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Irrigation volumes and seasonal weather conditions: challenges and reflections on FADN/RICA data analysis

Arianna Di Paola, CNR-IBE and Co.

Drought and land use in agriculture: scenarios, impacts and adaptation strategies.
First results of the NEUTRALISE project
November 13, 2024. 10:00am - sala Silvestri - Piazzale Aldo Moro, 7 Rome

Task 1.1. Aim: figure out the relationship (if any) between «water uses» as reported in the RICA and seasonal meteorological conditions.

Source data: RICA (Volume of water per hectare);
seasonal Precipitation (P) and Potential Evapotranspiration (PET), from ERA5L reanalysis.
Period: 2011-2022

Sistema Documentale RICA (SDR) Search

Home > BDR – portale informativo riservato > Tabelle dati > USO ACQUA

USO ACQUA

Questa tabella contiene le informazioni relative al consumo di acqua aziendale dettagliato per specie vegetale.

Campo	Formato	U.M.	Descrizione	Note
Cod. Specie Vegetale	Testo	–	Codifica della specie vegetale	
Specie Vegetale	Testo	–	Descrizione della specie vegetale	
Cod. Modalità Coltivazione	Testo	–	Codifica sulla modalità di coltivazione	
Modalità Coltivazione	Testo	–	Descrizione della modalità di coltivazione	
GG Medie Irrigazione	Numerico	Nr.	Numero di giornate medie di irrigazione	
Ore Totale Giorno	Numerico	Ore	Ore complessive di irrigazione giornaliere	
Volume Totale Acqua	Numerico	Mc	Volume complessivo di acqua distribuito	
SAU Coltura Irrigata	Numerico	Ha	Superficie Agricola della coltura irrigata	
Fertirrigazione	Testo	–	Fertirrigazione (S/N)	
Volume Acqua Ha	Numerico	Ha	Volume dell'acqua distribuita ad Ha	

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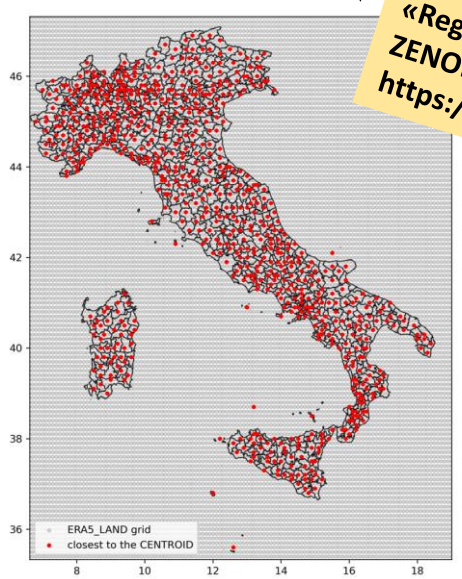
Presentazione
Procedure operative RICA
CLASS.CE – classificazione tipologica
GAIA – rilevazione dei dati aziendali
GAIA – Cruscotto Aziendale
GAIA – modulistica per la rilevazione
GAIA – Caso aziendale
GAIATEST – sistema dei controlli
ADE – Assistenza alle Decisioni
BS – bilancio semplificato
AREA – portale informativo pubblico
BDR – portale informativo riservato
Funzionamento
Tabelle dati
AZIENDE
AIUTI
ALLEVAMENTI
AMBIENTE
BESTIAME
BILANCIOCE
BILANCIOSP
CAMPIONE
CERTIFICAZIONE
CLASSIFICAZIONE
COLTURE
COSTO DEL LAVORO
FABBRICATI



«Regioni Agrarie» in shapefile format
ZENODO:
https://doi.org/10.5281/zenodo.11446949

- Grid points of ERA5L dataset closest to the **Agricultural Regions** centroid

Data overview and regression model. Approach

- **Farms level analysis**
  (Granular approach)
  Input variables = N. climatic features for **N. farms**, M-years
  Target = water uses from **N farms**, M-years

- **Farms data aggregated at the agronomic region scale**
  (Aggregative approach)
  Input variables = N. climatic variable (e.g. monthly P) for **773 Agronomic regions**, 11 years
  Target = average water uses for **773 agronomic regions**, 11-years
  *Only for mapping

