

Italian case study

Data & Analysis

Identified datasets and preliminary
data analysis results

Identified datasets

In situ measurements, remote sensing observations and modelled data

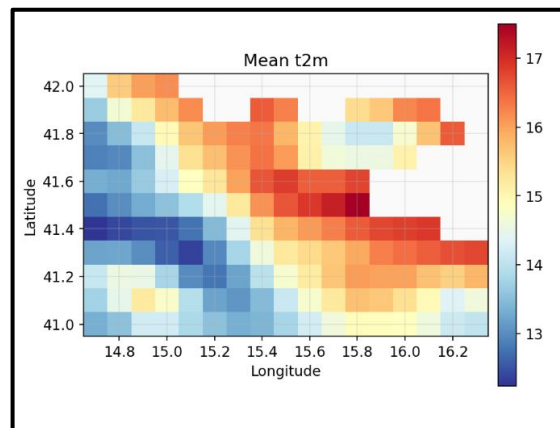


This project is part of the PRIMA programme supported by the European Union

ERA5 - Land

Temporal Resolution	Monthly & Hourly
Spatial Resolution	0.1° x 0.1° (~10 km)
Reference Period	1950(monthly)/1990(hourly) - Ongoing

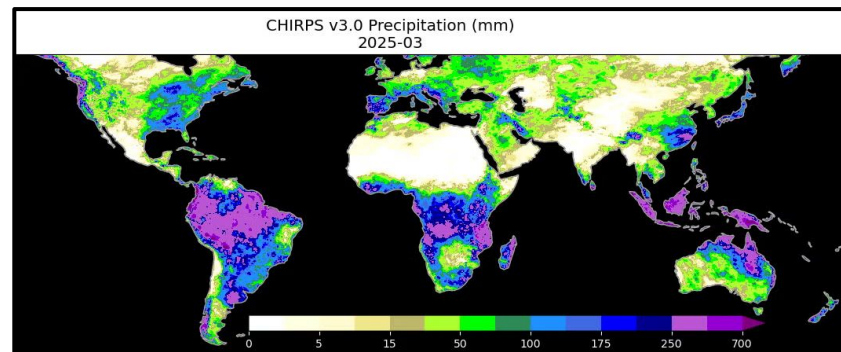
- **ERA5-Land** is a multi-decade climate reanalysis dataset detailing the evolution of global land variables.
- **Copernicus & Satellites:** Produced by the Copernicus Climate Change Service (C3S), it indirectly relies on millions of historical data and modern satellite observations.
- **Global Scope & Variables:** It provides a globally complete and consistent grid, offering a wide set of valuable surface variables useful to understand the climate system and hydrological cycle (e.g., surface temperature, precipitation, soil moisture, evaporation, etc.)



CHIRPS v3

Temporal Resolution	Daily/Pentad
Spatial Resolution	0.05° x 0.05° (~5 km)
Reference Period	1981 - Ongoing

- **High-Resolution Rainfall History:** It is a quasi-global dataset that accurately merges satellite-based infrared estimates with in-situ station observations.
- **Two-Tiered Production System:** It offers a rapidly updated "Preliminary" product delivered just two days after a 5-day period, alongside a "Final" monthly product that incorporates the most comprehensive station data.
- **Flexible Daily Downscaling:** specialized daily downscaling using either ERA5 climate reanalysis ('rnl') or NASA IMERG satellite data ('sat').



In-situ stations

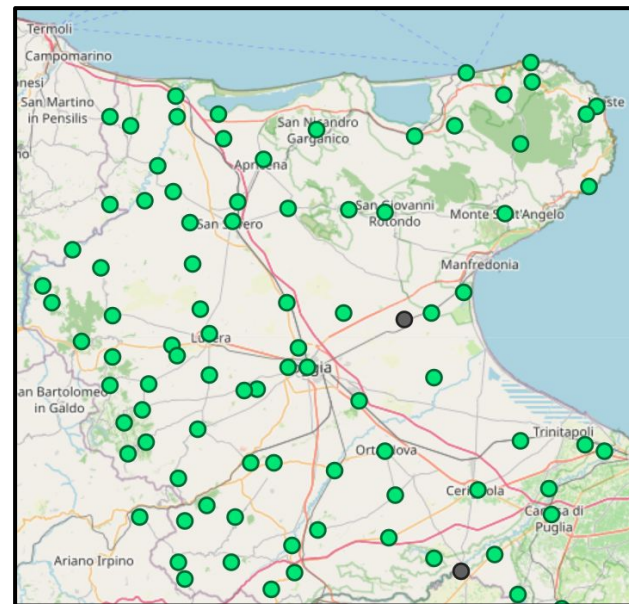
Temporal Resolution

Daily

Reference Period

2010 - 2025

- **Ground-Truth Measurements:** Provides direct, daily physical observations of temperature and precipitation from 2010 to 2025, serving as the gold standard for meteorological accuracy.
- **Validation & Local Trend Analysis:** Import for tracking recent climate extremes, validating satellite or reanalysis models, and understanding micro-climate variations over the last 15 years.



Hydrological yearbooks

Temporal Resolution

Daily

Reference Period

1950 - 1995

- Historical Italian thermometric and pluviometric dataset of the National Hydrographic Service (Servizio Idrografico Nazionale, SII)
- Daily maximum and minimum temperature and precipitation data

TABELLA I - Osservazioni termometriche giornaliere

Anno 1951

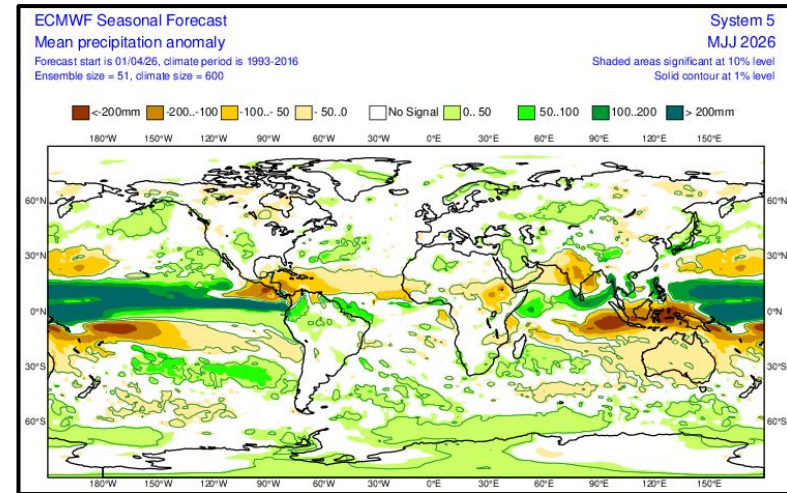
giorno	G		F		M		A		M		G		L		A		S		O		N		D	
	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min
	FOGGIA (Osservatorio)																							
(Tm)	Bacino: CANDELARO											Corso d'acqua: CELONE (74 m s. m.)												
1	10,4	0,5	9,5	3,0	10,5	2,0	20,8	7,5	25,2	10,5	30,4	15,8	31,6	16,1	33,4	16,0	34,0	21,6	23,2	12,2	19,0	9,9	11,8	3,5
2	12,3	3,6	9,2	4,1	9,1	2,6	17,0	2,4	21,0	11,6	31,9	14,8	29,2	16,9	35,5	18,5	31,4	18,2	21,8	11,4	18,5	9,7	16,6	1,4
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4	15,5	4,6	11,7	1,3	10,0	-1,6	20,6	4,0	21,6	11,6	28,4	11,3	26,8	13,0	38,3	21,3	31,0	17,6	22,4	12,0	17,9	5,4	15,9	8,5
5	14,0	5,5	12,5	4,5	9,8	4,2	16,8	6,5	24,5	12,4	23,7	14,4	31,2	18,3	37,6	21,6	22,9	17,2	23,8	13,1	18,2	10,2	12,4	3,8
6	11,5	2,0	13,4	6,1	9,2	4,5	15,3	4,7	24,0	11,4	23,3	13,4	33,0	18,0	38,2	19,5	23,0	16,5	20,6	11,8	20,3	8,9	13,0	2,0
7	11,0	0,6	18,9	7,0	14,3	6,2	18,0	5,0	23,3	10,8	24,5	14,0	29,3	17,1	35,3	20,0	25,6	15,4	18,9	9,5	19,7	8,1	17,7	7,2
8	12,4	0,8	13,5	5,2	13,5	6,4	21,6	8,2	25,0	13,9	27,2	15,7	29,9	17,4	36,2	23,1	26,0	17,3	19,0	10,6	22,6	10,3	15,8	9,5
9	13,5	2,2	12,6	5,0	15,2	5,5	19,8	10,5	24,6	12,0	28,6	15,3	32,6	20,3	37,7	23,9	25,2	15,1	15,6	8,7	17,7	11,7	15,2	6,4
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20	8,7	2,9	17,0	6,5	22,6	12,6	21,2	10,0	21,3	11,1	36,2	19,0	27,4	17,2	28,6	13,9	29,5	17,6	15,6	10,9	15,8	4,4	13,7	1,6
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24	14,4	2,7	15,4	2,6	13,4	2,9	13,5	3,4	28,6	14,0	32,7	21,4	34,8	23,6	23,8	16,6	27,1	17,6	20,8	10,0	13,4	3,4	13,0	0,7
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31	9,0	4,2		20,6	7,2			31,7	14,8			28,6	14,4	34,8	19,5			19,0	6,6			8,0	-0,2	
Medie	11,9	3,0	14,2	4,6	15,3	5,3	19,2	7,2	24,3	11,9	29,9	15,7	30,6	17,9	32,5	18,6	28,3	16,5	18,5	9,7	17,4	7,3	13,1	3,2
M.mens.	7,5		9,4		10,3		13,2		18,1		22,8		24,3		25,5		22,4		14,1		12,3		8,2	
M.norm.	6,4		7,3		10,1		13,6		18,1		22,8		25,8		26,0		22,0		17,0		12,0		8,0	

