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EGU25-3479

Assessing the Role of Irrigation in Groundwater Recharge in the Po Valley

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General context

Po River

length 650 km

Annual water withdrawal of the Po district

20 billion m³

Intensive agricultural use

(75% for irrigation)

15 billion m³
4,4 billion m³ for rice only

Urban use + Industrial use

5 billion m³

(AdB-Po, 2023)

SAU: ~ 3 milion ha
Irrigated area: ~ 2 milion ha (~ 70% SAU)

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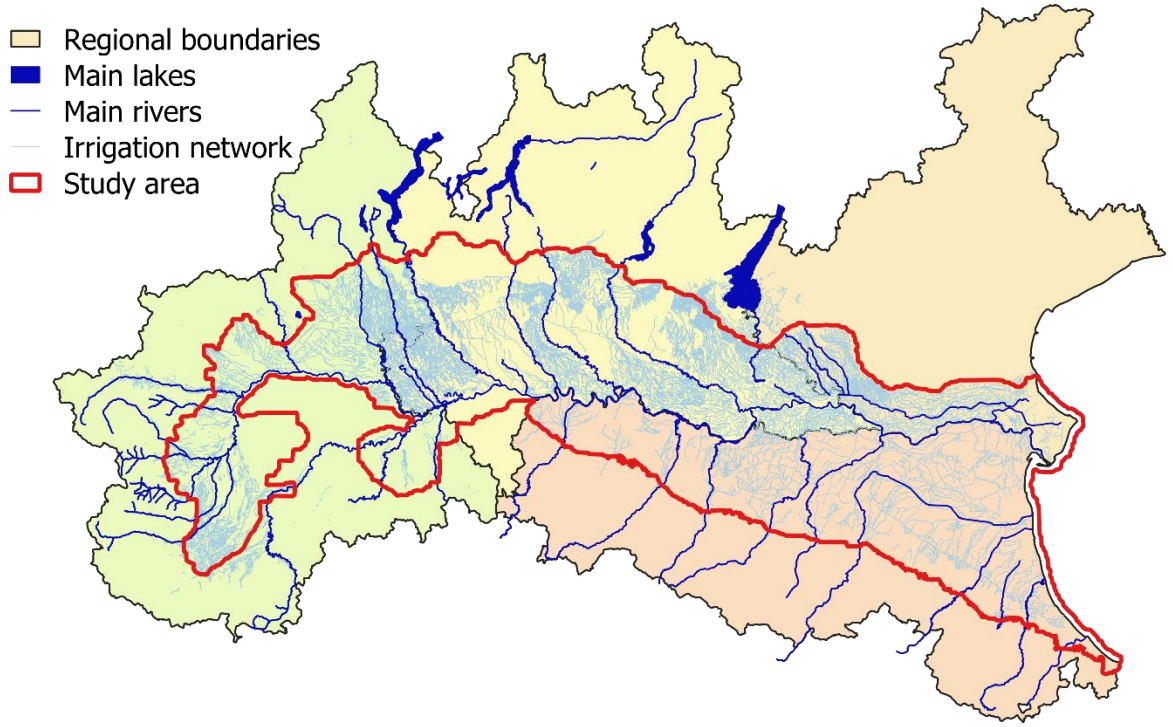
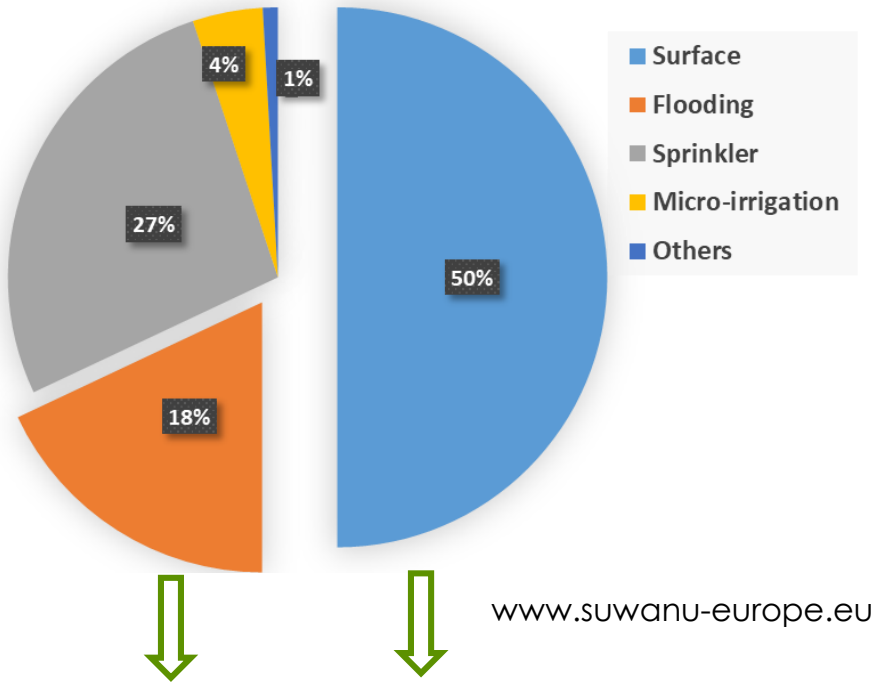
General context





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Traditional irrigation systems - water is drawn by gravity from surface sources and distributed to fields through an extensive network of irrigation canals.

1. **Supports** agricultural productivity
2. **Potential** effect of **groundwater recharge**

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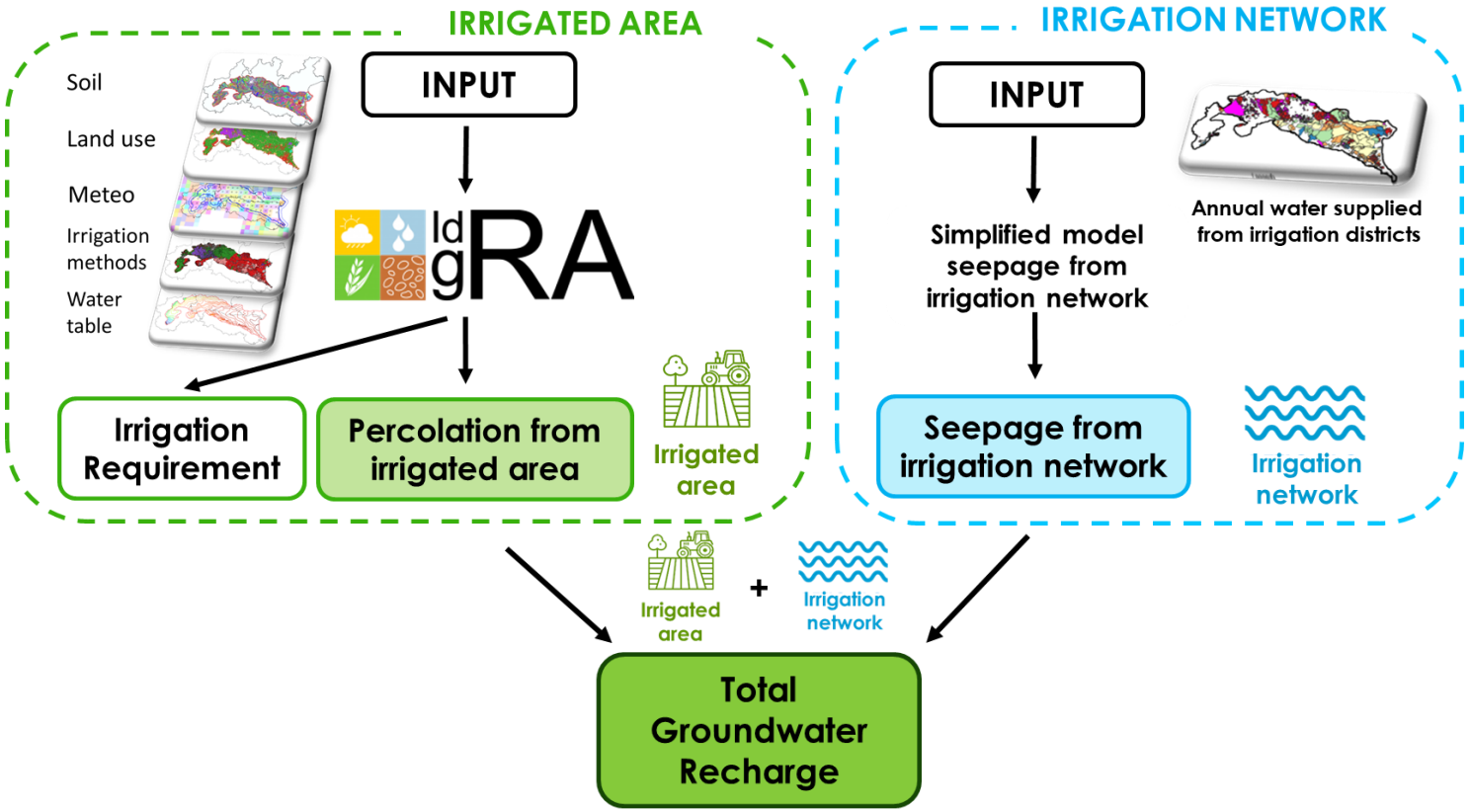
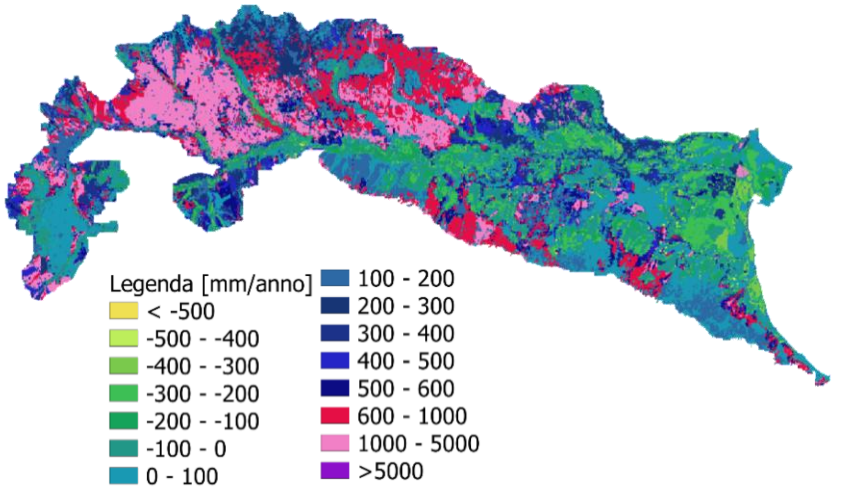
Methodology and preliminary results

Preliminary estimates of groundwater recharge in the Po Valley were made using the IDRAGRA model (https://idragra.unimi.it/), in the context of MidAS-Po project, considering agrometeorological data, soil characteristics, land use, irrigation methods, and interactions with the shallow aquifer.