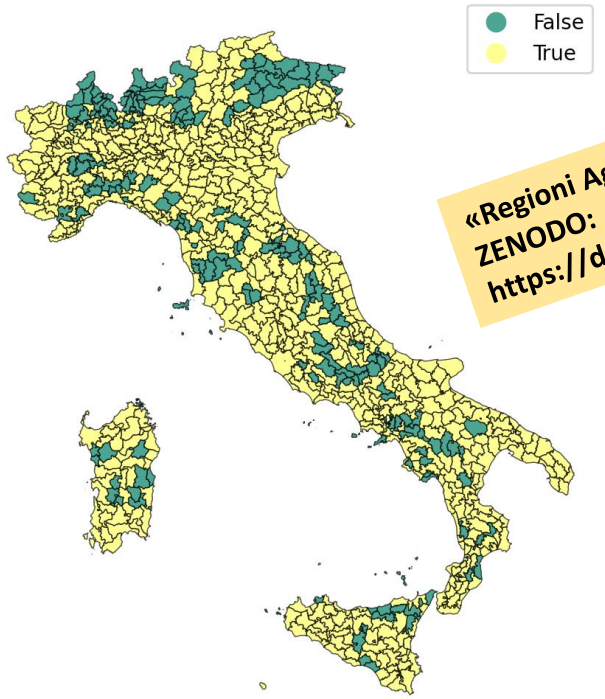
Regressive workflow
(modelling water uses vs. climate variables)

1. Selection/organisation of seasonal climate input variables
2. Initialization of a **Random Forest (RF)** regressor
3. RF Training and testing using **K-fold Cross-Validation** (CV).
4. IF unsatisfactory results: **Hierarchical Cluster Analysis** for data filtering (repeat regression within clusters)

(farm level) Data Overview: Dimensionality

Coltura	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Totale Farms	Regioni Uniche
Mais ibrido	281	493	581	684	746	775	771	759	766	784	818	715	8173	227
Mais a maturazione cerosa	75	197	229	290	281	312	326	325	328	356	330	293	3342	185
Soja	15	66	95	114	258	300	302	318	303	334	324	322	2751	121
Erba medica	32	72	132	206	196	214	219	223	286	307	297	256	2440	162
Vite per vino di qualità	26	175	235	299	299	354	340	391	430	448	476	490	3963	156
Olivo per olive da olio	108	133	183	203	199	204	214	207	226	221	213	186	2297	120
Melo	41	234	286	351	333	341	344	346	329	350	352	313	3620	88
Pomodoro da industria	21	47	71	97	99	95	101	86	110	137	138	116	1118	101
Patata comune	15	87	100	114	117	119	148	145	157	186	171	169	1528	83
Pesco	64	114	174	222	176	180	187	182	172	160	158	132	1921	85
Arancio	51	106	141	189	198	194	231	197	206	210	219	198	2140	69
Prato polifita	93	79	85	133	125	125	136	139	112	121	132	93	1373	56
Barbabietola da zucchero	7	22	42	41	42	32	37	48	69	69	54	57	520	46

Regioni Agrarie nella RICA



«Regioni Agrarie» in shapefile format
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https://doi.org/10.5281/zenodo.11446949

(farm level) Data Overview: Water uses and yields

Figure (left):
Water uses vs. yield scatter plot for selected crops
(data from 2011-2022)
Irr = water use (mm)
Resa = yield (QL/ha)
QL = 100 Kg