ECMWF (European Centre for Medium-Range Weather Forecasts)

Seasonal Forecasts

- **Core Forecasting System:** The ECMWF SEAS5 produces monthly seasonal forecasts using a 51-member ensemble to predict precipitation over the next 6 months.
- **Climatological Baseline:** Forecast statistics are calculated by comparing current ensemble predictions against a 24-year (1993–2016) historical model distribution.

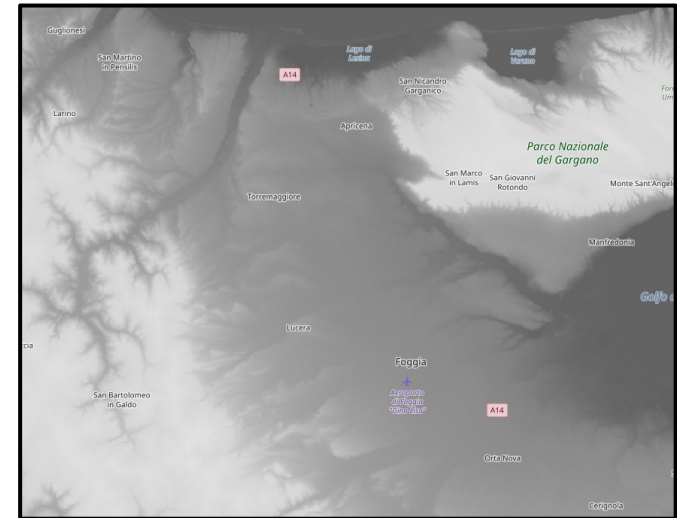
Spatial Resolution	~36 kilometers
Release Frequency	Monthly
Reference Period	1981 - Onwards



DEM - Digital Elevation Model

- **Digital Surface Model (DSM):** Represents the Earth's surface topography, with specialized edits for water bodies and terrain consistency.
- **Global availability:** The model, released by the Copernicus programme, is freely available for all users and encompasses the entire world.

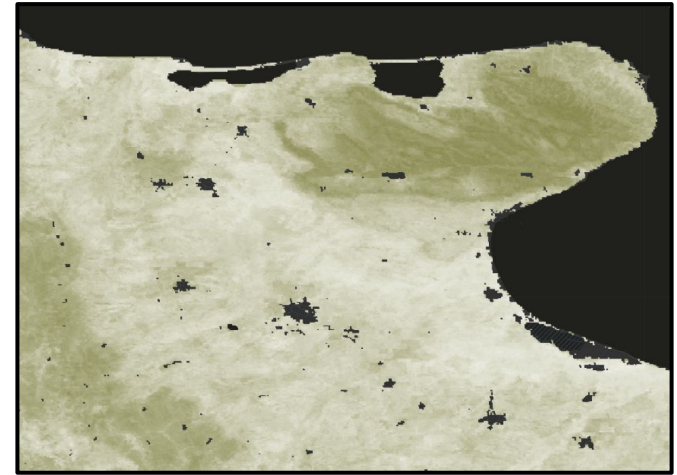
Spatial Resolution	30 meters
Acquisition Period	2011 - 2015



Soilgrids (v2)

Spatial Resolution	250 meters
Acquisition Period	2017 - Present

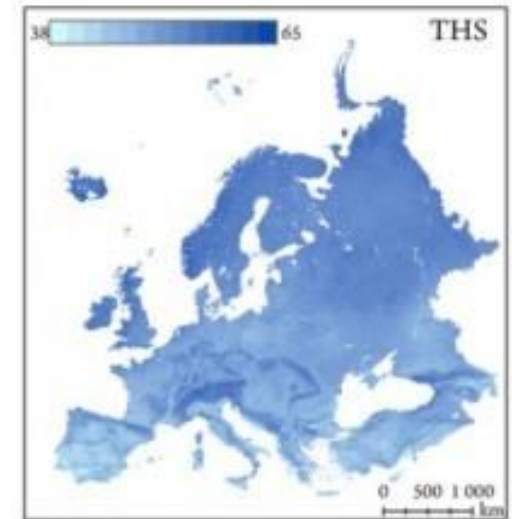
- **Global Mapping via Machine Learning:** SoilGrids uses state-of-the-art machine learning to predict soil properties globally, combining over 230,000 physical soil profile observations with hundreds of environmental satellite data layers.
- **High-Resolution Properties:** It generates 250-meter resolution maps for soil characteristics (such as pH, organic carbon, texture and water content) across six standardized depth intervals, maxing out at 200cm.
- **Global availability:** this dataset is publicly accessible on a global scale.



EU - SoilHydroGrids

Spatial Resolution	250 meters
Reference Period	2017

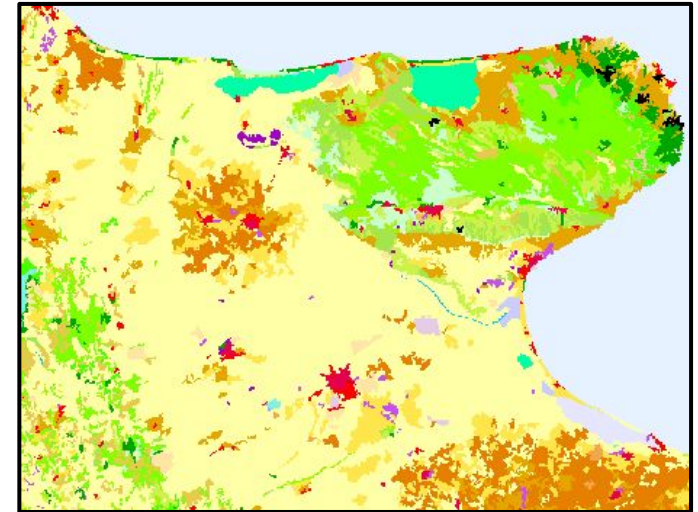
- **Foundation & Methodology:** The EU-SoilHydroGrids database was created by applying specialized European pedotransfer functions (trained on over 18,000 physical soil samples) to the high-resolution data from SoilGrids.
- **Key Hydraulic Parameters:** It provides detailed spatial data on essential soil moisture metrics, including saturated water content, field capacity, wilting point, and comprehensive hydraulic conductivity curves.