Methodology



Preliminary results



Groundwater recharge 2020

Drainage considering interaction with shallow water table

Thank you for your attention

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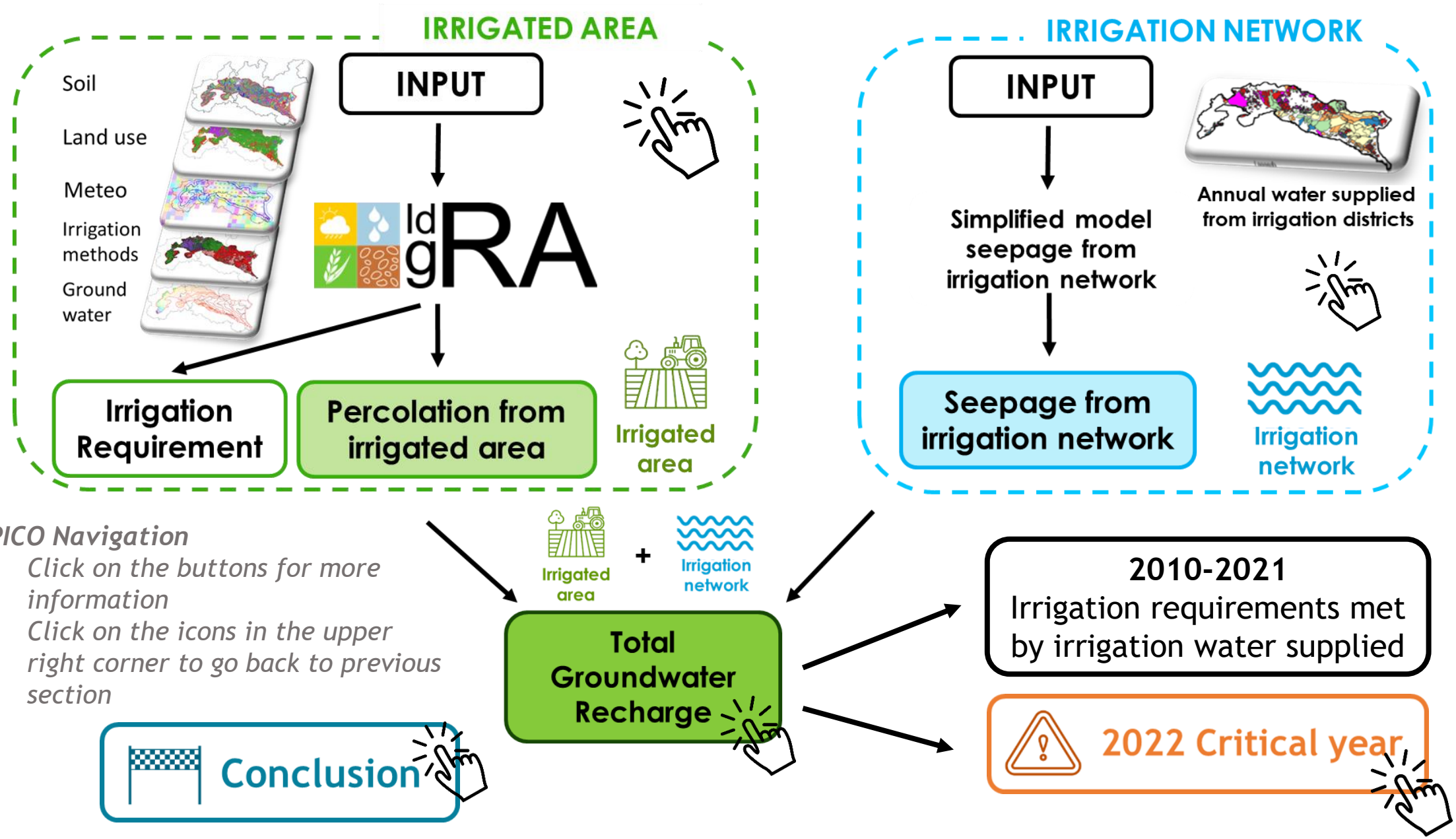
Methodology



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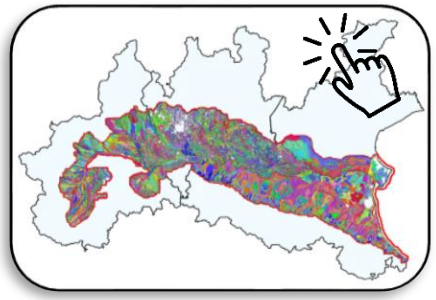
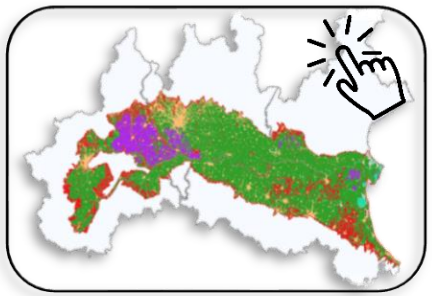
Methodology

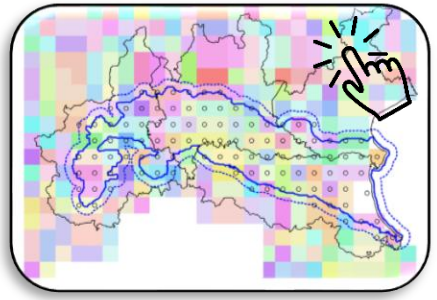
INPUT



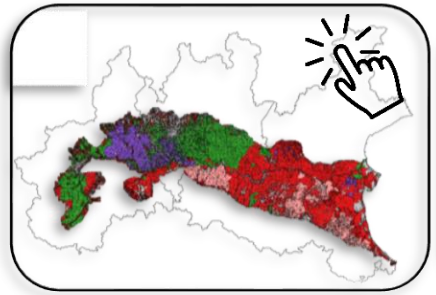
Soil



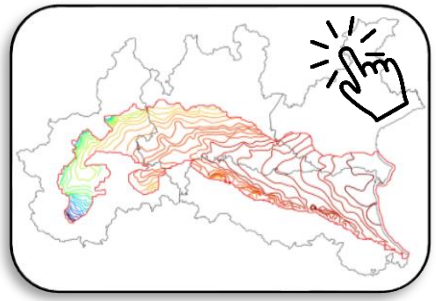
Land use



Meteo



Irrigation methods



Water table depth

PICO Navigation

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IdgRA

Soil water balance model
NEED MODE (grid 0.25 km²)
https://idragra.unimi.it/

OUTPUT

Irrigation Requirement

Percolation from irrigated area

Input data - Soil

Soil map

Soil profiles

PTF

Hydrological parameters

Homogenization and spatialization

1. **Creation of a district database** containing (in table format) the hydro-pedological information collected in the different regional catalogues

STRATEGY: identify a representative profile for each soil type, with the inputs required by the most demanding PTF (Ungaro&Calzolari)

2. **PTF selection and application** for estimating hydrological parameters (bulk density, retention curve and Ksat)
3. **Attribution of the hydrological parameters** of each soil type **to the polygons** of the soil map

