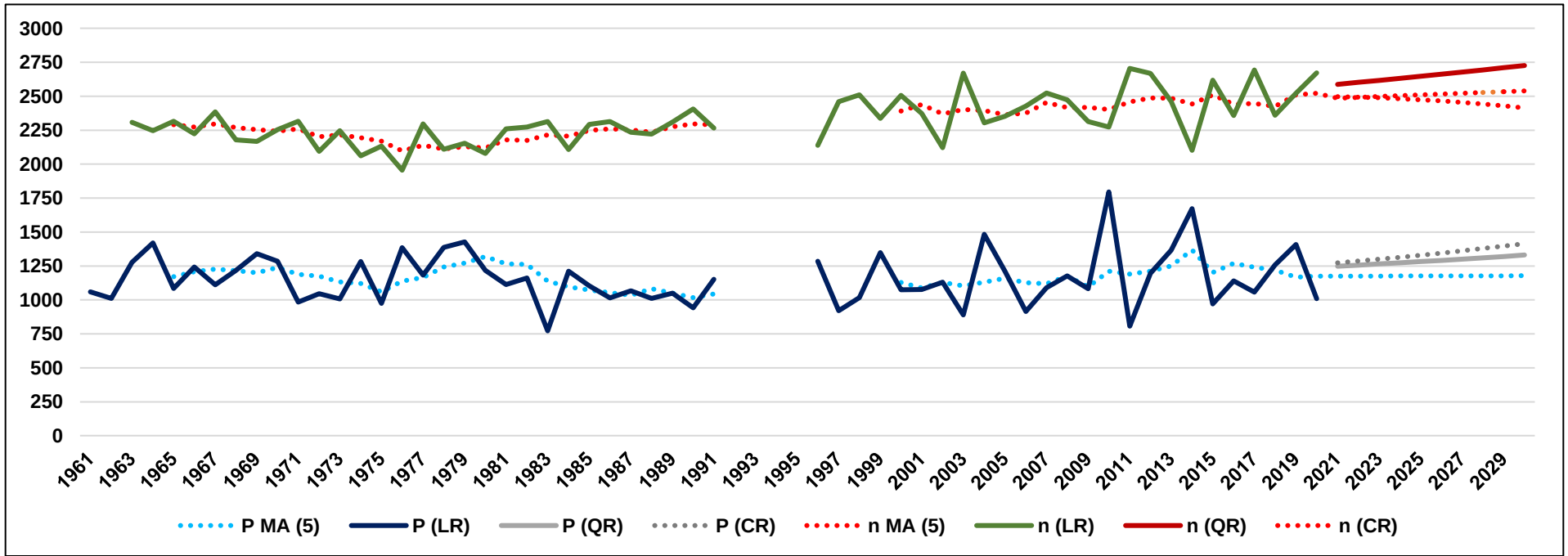
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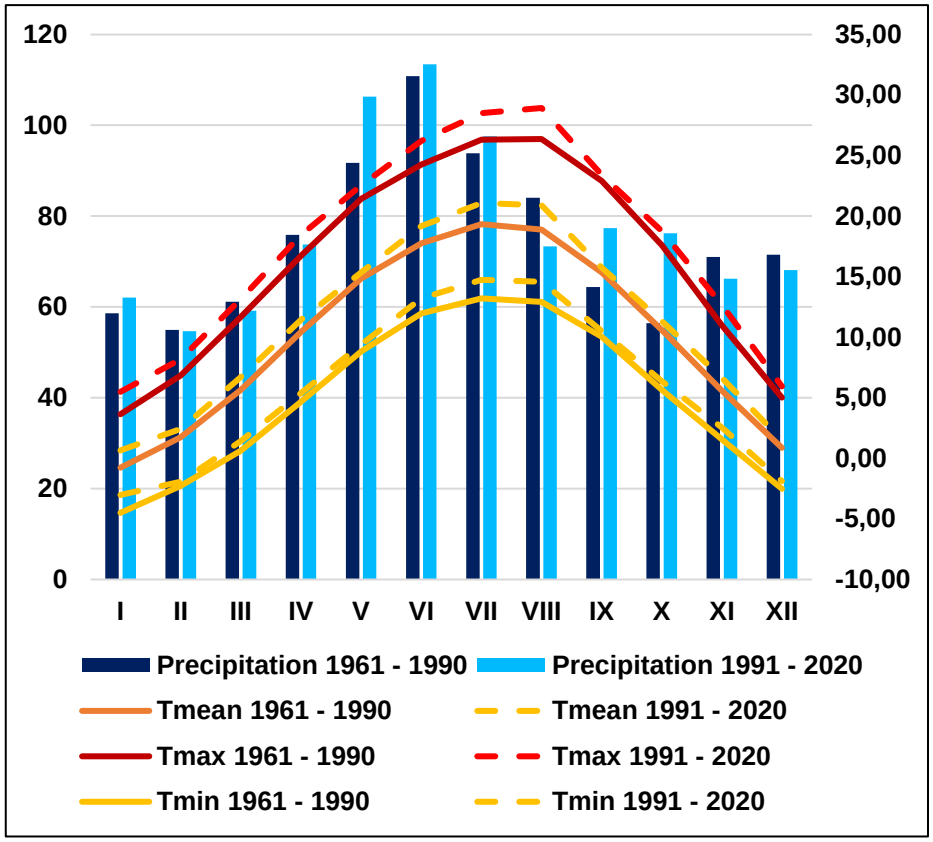
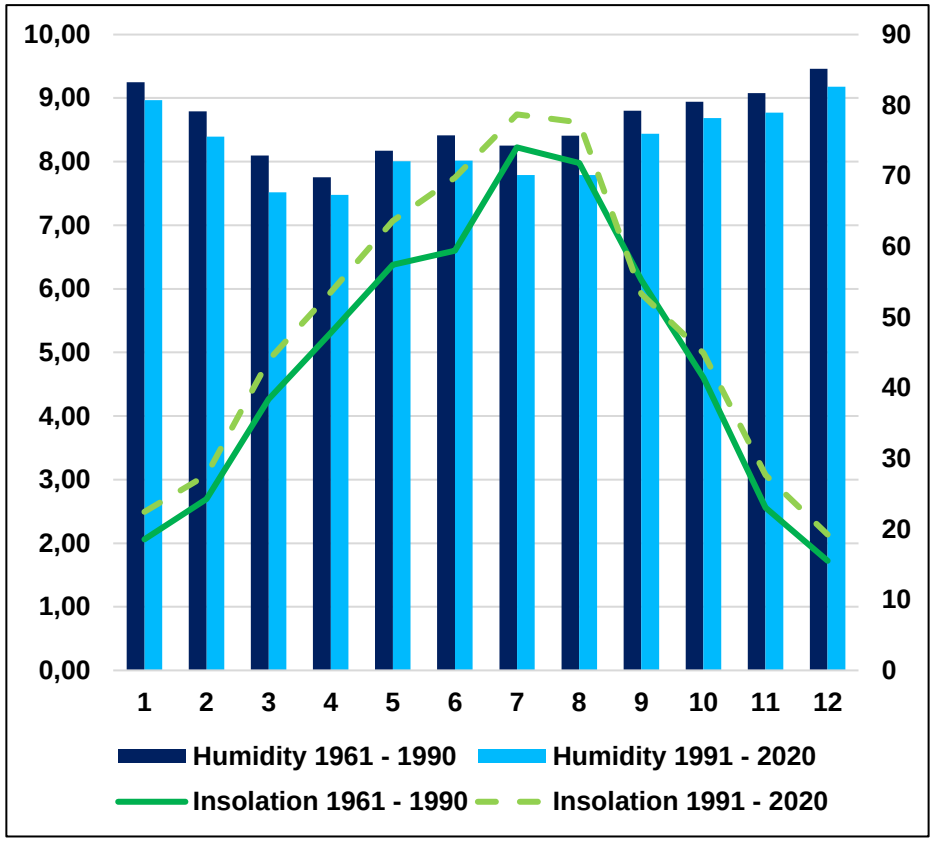
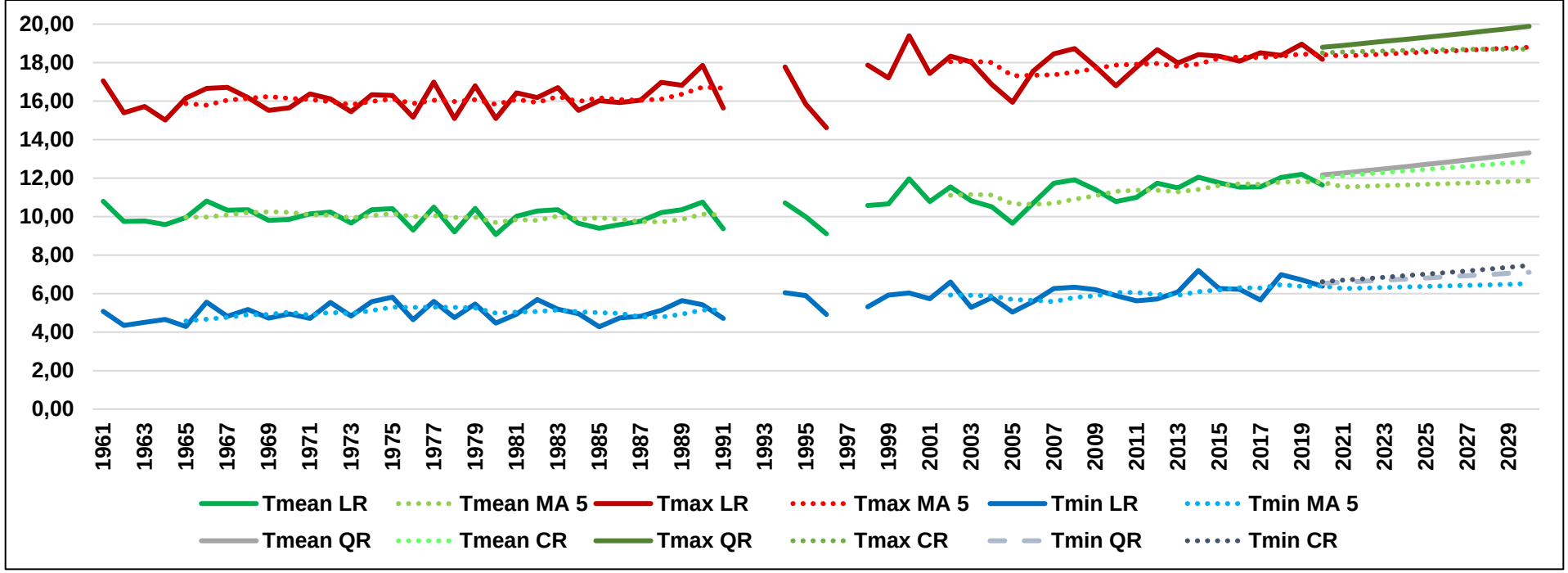
Average monthly weather data – Tuzla



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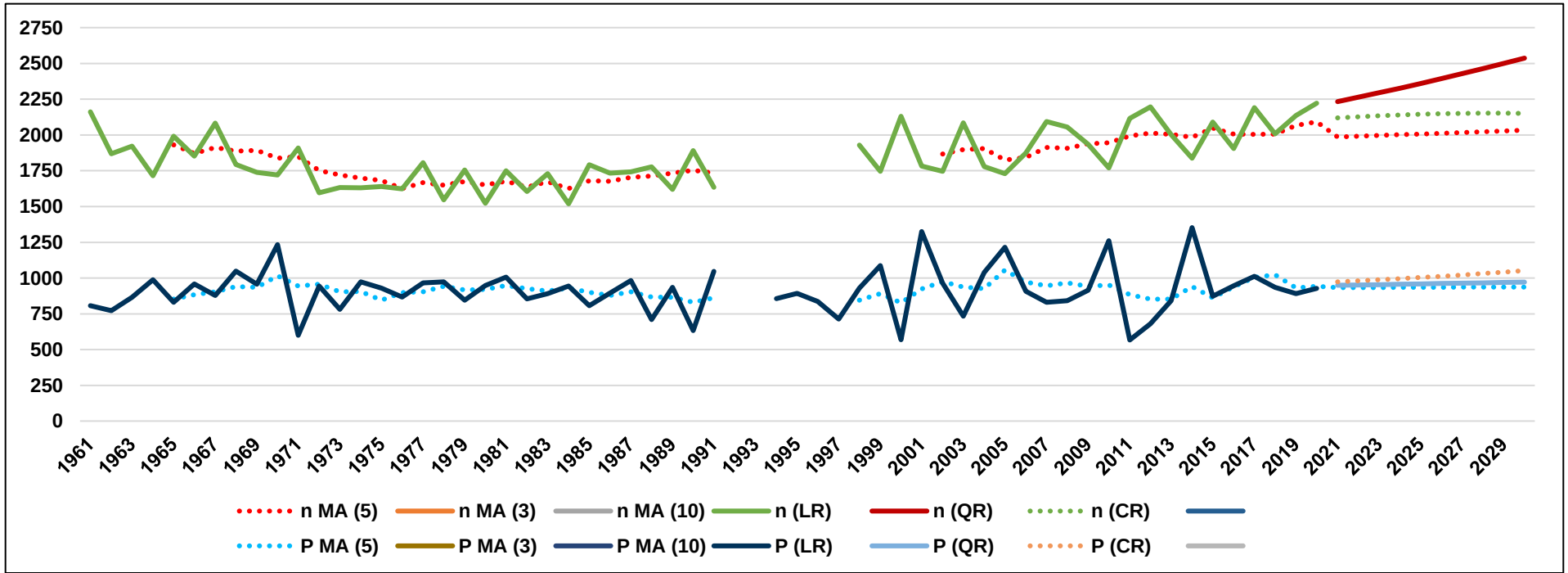
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Upcoming tasks

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1. Input daily weather data (1961-2020) into Excel irrigation tool for all three locations
2. Input location-specific soil physical data (depth, FC, WP)
3. Input crop-specific parameters (yield, T_{base}, T_{cutoff}, growth stages, K_c, K_y)
4. Identify changes in days under stress, ET_o, ET_c, NIR, GDD
5. Examine climate change's severity on agricultural water management
6. Understand climate change's impact on agricultural crop production in BiH
7. Future developing of strategies for water management and crop production

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THANK YOU !

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