CORINE - Land Cover

Spatial Resolution	100 meters
Release Frequency	Every 6 years (2 years delay)
Reference Period	1990 - Ongoing

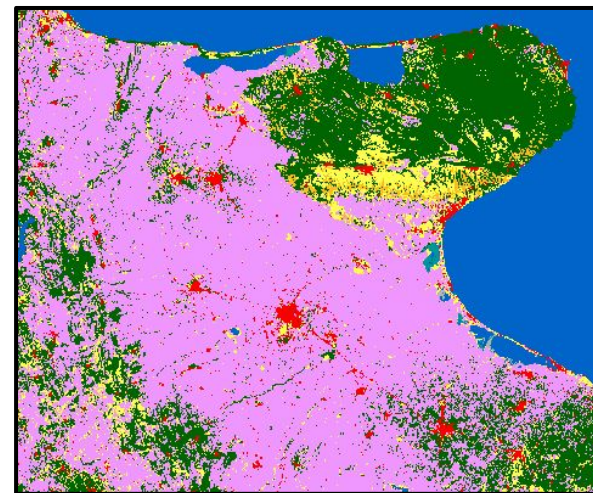
- **Standardization:** it provides a harmonized, continent-wide methodology for mapping European land cover and land use.
- **Detailed Classification & Updates:** The pan-European inventory features 44 specific thematic classes—ranging from urban areas to individual vineyards—and is systematically updated with new status and change layers every six years.



Global Dynamic Land Cover

Spatial Resolution	100 meters (2015 - 2019)
	10 meters (2020 - Ongoing)
Release Frequency	Yearly (2 years delay, more for new version)

- **Global Scope:** Provides dynamic, worldwide land monitoring to track macro-trends like urbanization and agricultural area changes
- **Annual Mapping:** Delivers consistent yearly land cover maps with multi-level classifications, although they remain more general than CORINE.



Crop Types & Crop Patterns

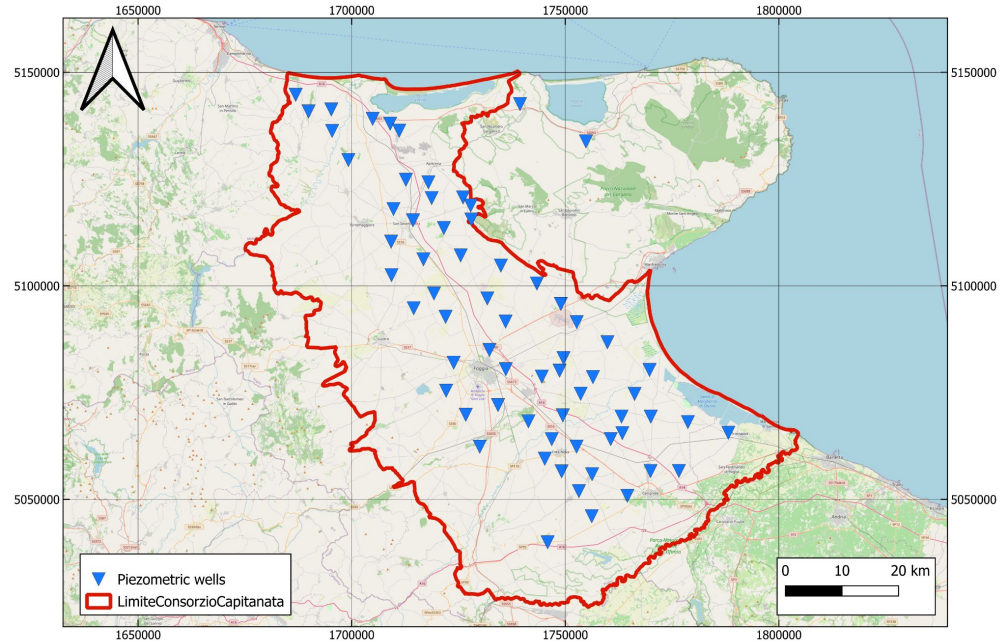
Spatial Resolution	10 meters (MMU = 0.25 ha)
Release Frequency	Yearly (3 years delay)
Reference Period	2017 - Onwards

- **Detailed Agricultural Insights:** Features a "*Crop Types*" layer to identify specific cultivations, alongside a "*Cropping Patterns*" layer that tracks vital cycles like emergence, harvest, bare soil periods, and crop rotation.
- **Policy-Driven Purpose:** Designed to support key EU sustainability initiatives, by monitoring the environmental and climate impacts of agriculture.

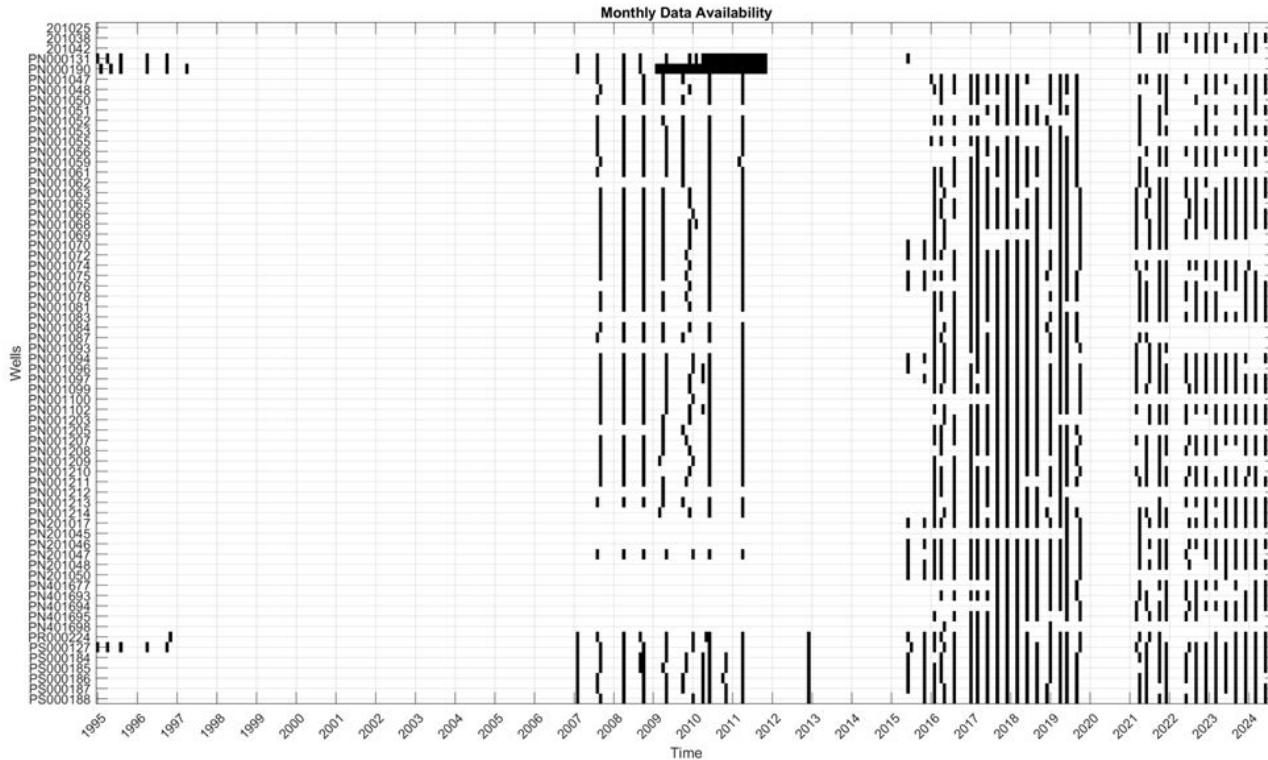


Groundwater data

- **Piezometric wells:**
elevation of the piezometric surface at given locations
- **Temporal coverage** from 2007 to 2025, almost continuous
- **Temporal resolution** can be considered seasonal



Groundwater data



Groundwater data

- Groundwater quality wells

Specific electrical conductivity

Dissolved oxygen

pH

Redox potential

Temperature

Turbidity

Ammonia (ammonium ion)