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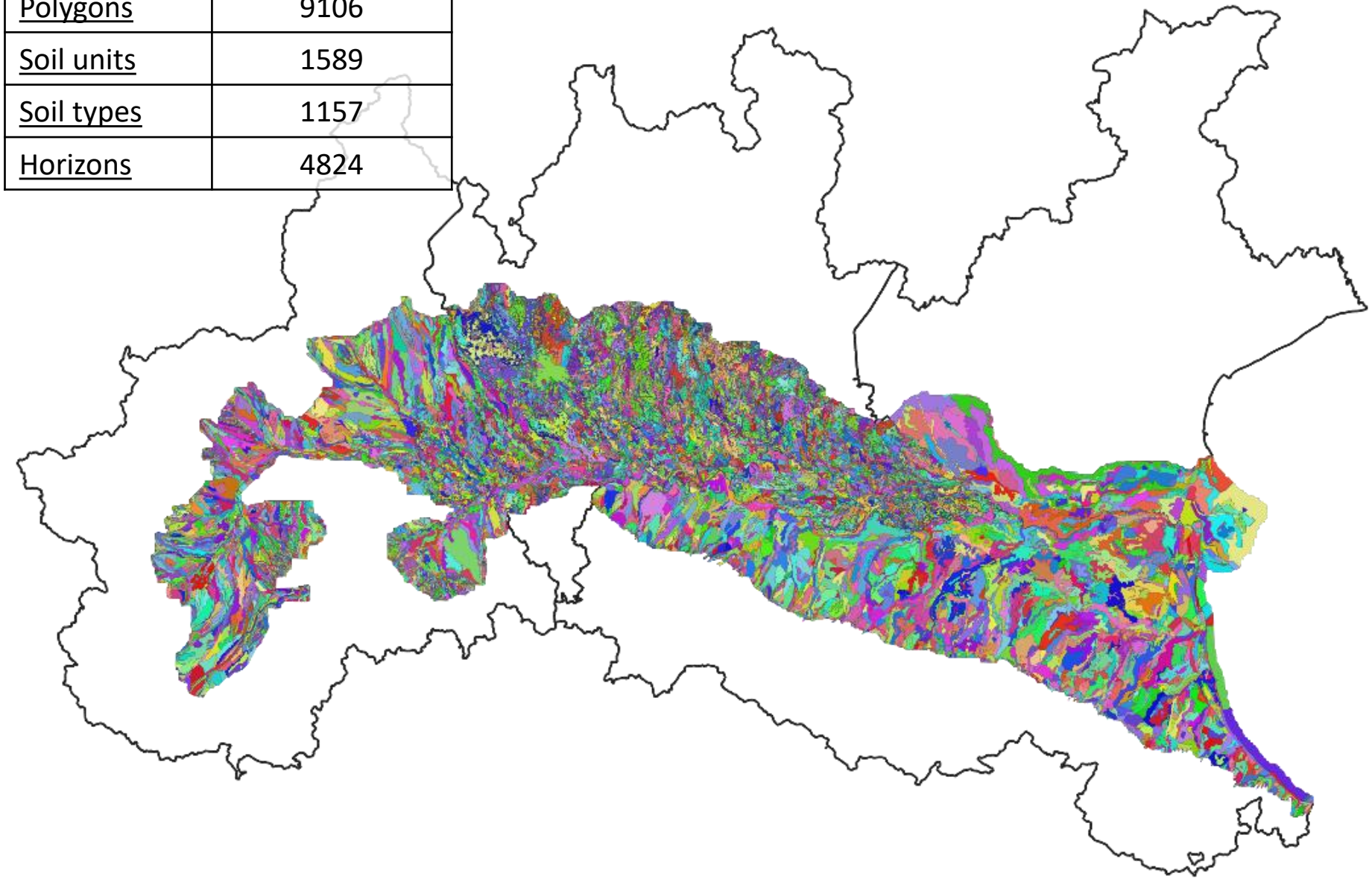
Input data - Soil

Polygons	9106
Soil units	1589
Soil types	1157
Horizons	4824

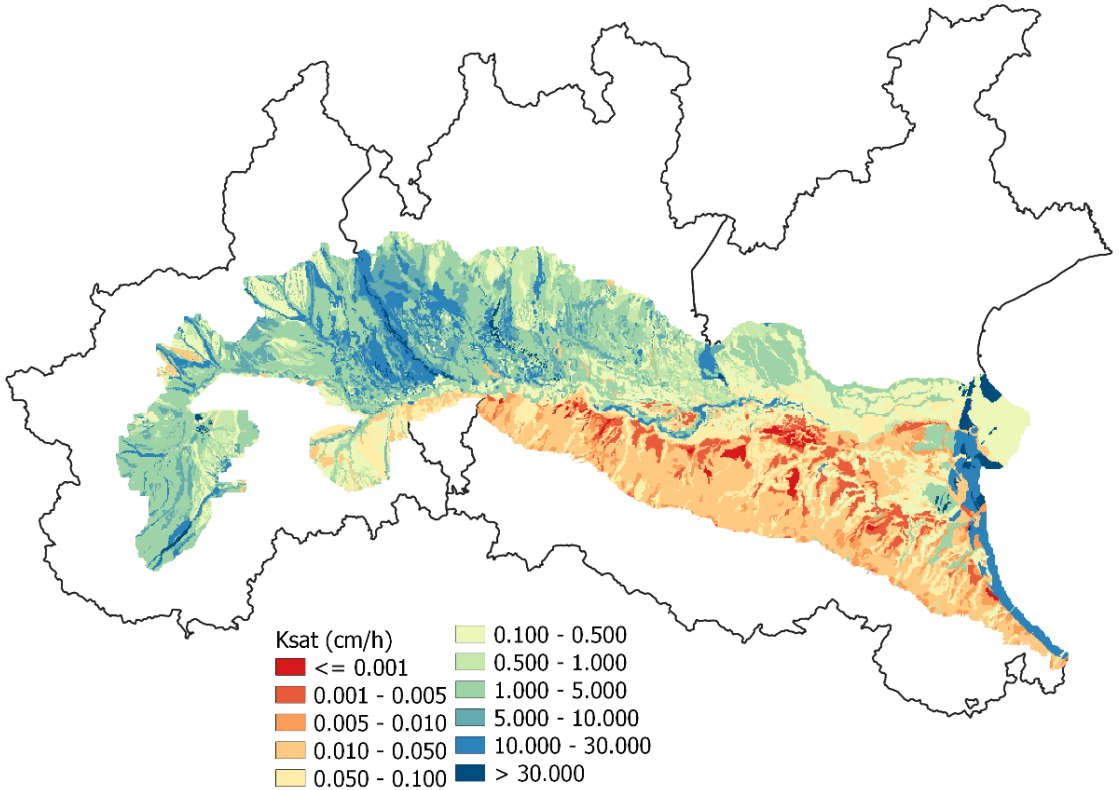


Polygon

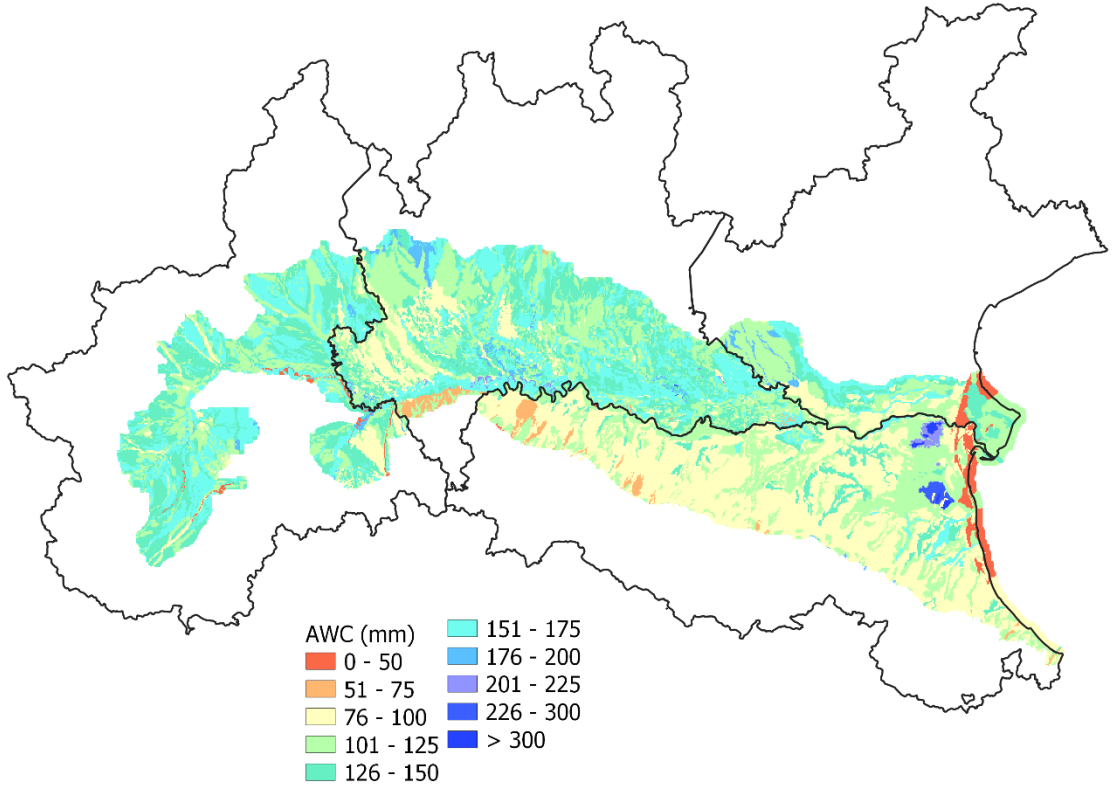
Code

Soil profile
Hydraulic parameters

Input data - Soil



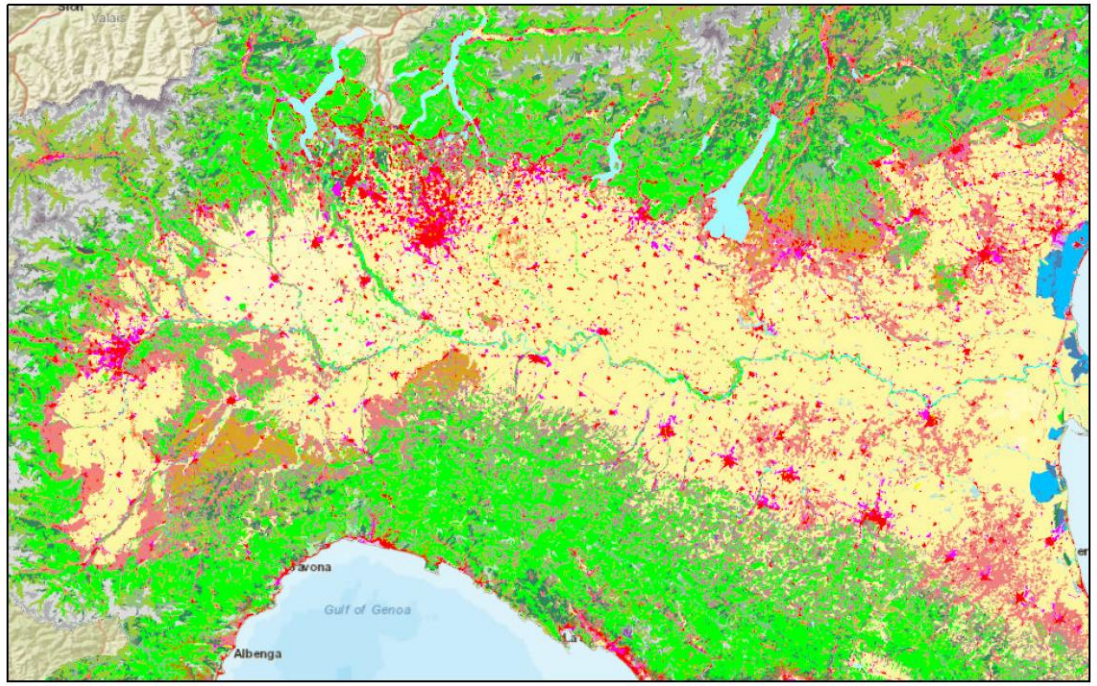
Saturated hydraulic conductivity (Ksat) calculated at 1 meter depth