Highlights:
- No correlations,
- Abrupt ranges

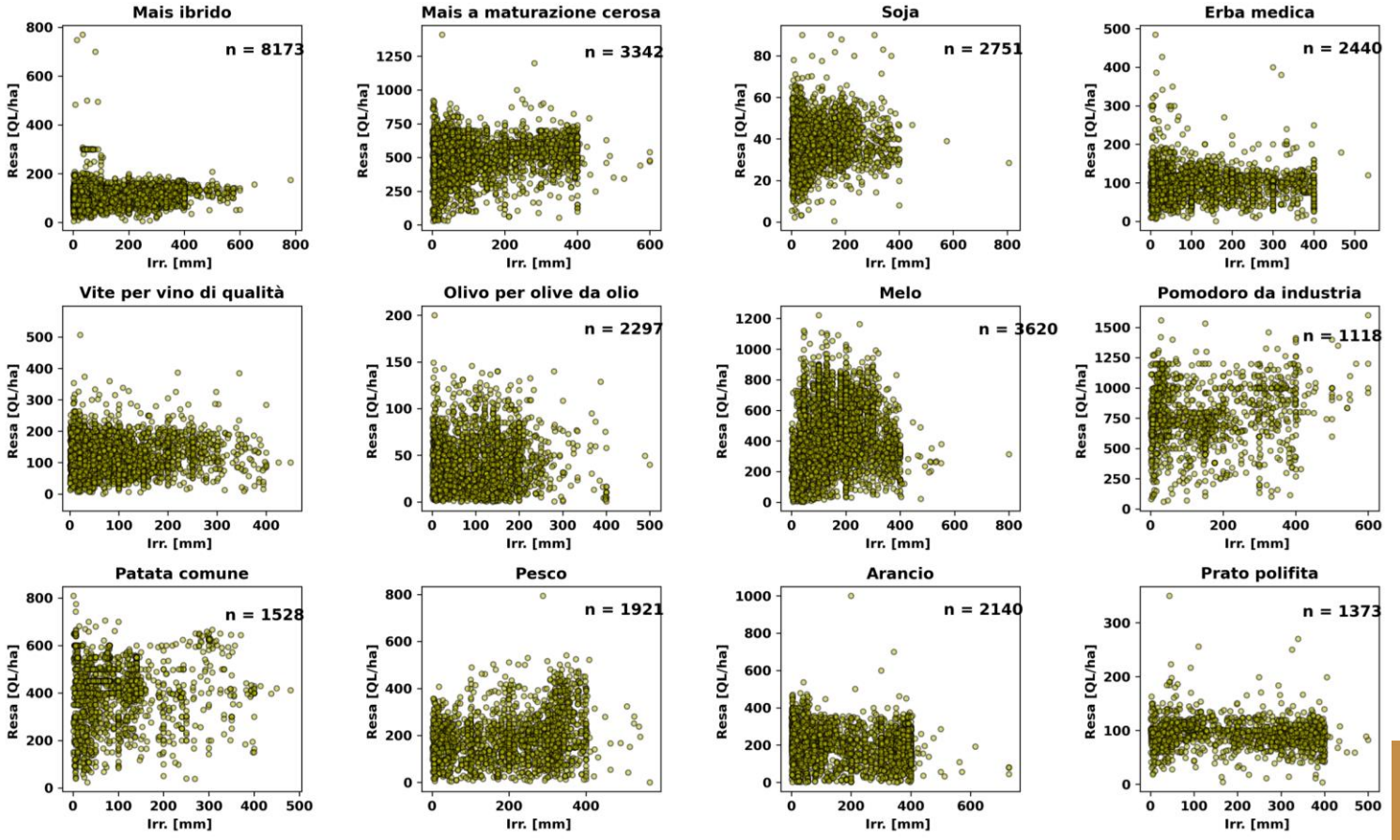