Nitrates

Bromides

Chlorides

Fluorides

Phosphates

Nitrites

Sulfates

Calcium

Magnesium

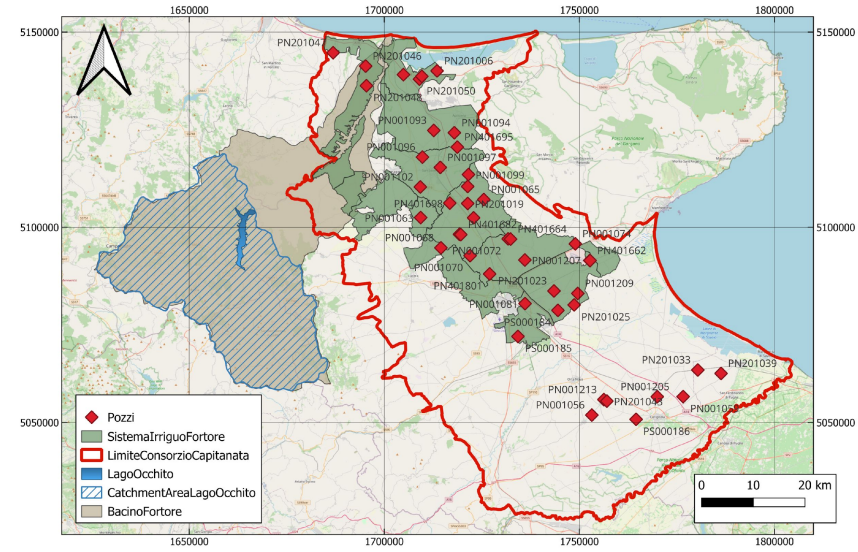
Potassium

Sodium

Total alkalinity (as HCO₃⁻)

Ion balance

Free cyanides



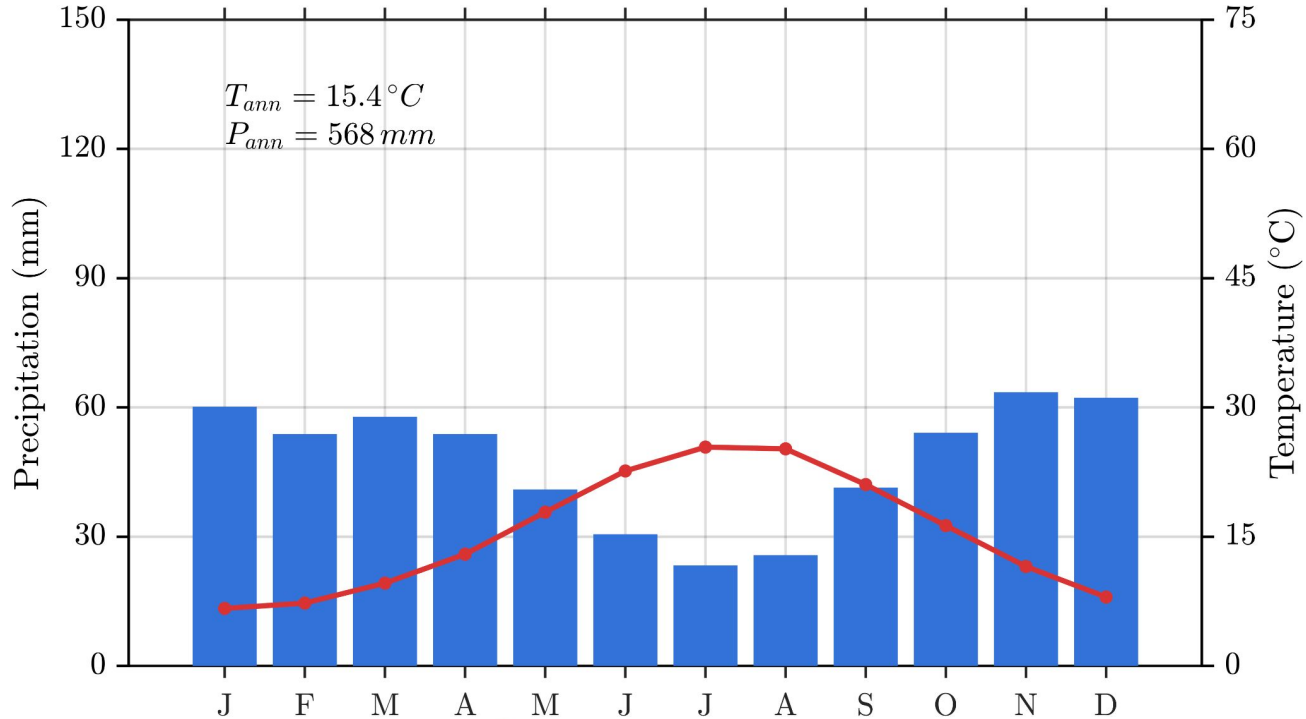
Temporal coverage: 2015 - 2024

Data analysis results



This project is part of the PRIMA programme supported by the European Union

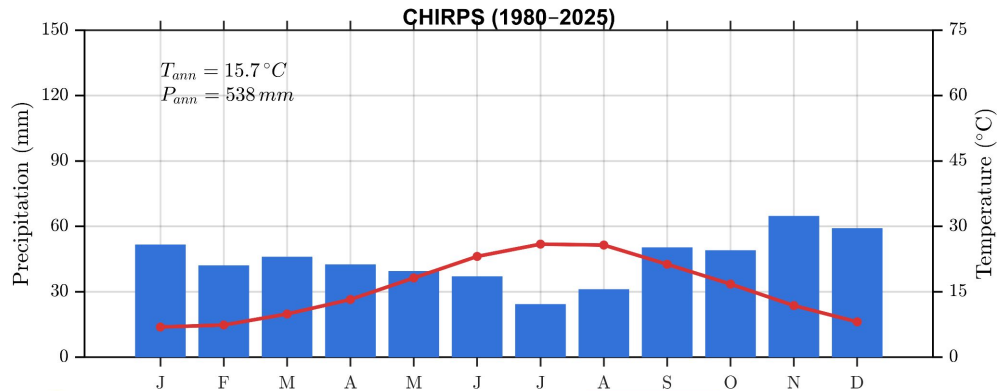
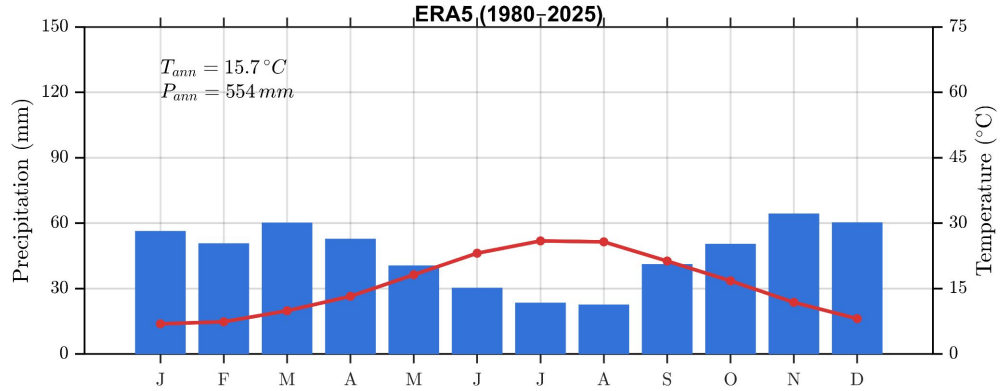
Capitanata, Italy - ERA5 climatology