Available Water Content (AWC) calculated at 1 meter depth

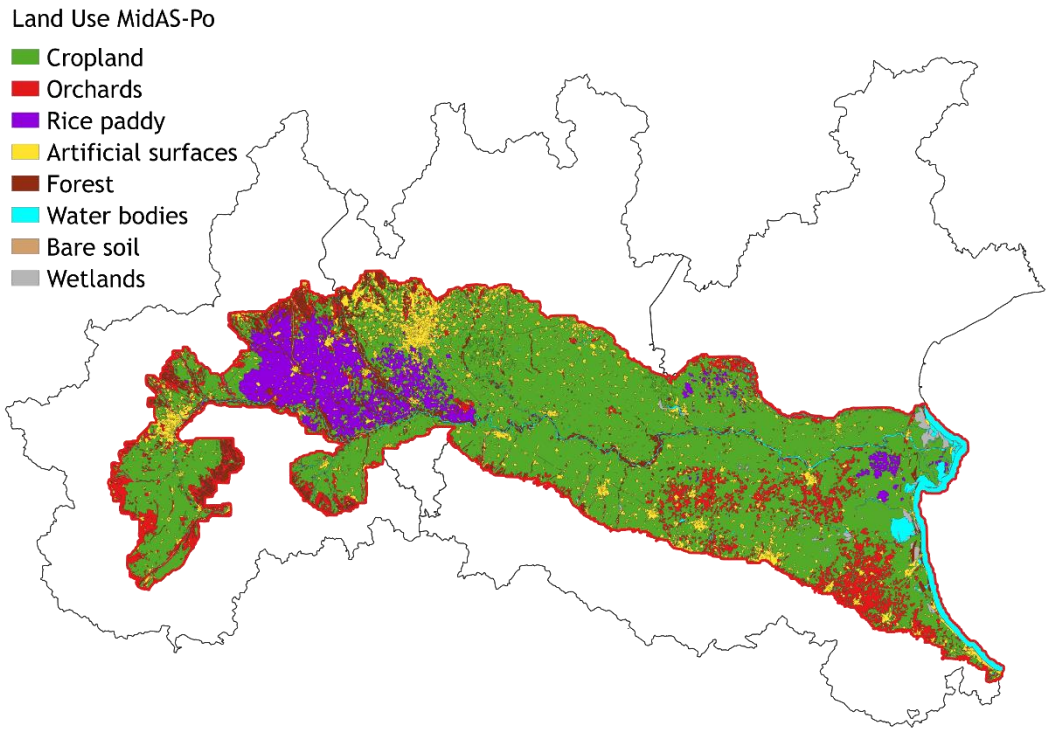
Input data - Land use

Original Corine Land Cover Dataset



- **Corine Land Cover 2012 and 2018** from European Enviroment Agency in “Copernicus - Land Monitoring Service”
- 44 land use classes (5 macro-categories, 3 classification levels)
- Spatial resolution: 25 ha

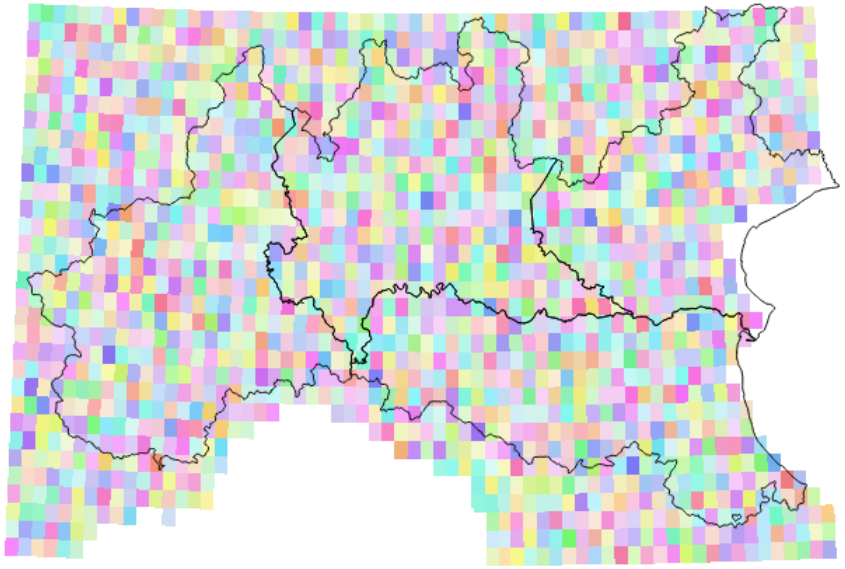
Elaborated Corine Land Cover Dataset



- Checking Corine Land Cover with respect to regional land use maps
- Semplification of the Corine classification into 8 macro land use classes

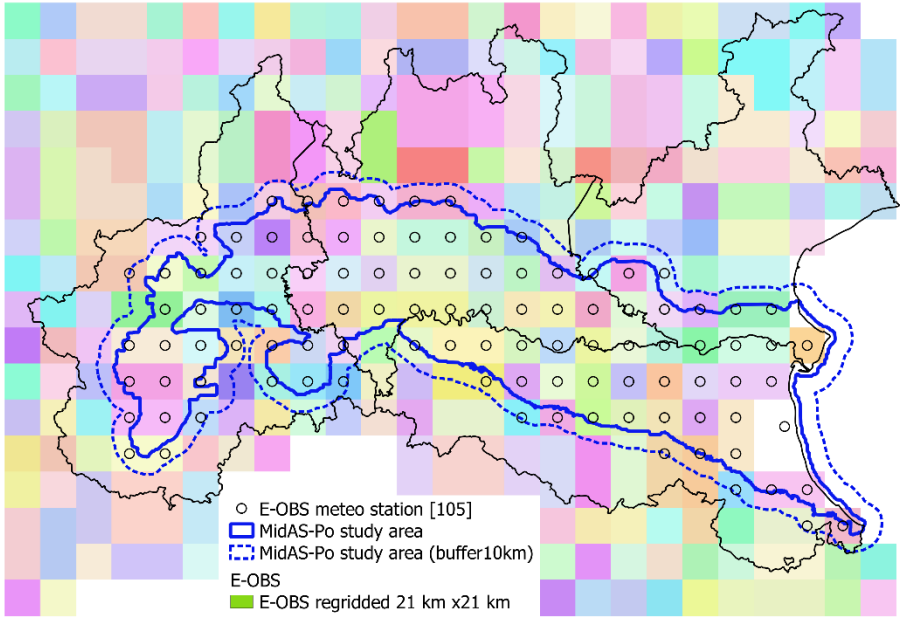
Input data - Meteo

Original E-OBS Dataset



- **E-OBS** meteorological dataset obtained from the interpolation of **ground weather station data**, from European Enviroment Agency in “Copernicus – Climate Change Service”
- **Daily series** of Tmin, Tmax, Prec, RHavg, Wind (10m), solar radiation
- Original spatial resolution: 9 km x 9 km
- Historical horizon: from 1950 to now

Elaborated E-OBS Dataset



- Identification of **105 weather stations** as the centroids of E-OBS regridded cells (21 km x 21 km) within the MidAS-Po domain + 10 km buffer

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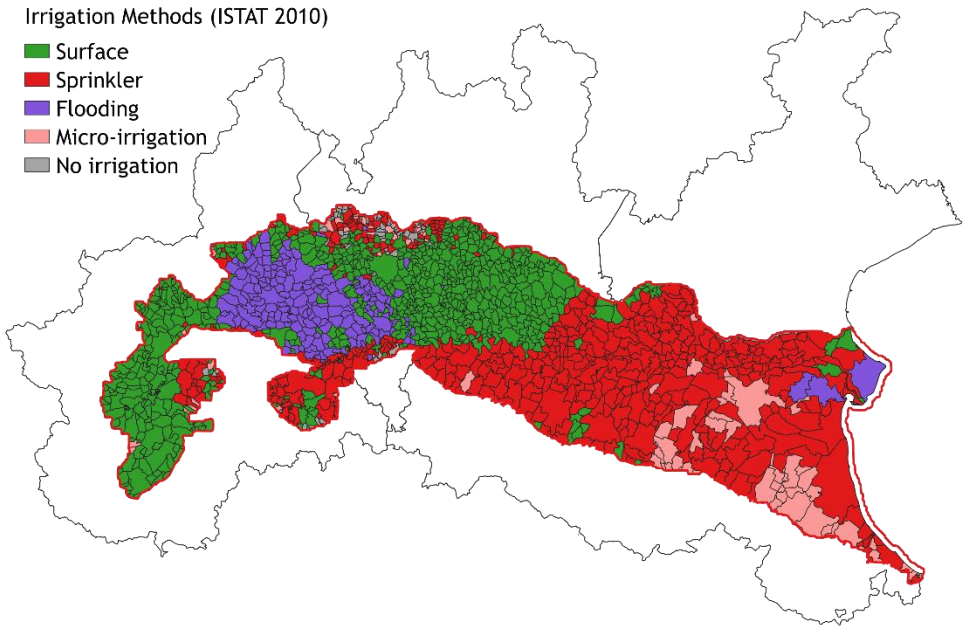
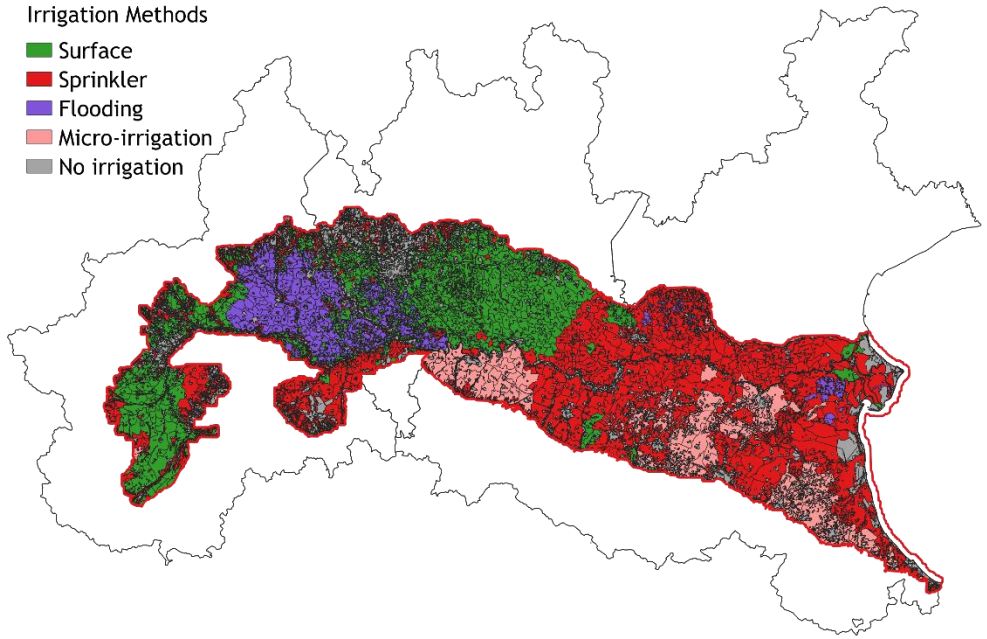
Input data - Irrigation methods