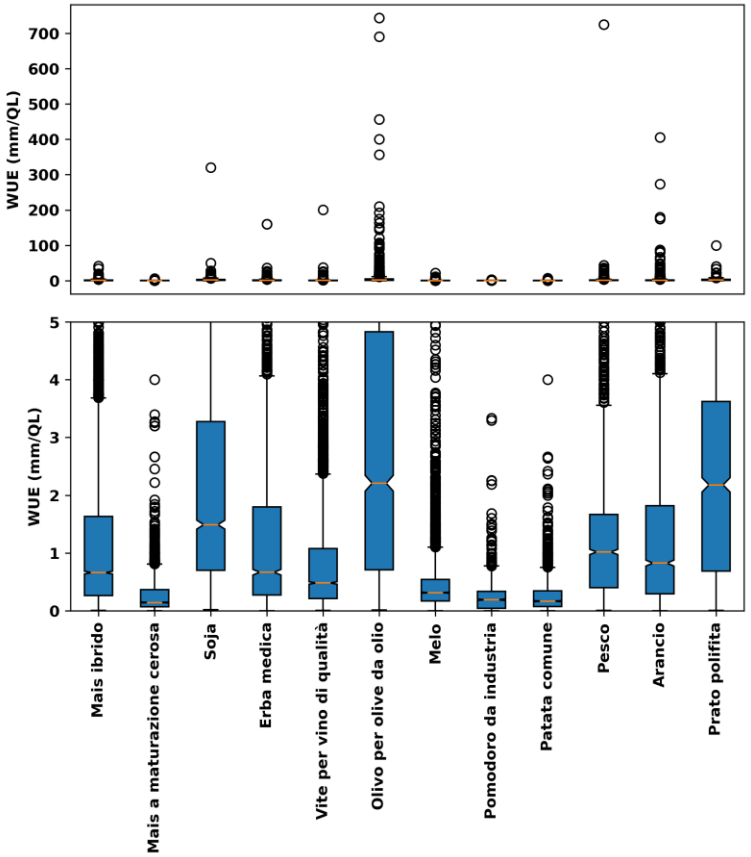
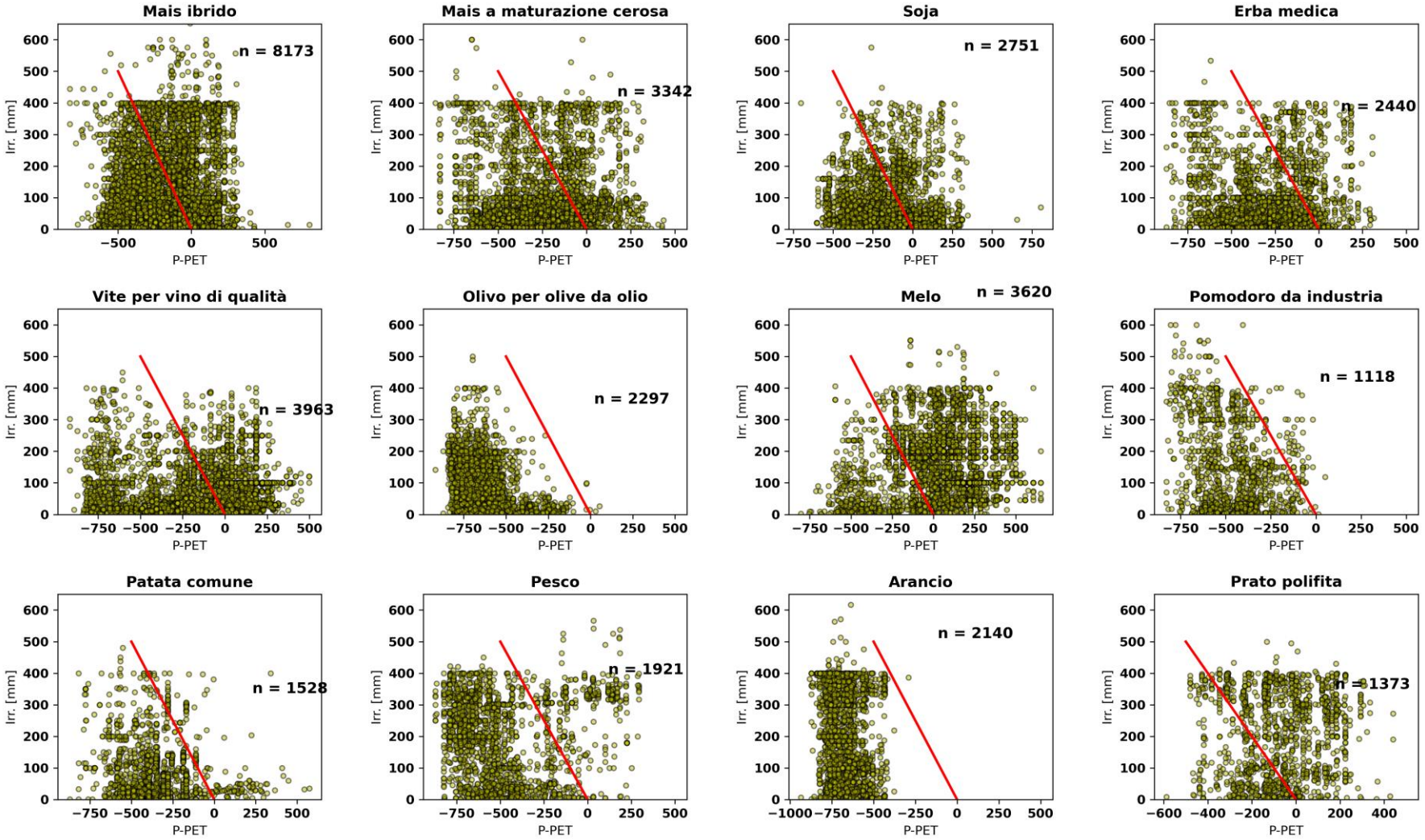