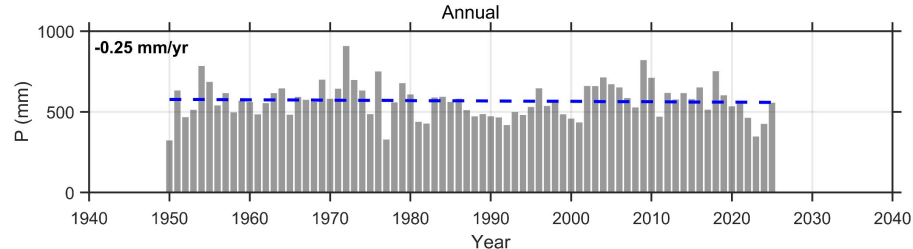
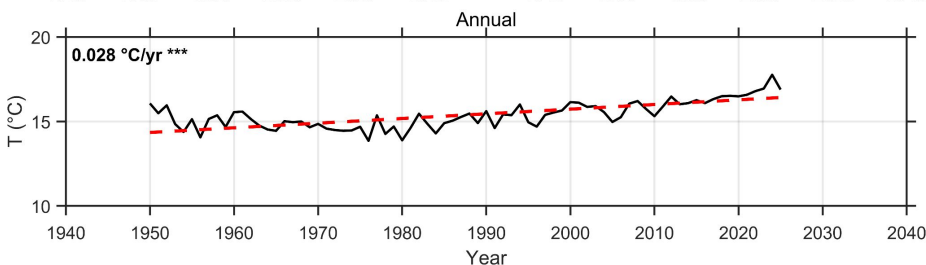
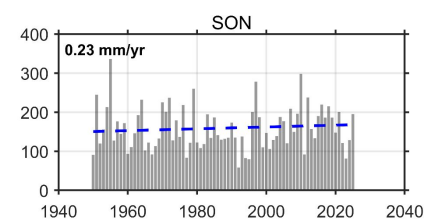
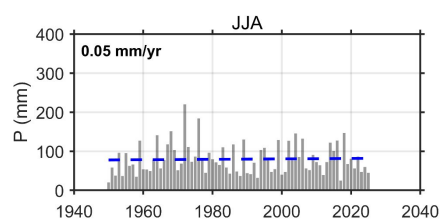
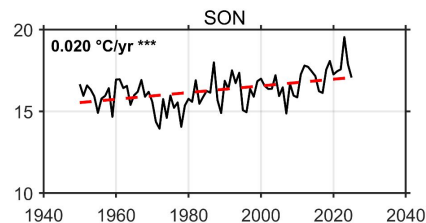
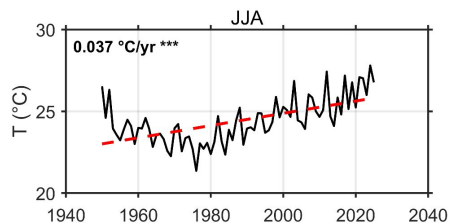
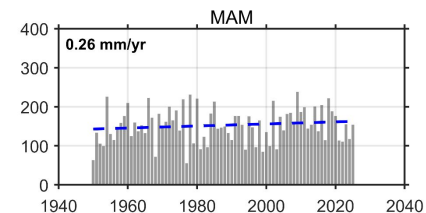
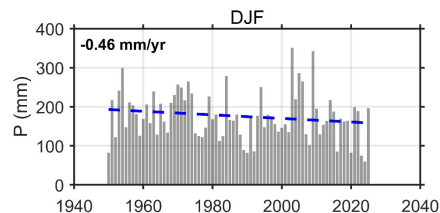
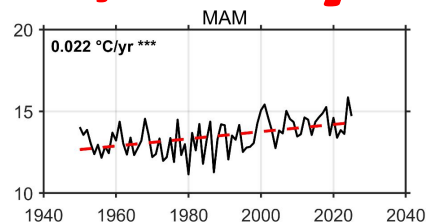
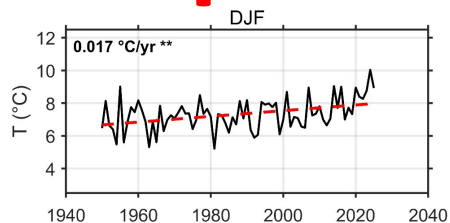
Capitanata, Italy - ERA5 vs CHIRPS climatology

Uncertainty related to the choice of the reference dataset

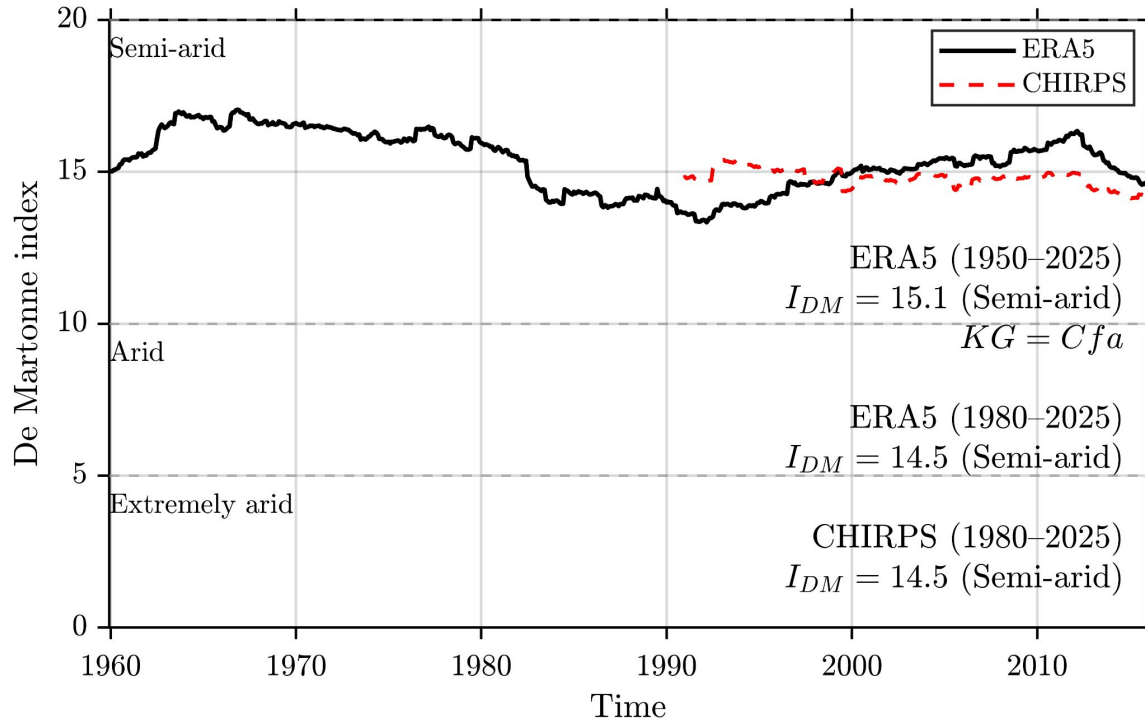
E.g. difference in total annual Precipitation between ERA5 Land and CHIRPS datasets (554 mm vs. 538 mm)