Original ISTAT 2010 Dataset



The **ISTAT 2010 Agriculture Census** contains the predominant irrigation method in each municipality

Elaborated ISTAT 2010 Dataset



Elaboration and correction of the original data:

- intersection with land use map
- local integration of SIGRIAN* information about irrigation methods

**National information System for the management of water resources in agriculture*

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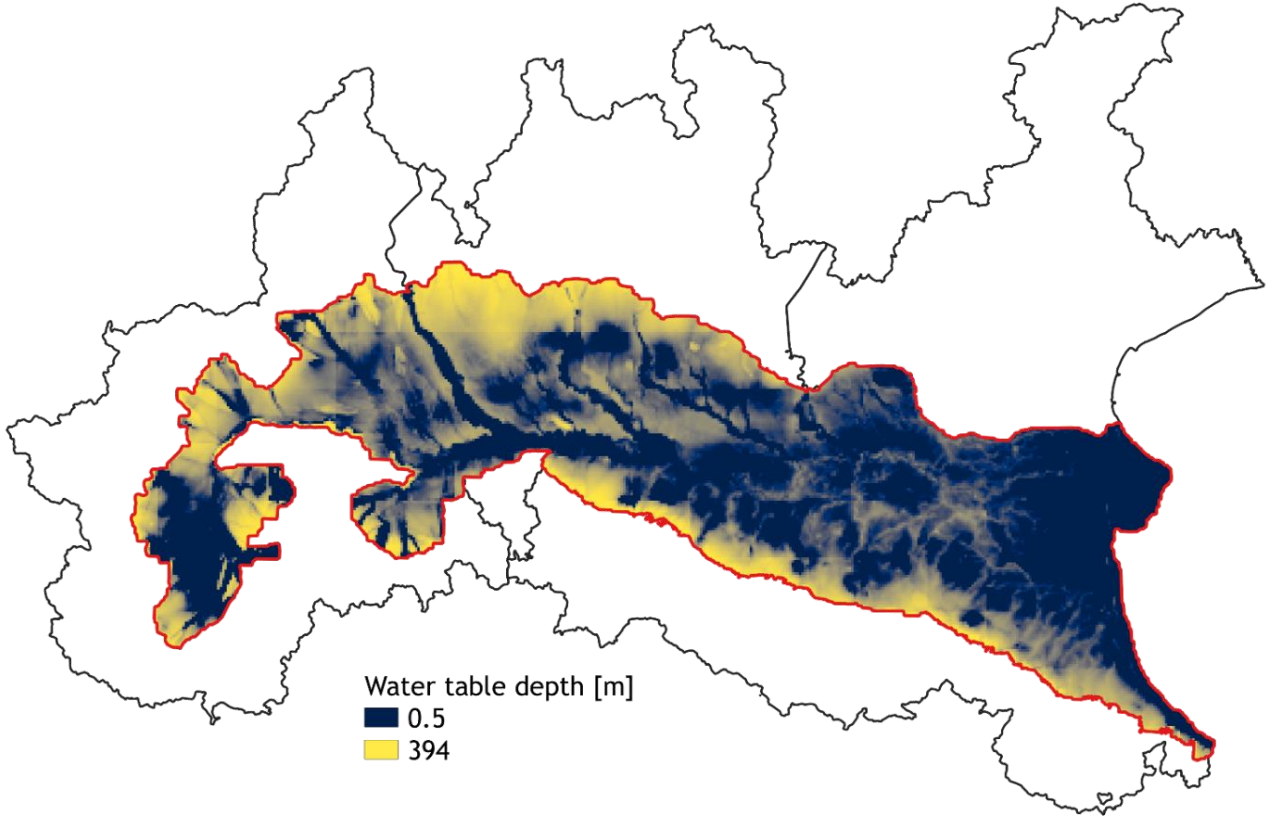
Input data - Water table depth

- Water table depth calculated from the piezometric map by Giuliano et al. (1998) and from DTM (1 km)
- Negative values of water table depth (water table depth > ground level) were corrected at 0.5 m
- The water table depth was assumed constant throughout the simulation period (2010-2022) → both interannual and seasonal



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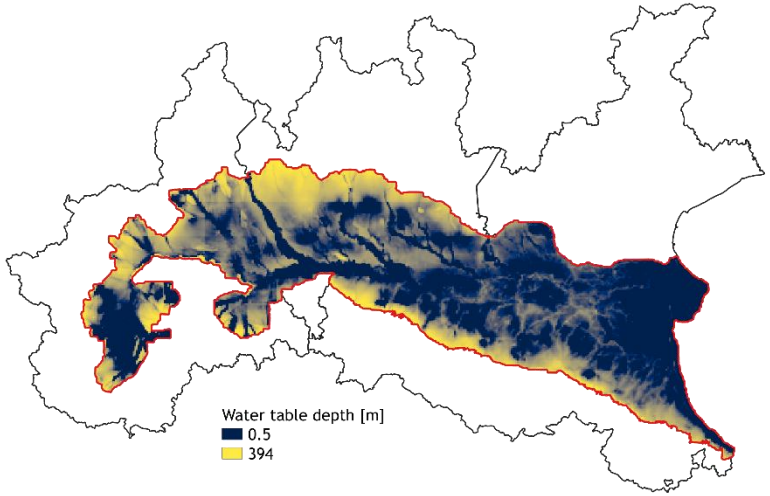
Model implementation

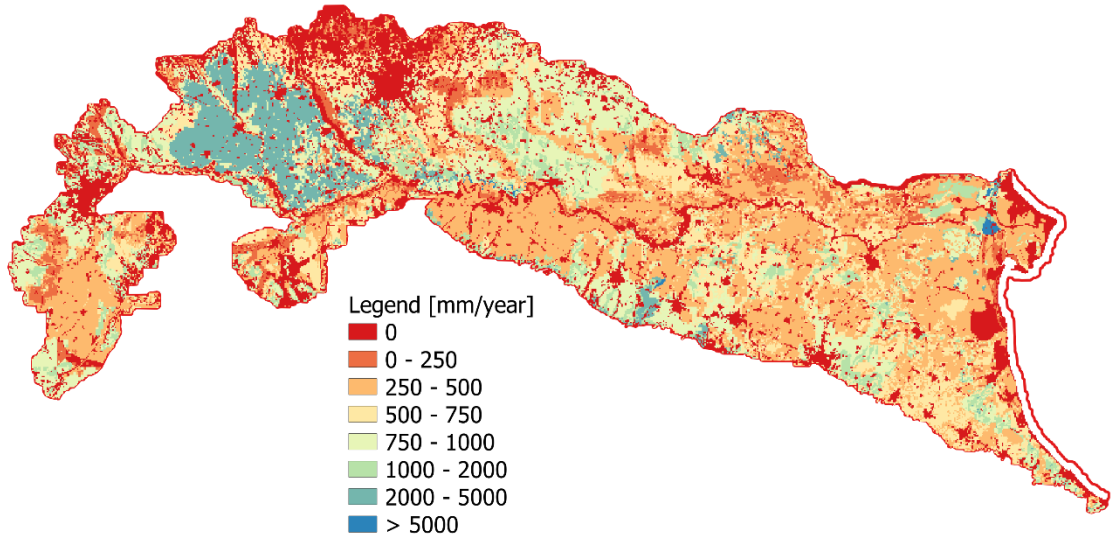
Input Data	MidAS-Po simulation
Land Use	Land use map derived from Corine Land Cover 2018 elaborated (8 classes)
Meteo	Meteo data derived from E-OBS elaborated
Soil	Soil map derived from regional soil maps elaborated
Irrigation methods	Irrigation methods derived from ISTAT 2010 Agriculture Census elaborated
Irrigation mode	Irrigation mode 'FIXED VOLUMES' (https://idragra.unimi.it/)
Groundwater	Drainage considering both interaction and not interaction with shallow water table
Spatial resolution	0.25 km^2
Temporal horizon	2010 - 2022