Figure (right)
Water Use Efficiency
(water uses : yield *ratio*)



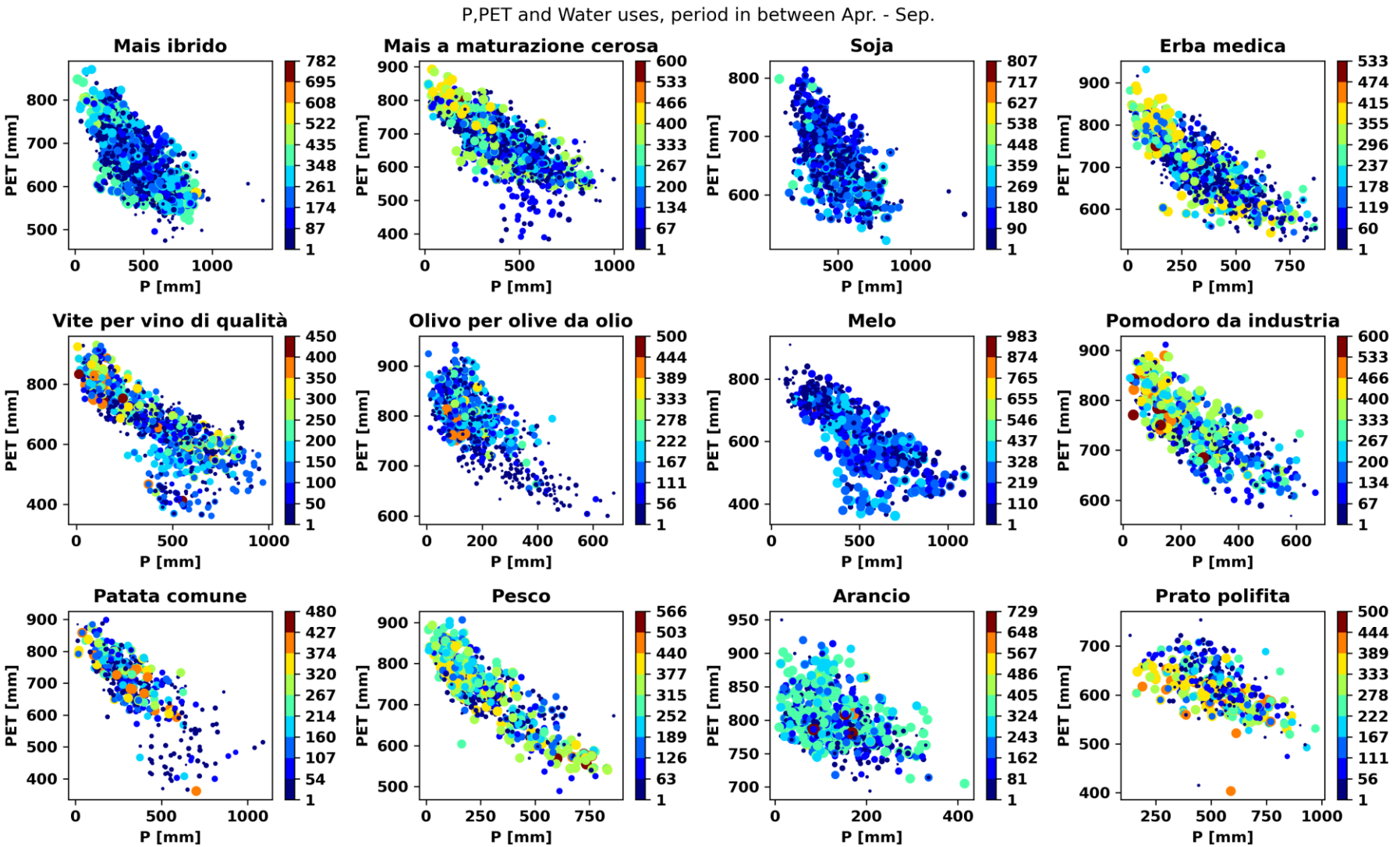
(farm level) Data Overview: Precipitation, Potential EvapoTranspiration and Water uses