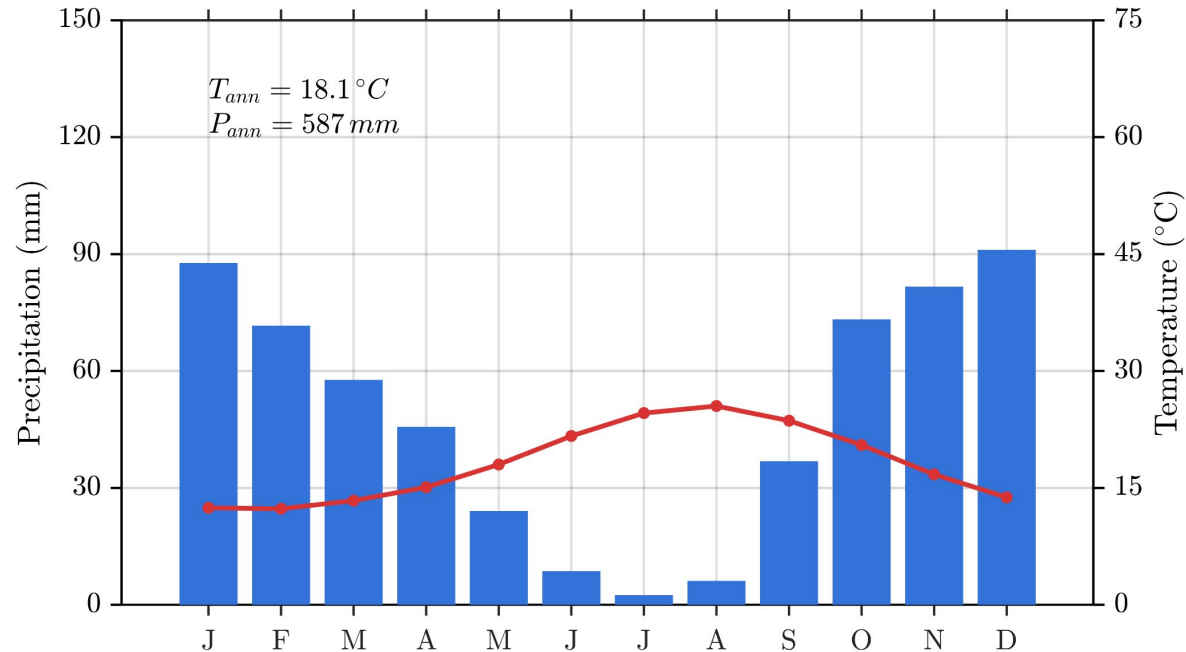
Capitanata, Italy - ERA5 trends



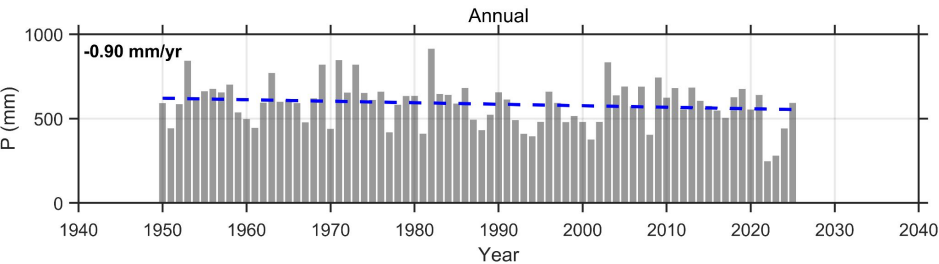
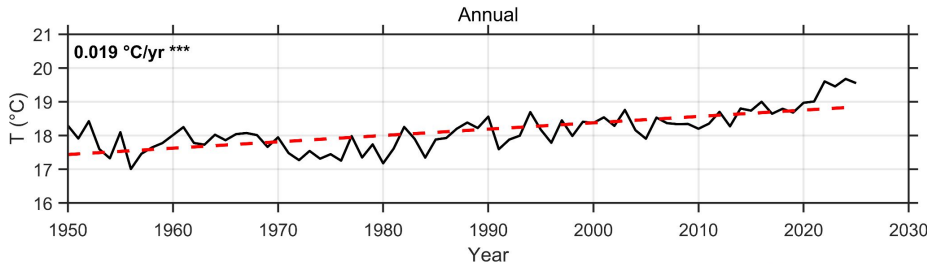
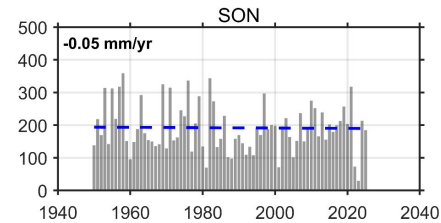
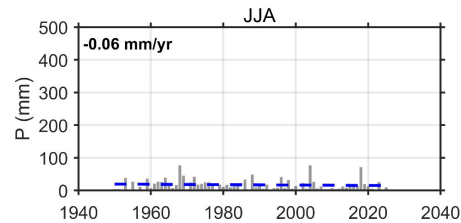
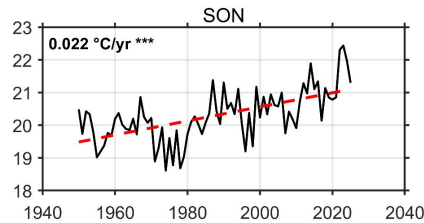
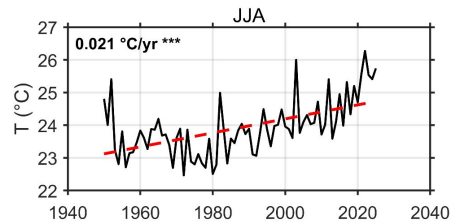
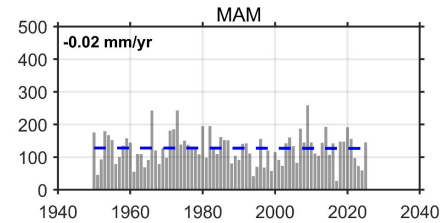
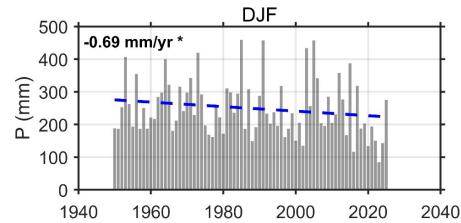
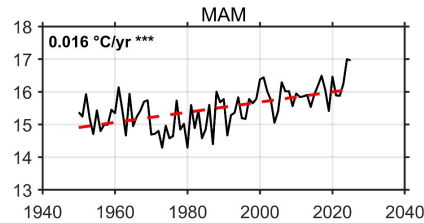
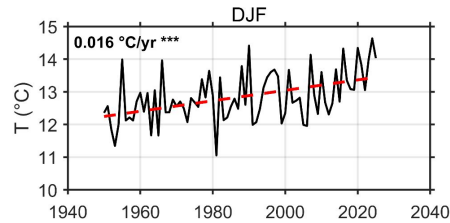
Capitanata, Italy - ERA5 climate classification