Results - Irrigation requirements



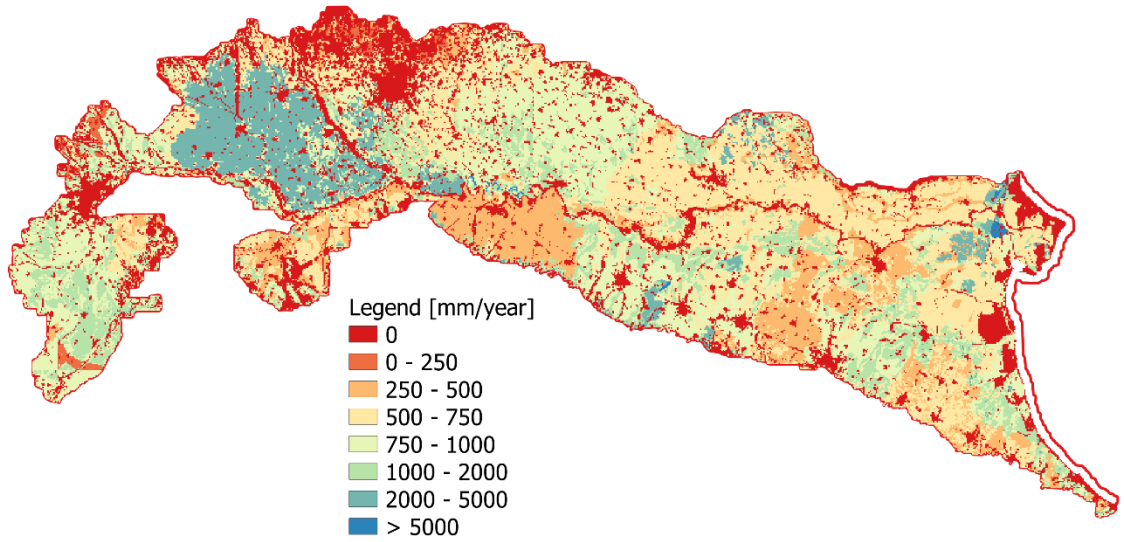
Midas-Po Irrigation Requirements 2020

interaction with shallow water table



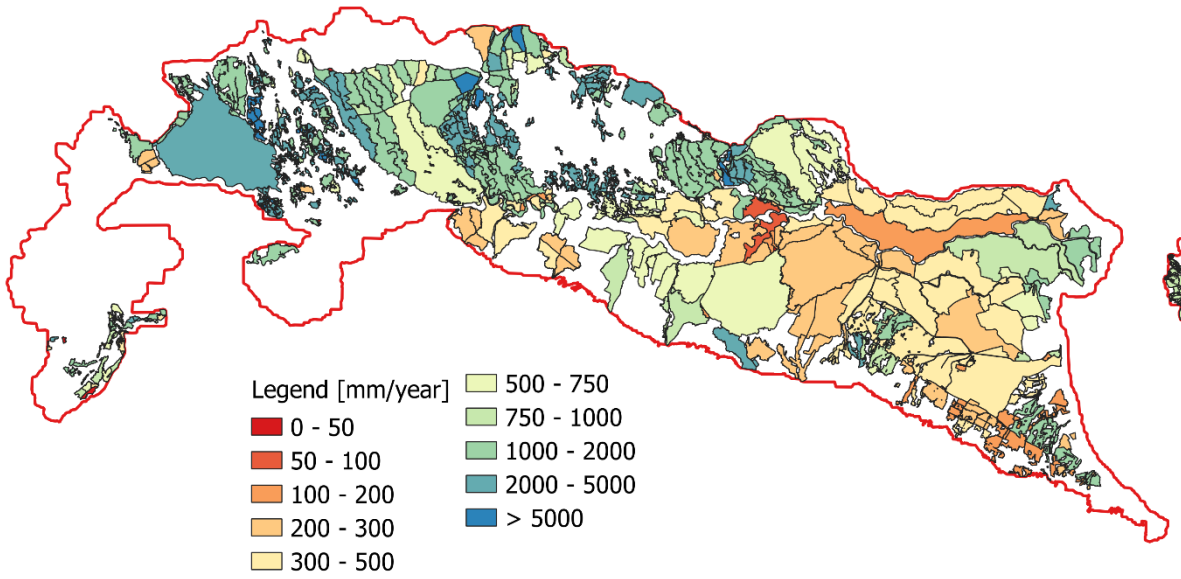
Midas-Po Irrigation Requirements 2020

no interaction with shallow water table



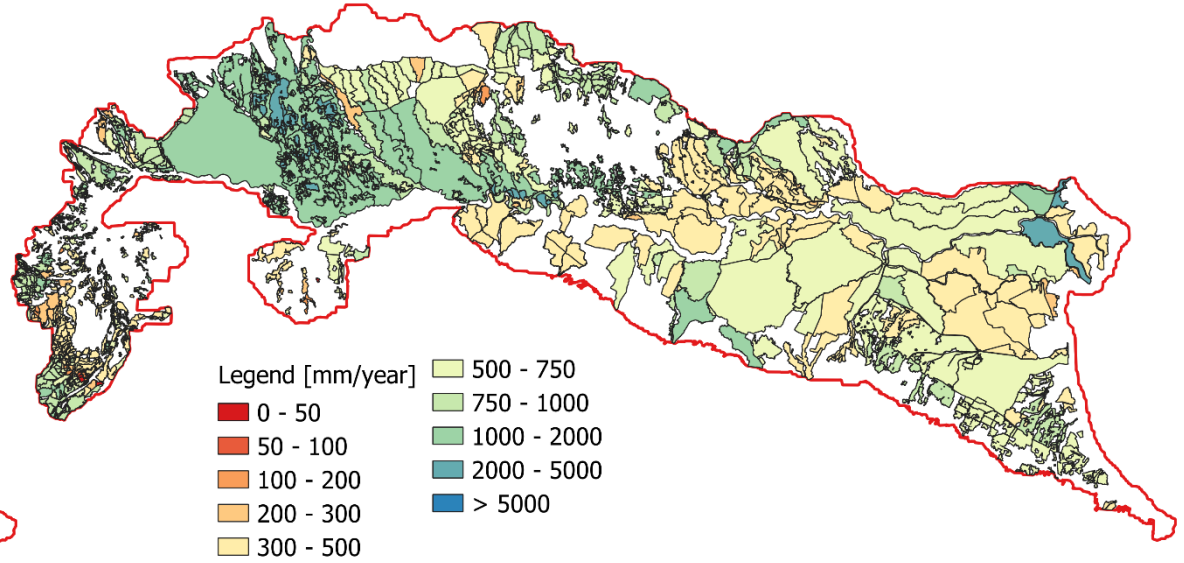
Results - Validation of irrigation requirements