Water uses vs. (P – PET) balance over April-September
for selected crops
(data from 2011-2022)
Irr = water use (Mc/ha)
Resa = yield (QL/ha)
QL = 100 Kg



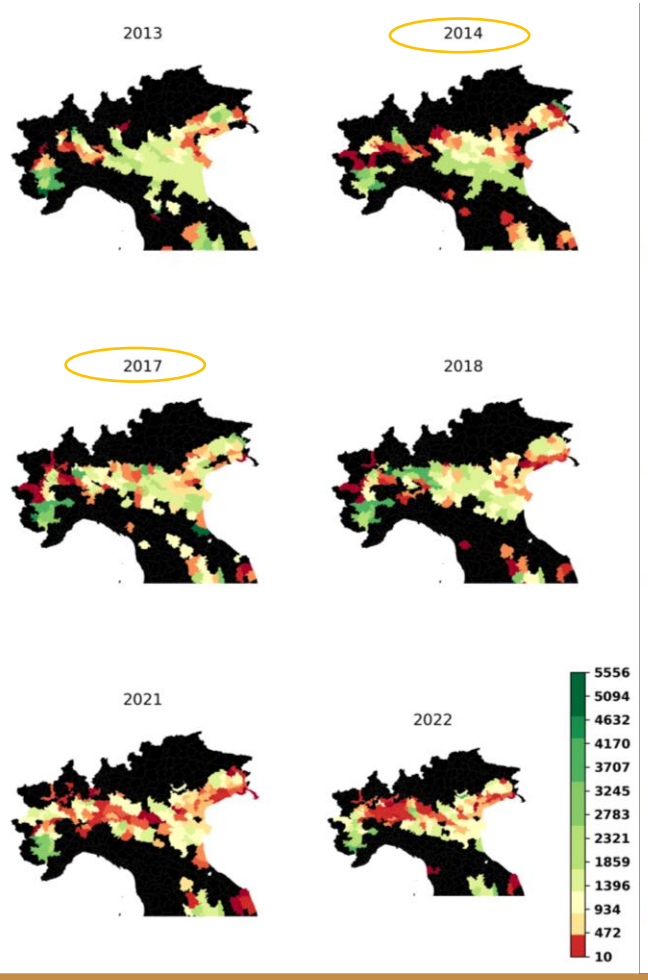
(farm level) Data Overview: Precipitation, Potential Evapotranspiration and Water uses

P vs. PET over April - September:
regional distributions grouped by RICA water uses level
(data from 2011-2022)
NB. Water uses are converted into mm equivalent