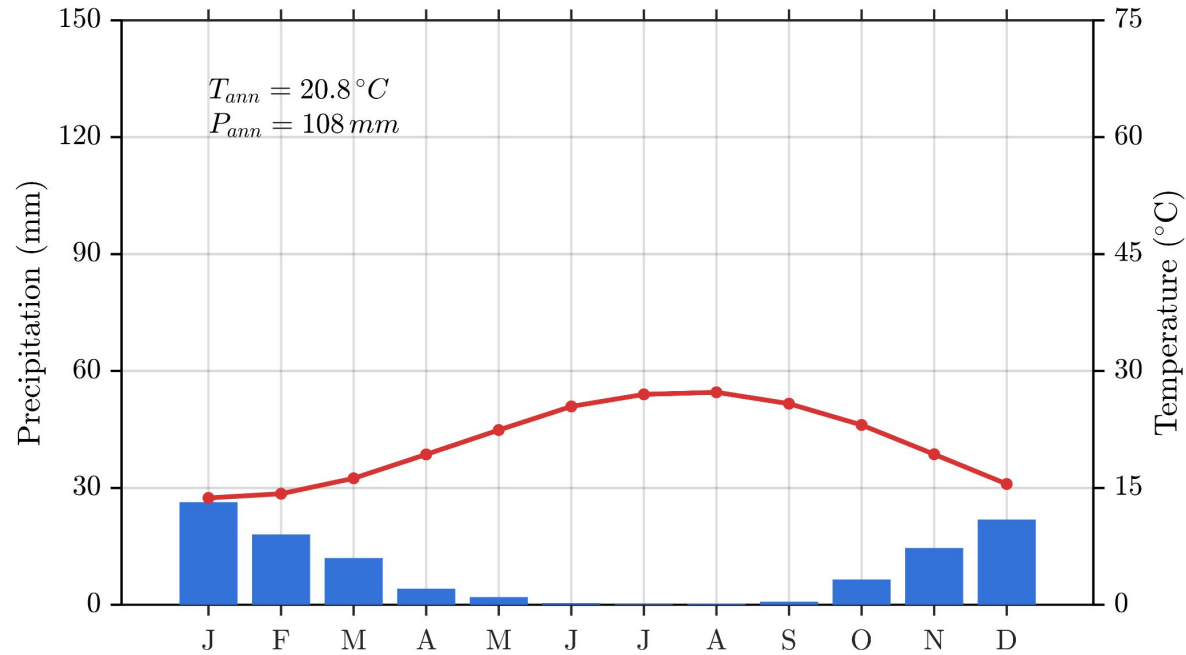
Ras Jabel, Tunisia - climatology



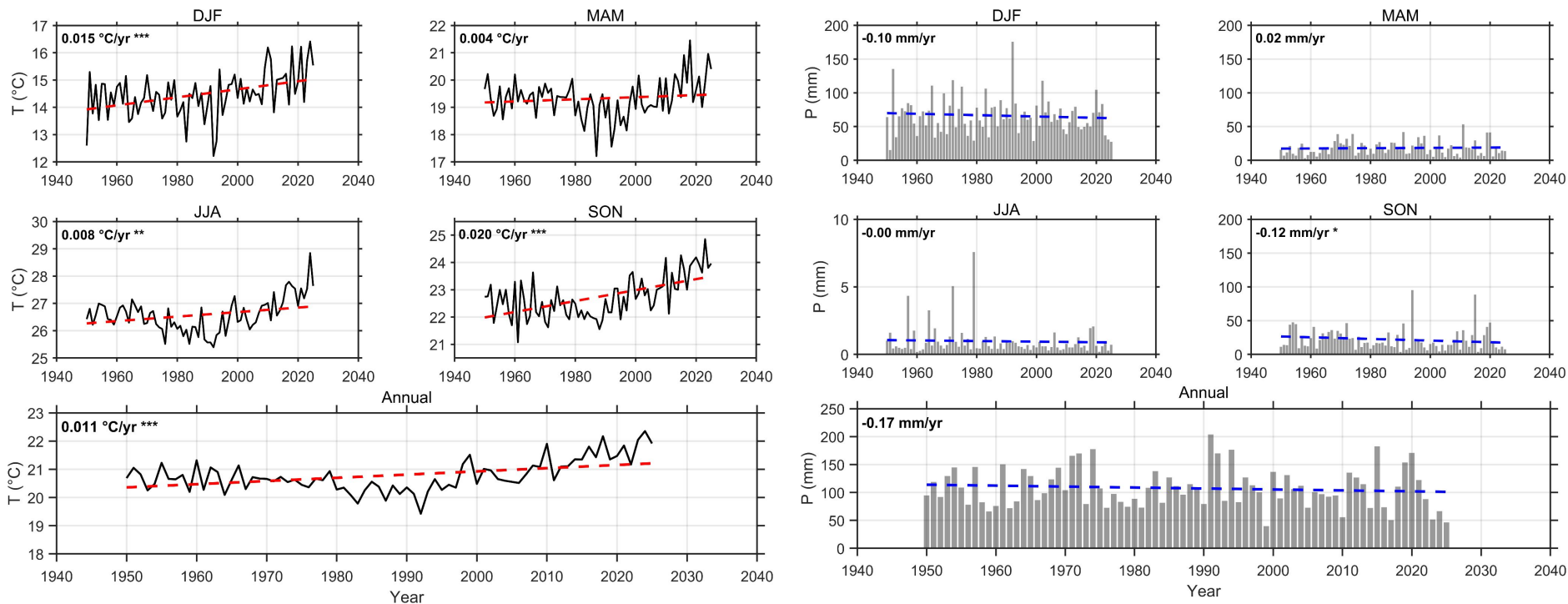
Ras Jabel, Tunisia - trends



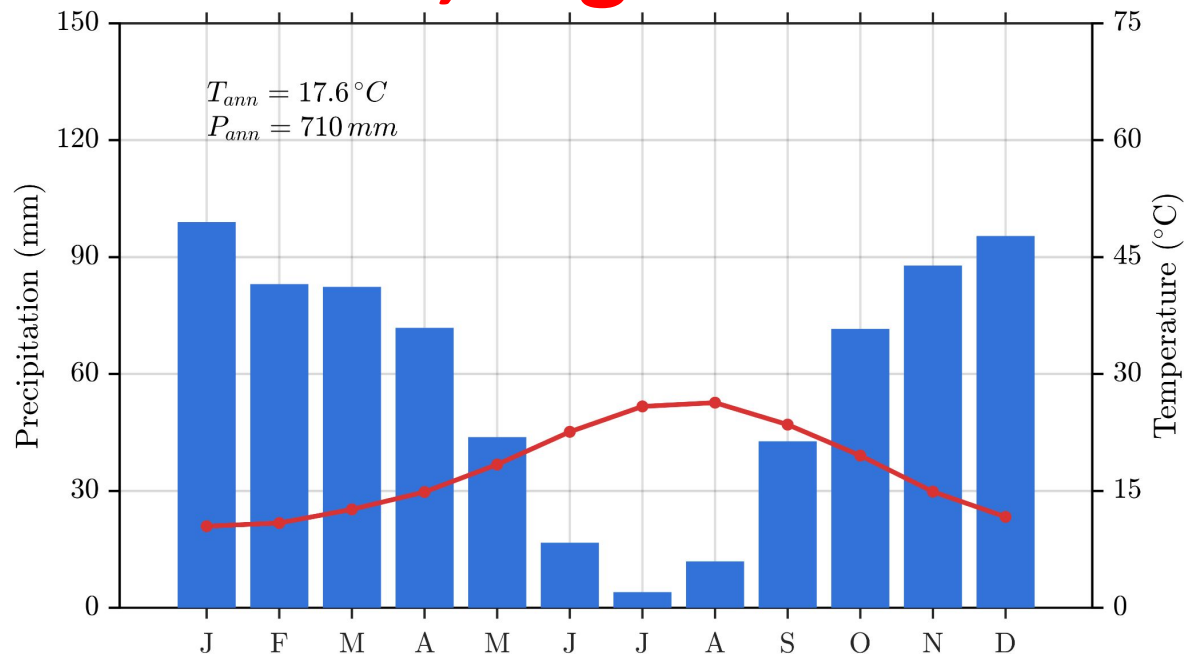
The Coastal Nile Delta Basin - climatology



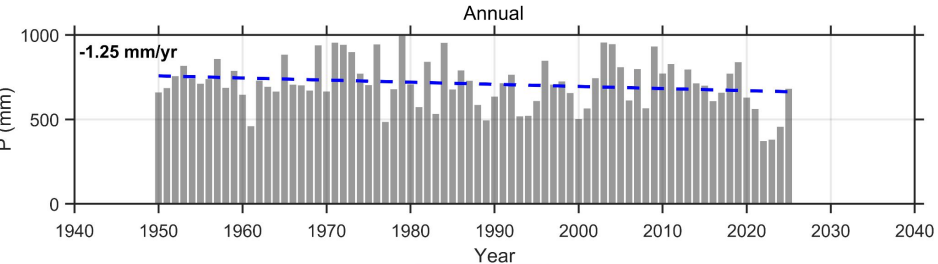
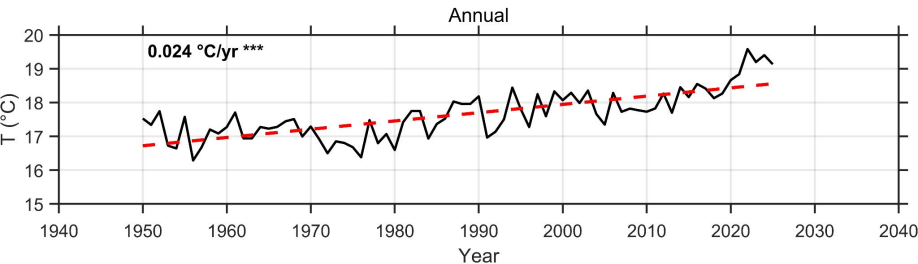
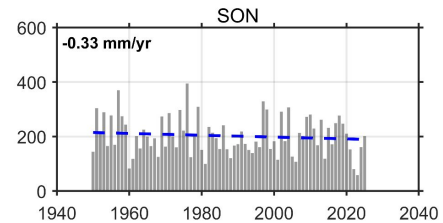
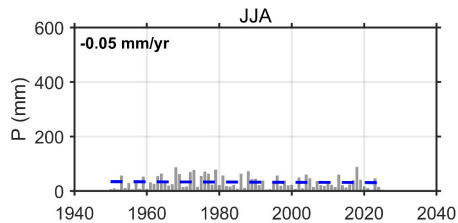
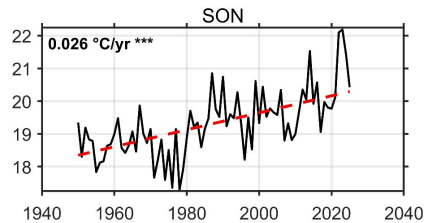
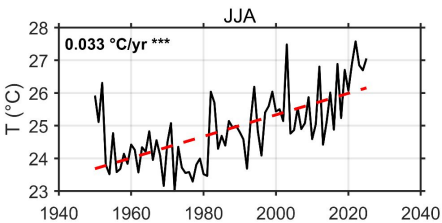
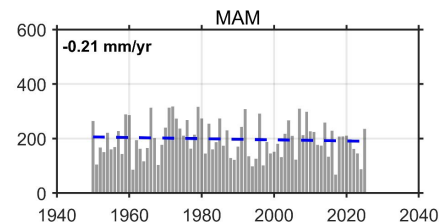
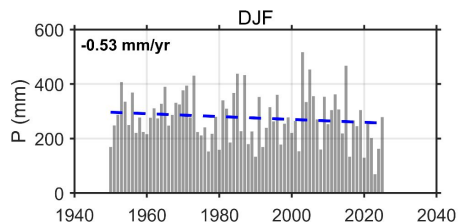
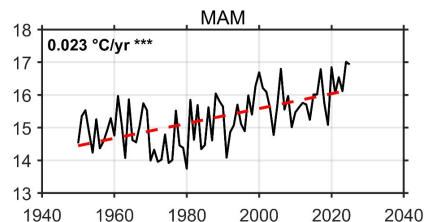
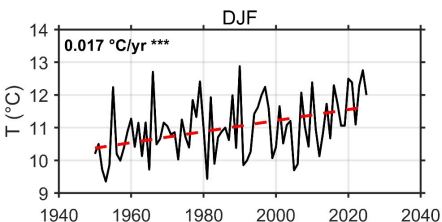
The Coastal Nile Delta Basin - trends