Water Supplied from Irrigation Districts (SIGRIAN) 2020



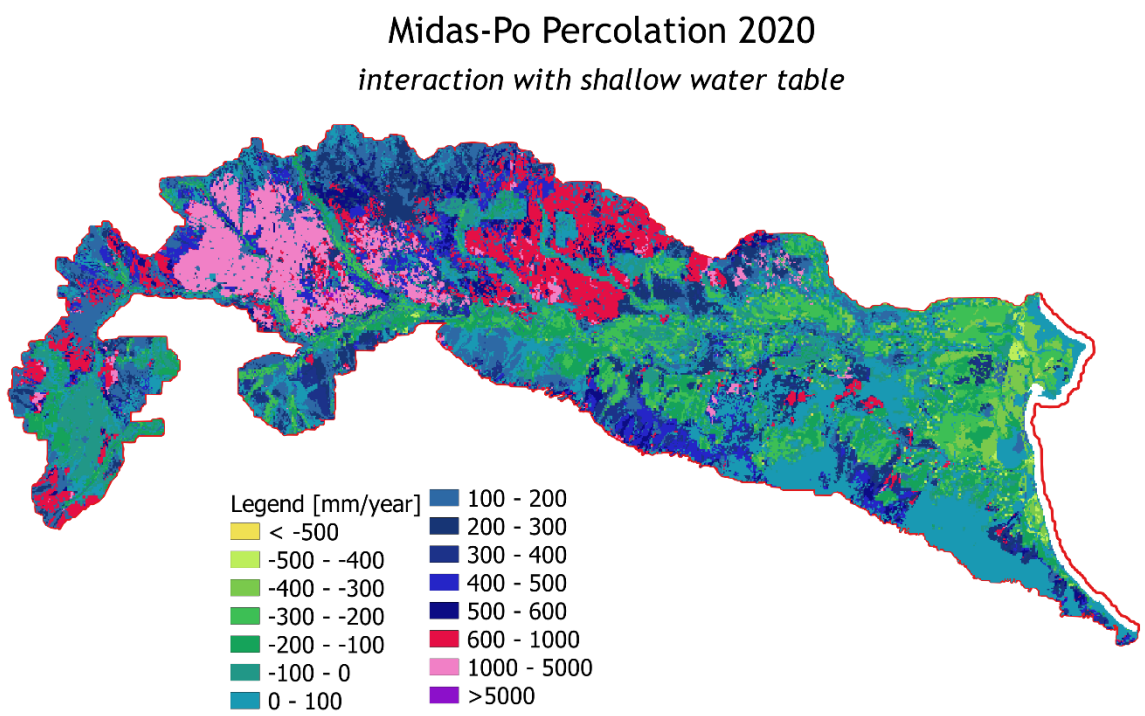
Midas-Po Irrigation Requirements 2020

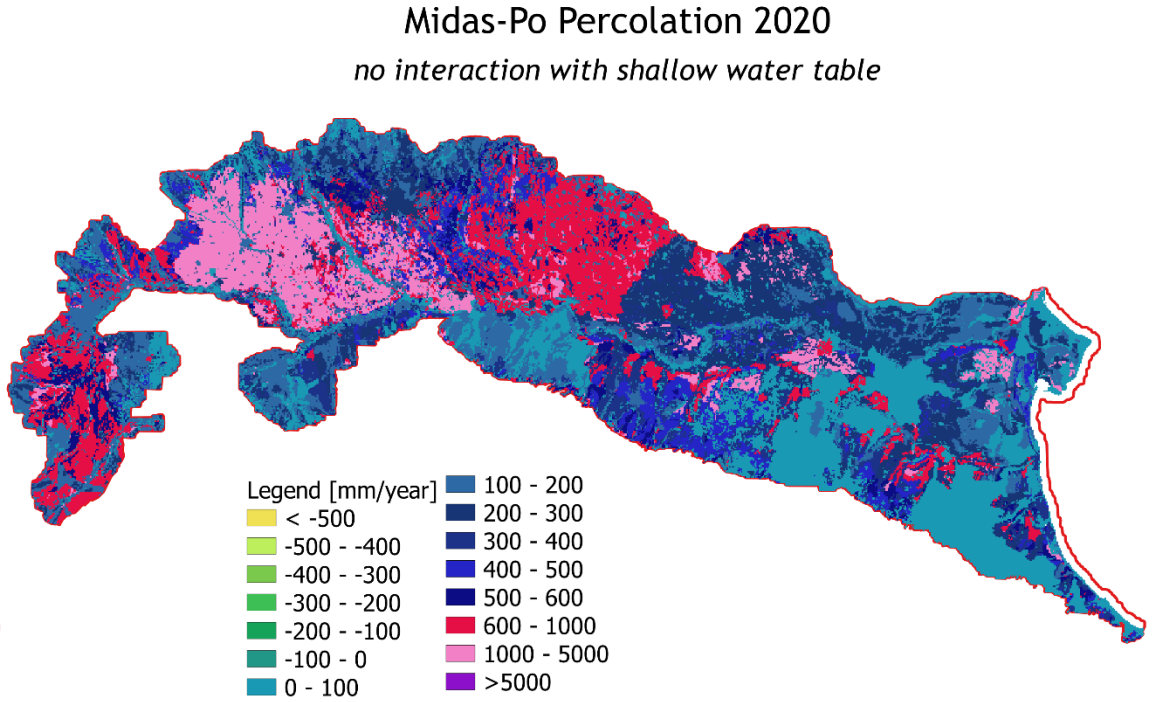
interaction with shallow water table



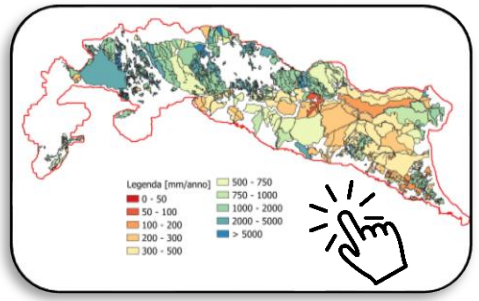
SIGRIAN: National information System for the management of water resources in agriculture

Results - Percolation from irrigated area





Methodology



Annual water supplied from irrigation districts

⇩

Simplified model seepage from irrigation network

⇩

Seepage from irrigation network

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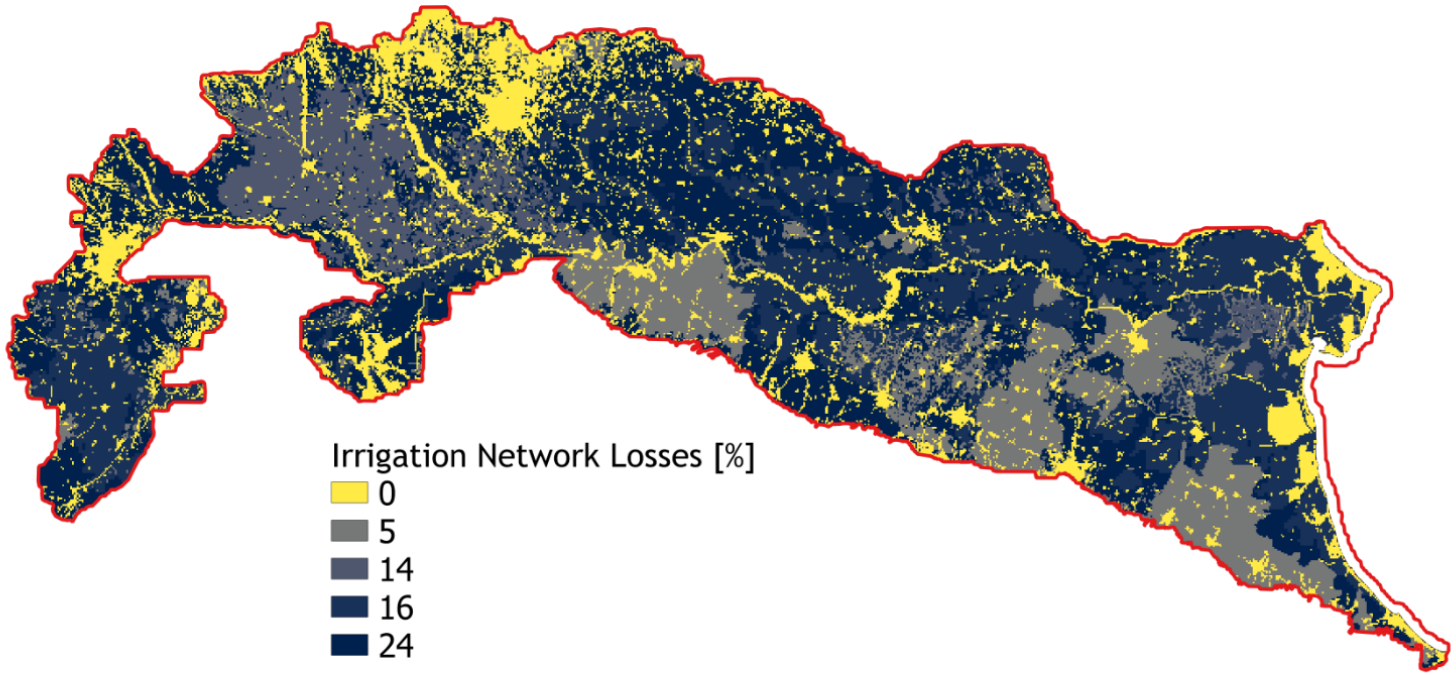
Seepage from irrigation network

$$\left(1 - \frac{Irrigation\ Requirements}{Water\ Supplied}\right) * 100\ [\%]$$



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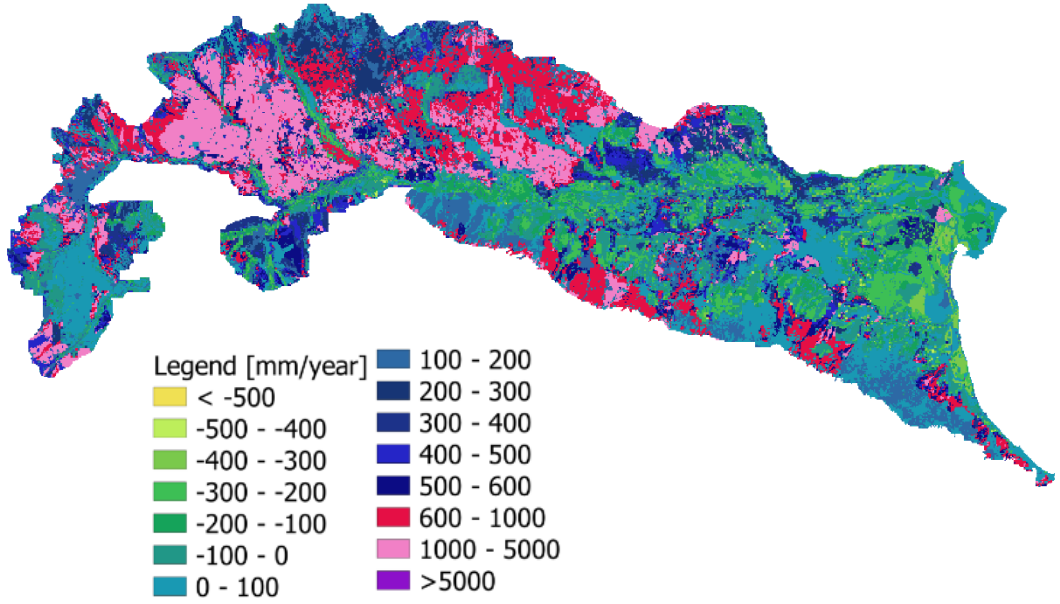
Results - Total groundwater recharge