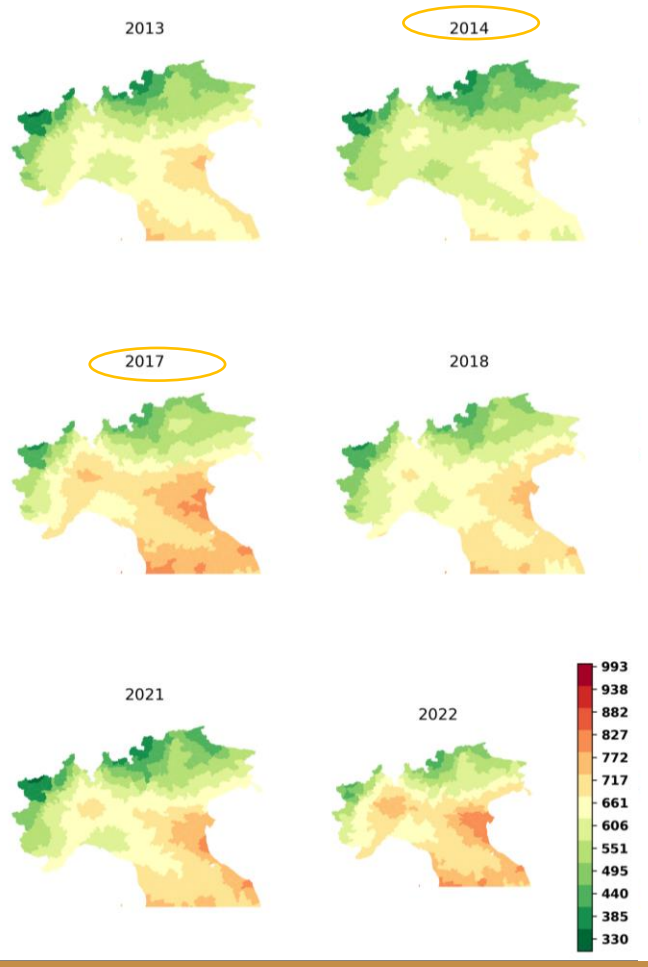


Inter-annual spatial variability. P, PET (April - September) and water uses (regional averages)

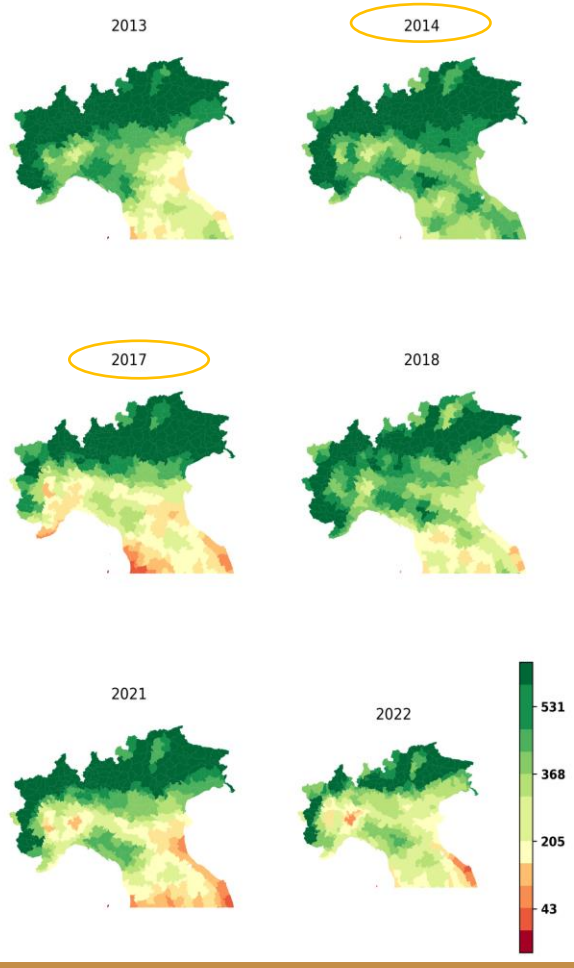
Water uses (regional averages)



PET (regional averages)