The Coastal Constantinois Basin and Seybouse basin, Algeria - climatology



The Coastal Constantinois Basin and Seybouse basin, Algeria - trends

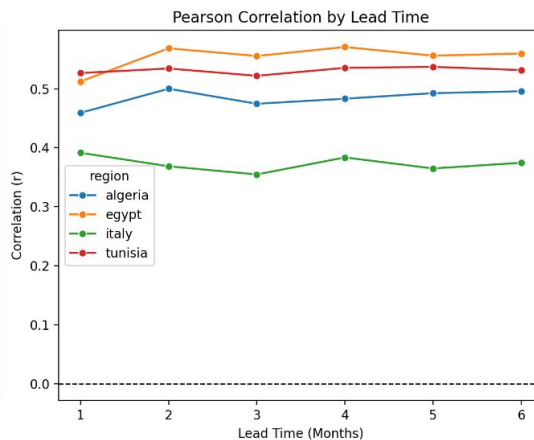
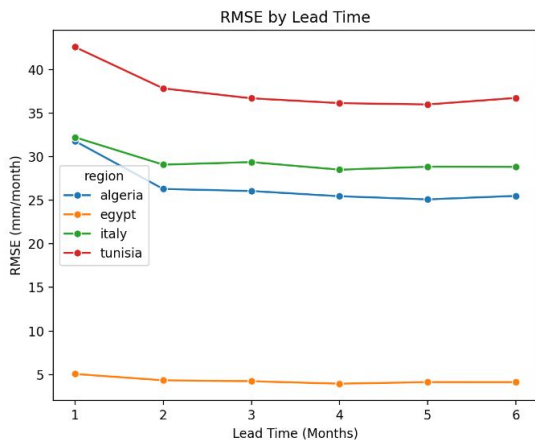
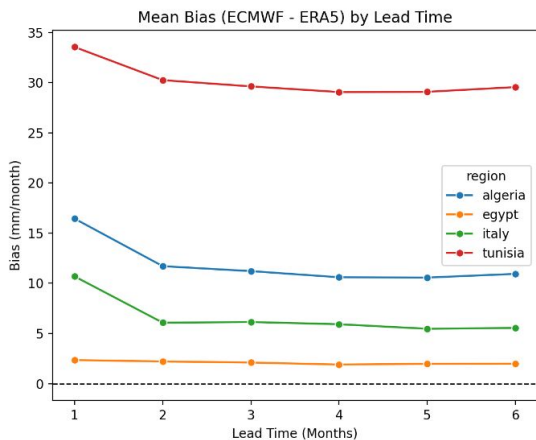


ERA5 & CHIRPS Validation vs Station

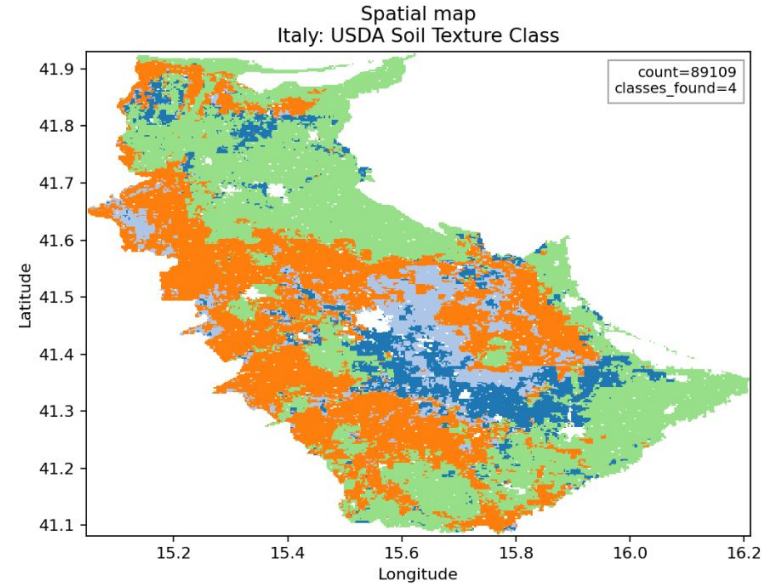
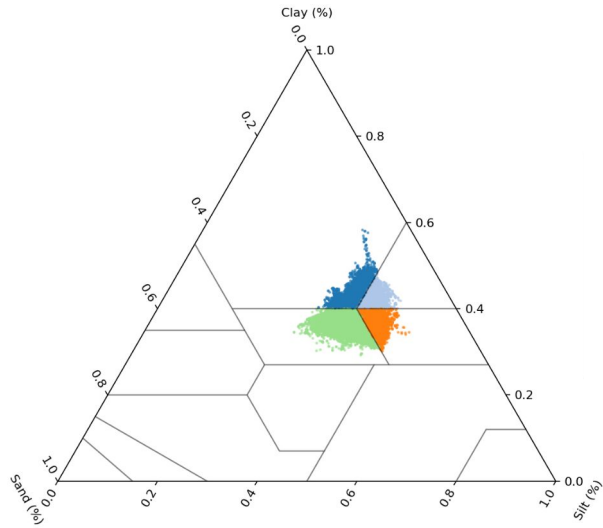
- **Correlation Strengths:** When validated against station data:
 - **ERA5** demonstrates strong alignment, achieving high average Pearson correlations of **~0.70** at the **daily** level, **~0.75** for **pentad** (5-day), and **~0.80** monthly in a station by station comparison.
 - Looking at **regional mean** instead, ERA5 achieves **>0.90** correlation in all three cases.
 - **CHIRPS** exhibits slightly lower average correlations in general comparisons (**~0.53/0.57/0.65**, station by station) (**~0.70/0.77/0.82**, regional mean), both remain capable and robust datasets for tracking precipitation.
- **Importance of Local Validation:** Performance could be highly dependent on the specific case study and region. ERA5 and CHIRPS can be used interchangeably based on local validation results.

ECMWF Validation vs ERA5

- **Weak Anomaly Signal:** General predictive correlation across lead times is low-to-moderate ($r \approx 0.35$ in Italy to 0.55 in Egypt). ECMWF captures broad seasonal timing but struggles to forecast specific monthly anomalies.
- **Flattening of Extremes:** The model underestimates major storm events (bias -29 mm/mo) while overestimating dry periods (bias $+18$ mm/mo). Some kind of bias correction may be envisioned.



Soil Texture Maps



- **Spatial maps:** Using Soilgrids data for *Clay/Sand/Silt* percentages, we have created texture maps for the four case studies.
 - This information will be useful for modeling crop, irrigation, and precipitation dynamics, but it still needs to be validated

Further data needed

- **Occhito Reservoir characteristics:**
 - Water level data
 - Stage-discharge curve
 - Stage-volume curve
 - Water management policies
- **Water distribution**
 - Distribution points
 - Distribution schedule and policies
- **Others:**
 - crop type validation (georeferenced or aggregated)
 - other?

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Hydrological issues in Mediterranean coastal semiarid irrigation districts in the context of the AI4Water PRIMA project

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Thank you for your attention!



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