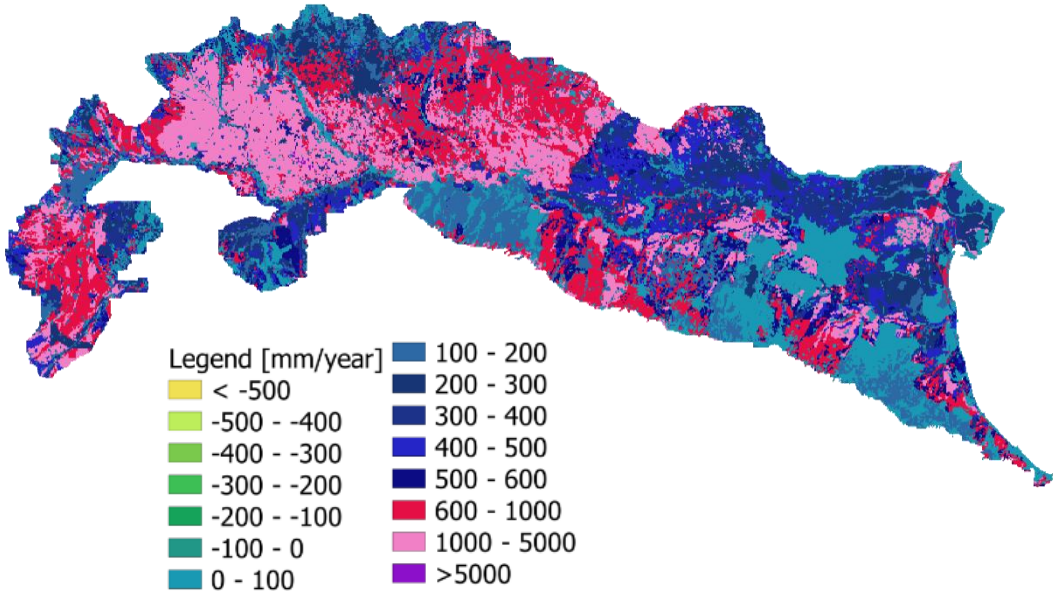
Midas-Po Percolation 2020

interaction with shallow water table



Midas-Po Percolation 2020

no interaction with shallow water table



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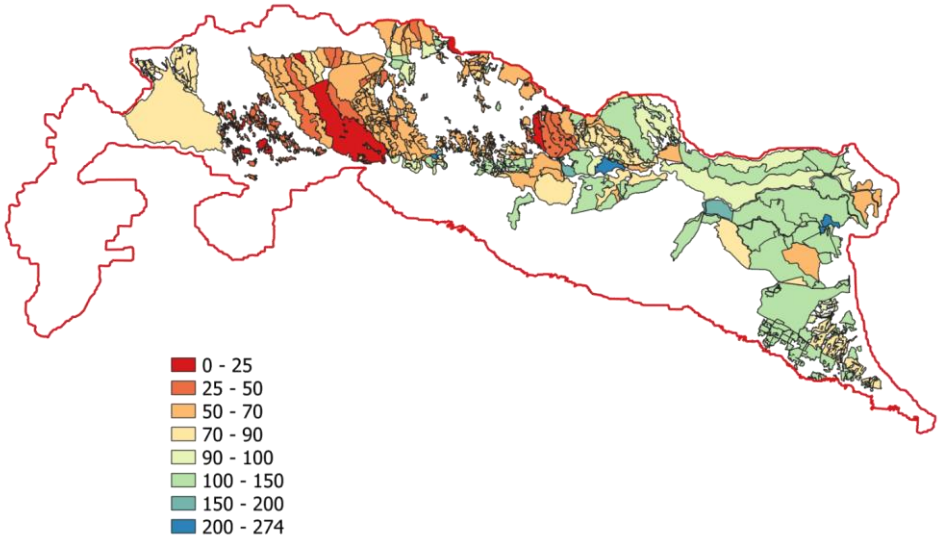
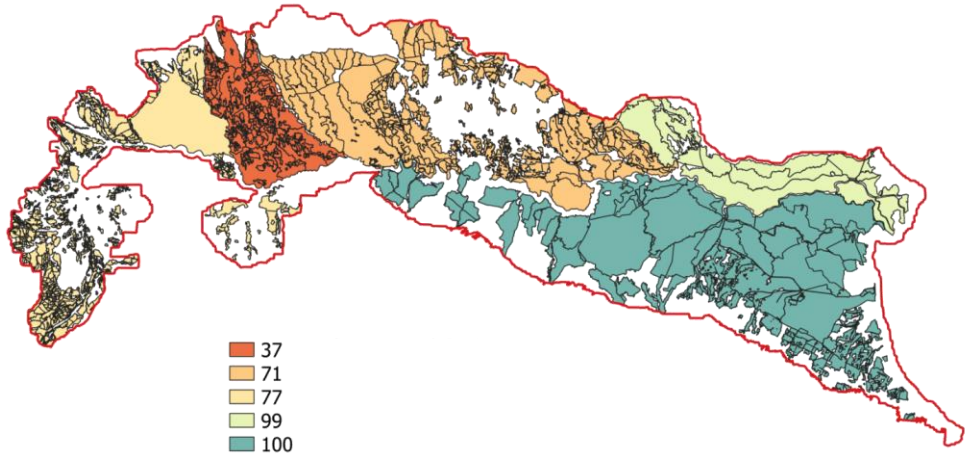
Critical year 2022 - Reduction coefficient of water supplied

$$\left(\frac{Water\ Supplied_{2022}}{Water\ Supplied_{avg(2016-2021)}}\right) * 100\ [\%]$$

Original available SIGRIAN data



Extension to overall irrigation districts



Application of a reduction coefficient on the total groundwater recharge, due to the limited irrigation water supplied

$$\left(1 - \frac{Water\ Supplied_{2022}}{Water\ Supplied_{avg(2016-2021)}}\right) * 100\ [\%]$$

Distribution of the reduction coefficient over the study area

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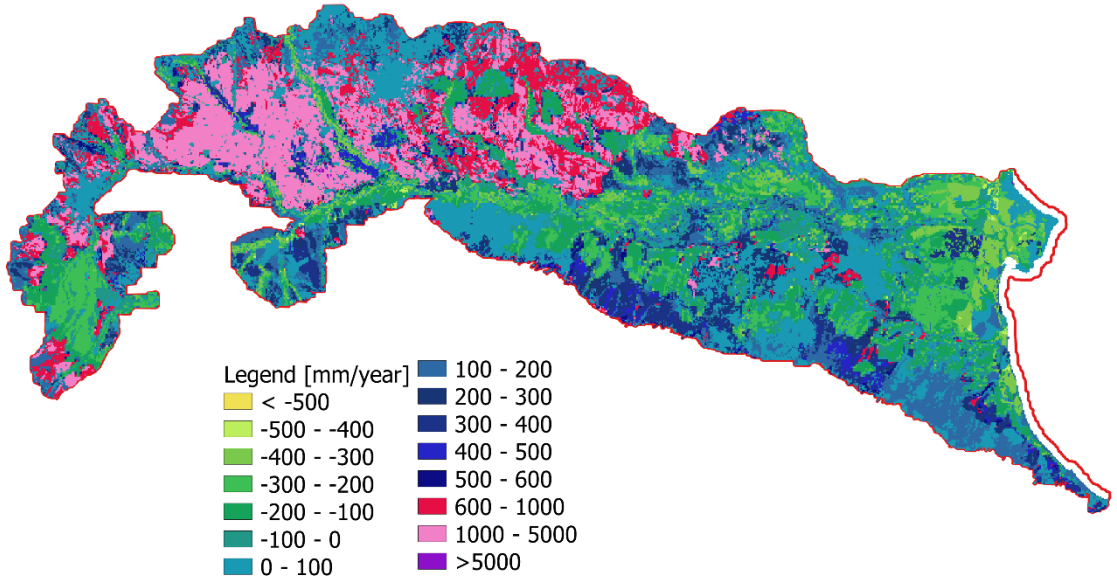
Critical year 2022 - Total groundwater recharge

Before reduction coefficient application

Midas-Po Percolation 2022

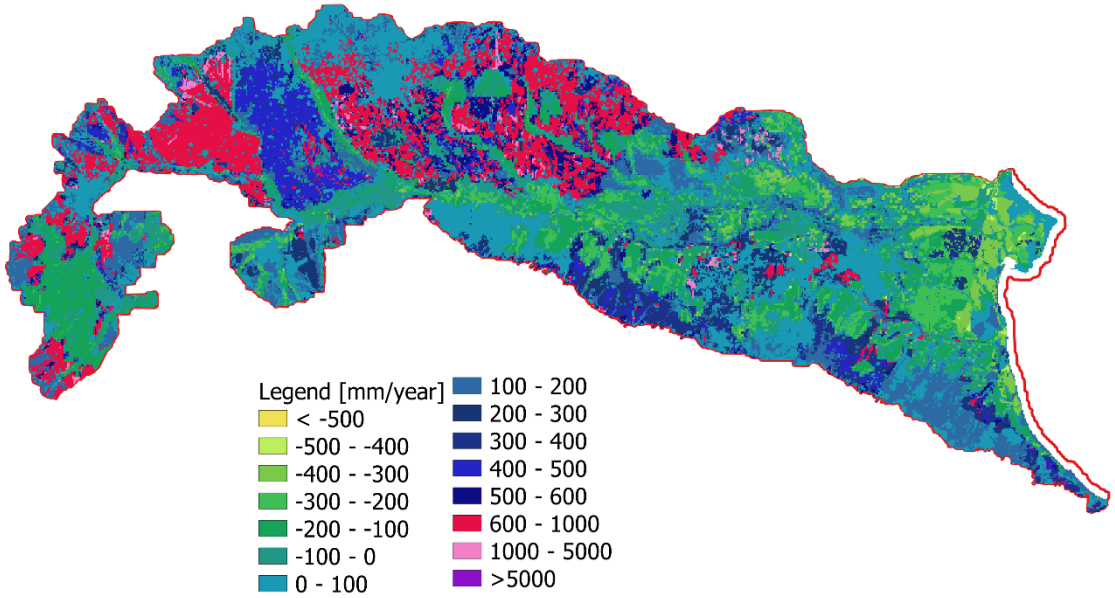
interaction with shallow water table



After reduction coefficient application

Midas-Po Percolation 2022

interaction with shallow water table



Conclusion

- The resulting **preliminary estimate** of groundwater recharge **driven by irrigation practices** marks a significant step forward in understanding the role of irrigation in aquifer replenishment across the Po Valley.

- **Further investigations** will be conducted to more accurately **quantify the contribution** of traditional irrigation systems to groundwater recharge. This will involve **improving the quality of the input data**, including:

  - Volumes of water diverted from canals and extracted from aquifers;
  - Detailed information on local irrigation methods and practices;
  - The use of regional land use instead of the global data (CORINE-LAND COVER)
  - More precise data on groundwater table levels.

- These efforts aim to demonstrate that **traditional irrigation systems**—characterized by water distribution through canals and surface application in fields—despite **often being** considered **inefficient**, play a **crucial** role in **sustaining** the groundwater **recharge** in the Po Valley, which is marked by a **strong interaction** between surface water and groundwater.

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DiSAA

ADBPO Autorità di bacino distrettuale del fiume Po

FSC Fondo per lo Sviluppo e la Coesione

MINISTERO DELL'AMBIENTE E DELLA SICUREZZA ENERGETICA