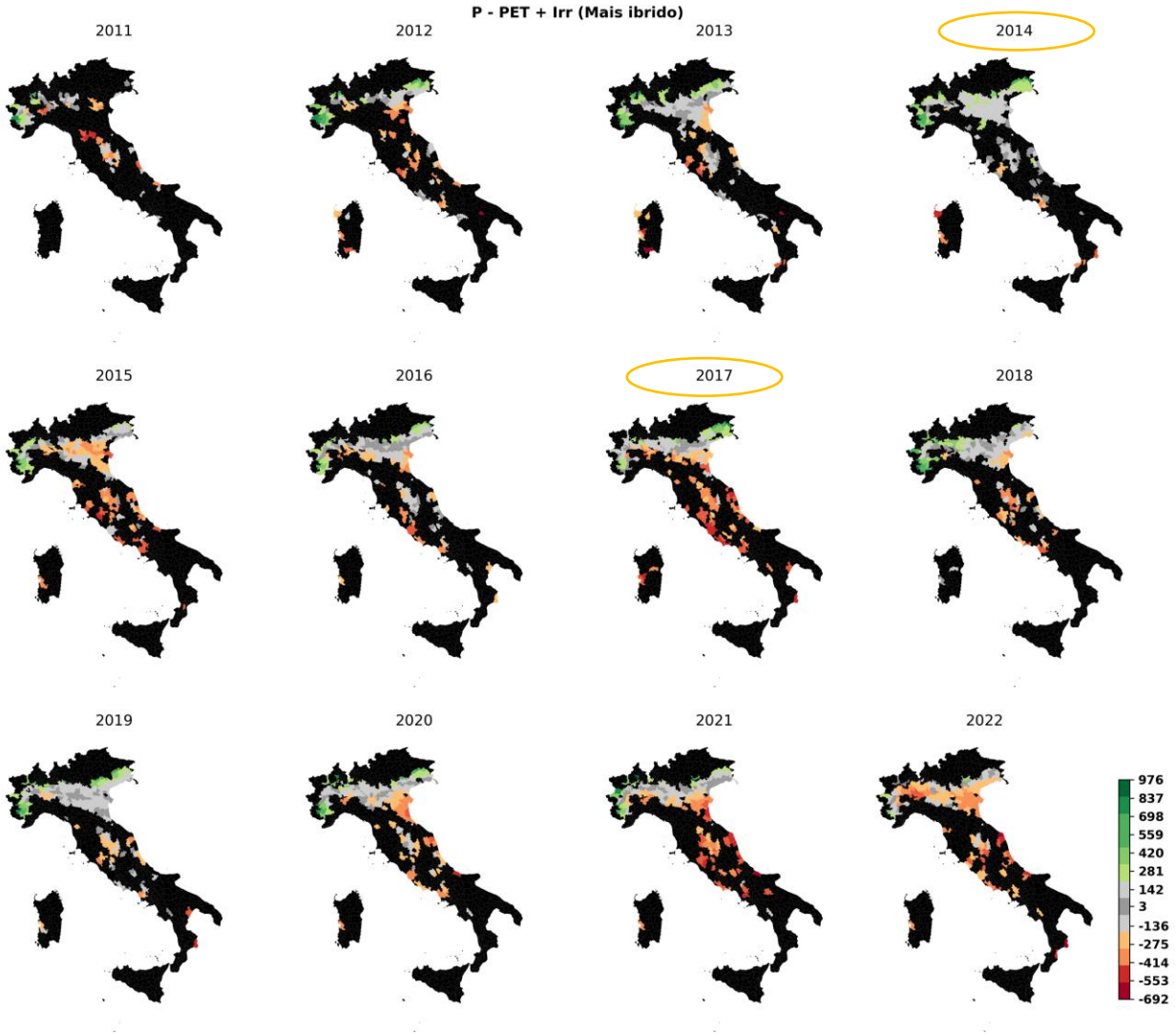


P (regional averages)



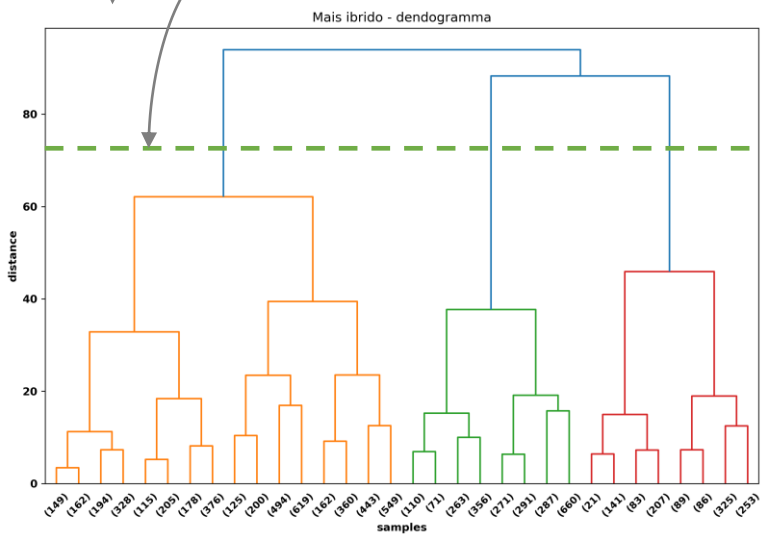
Inter-annual spatial variability. P – PET (April - September) + water uses (regional averages)

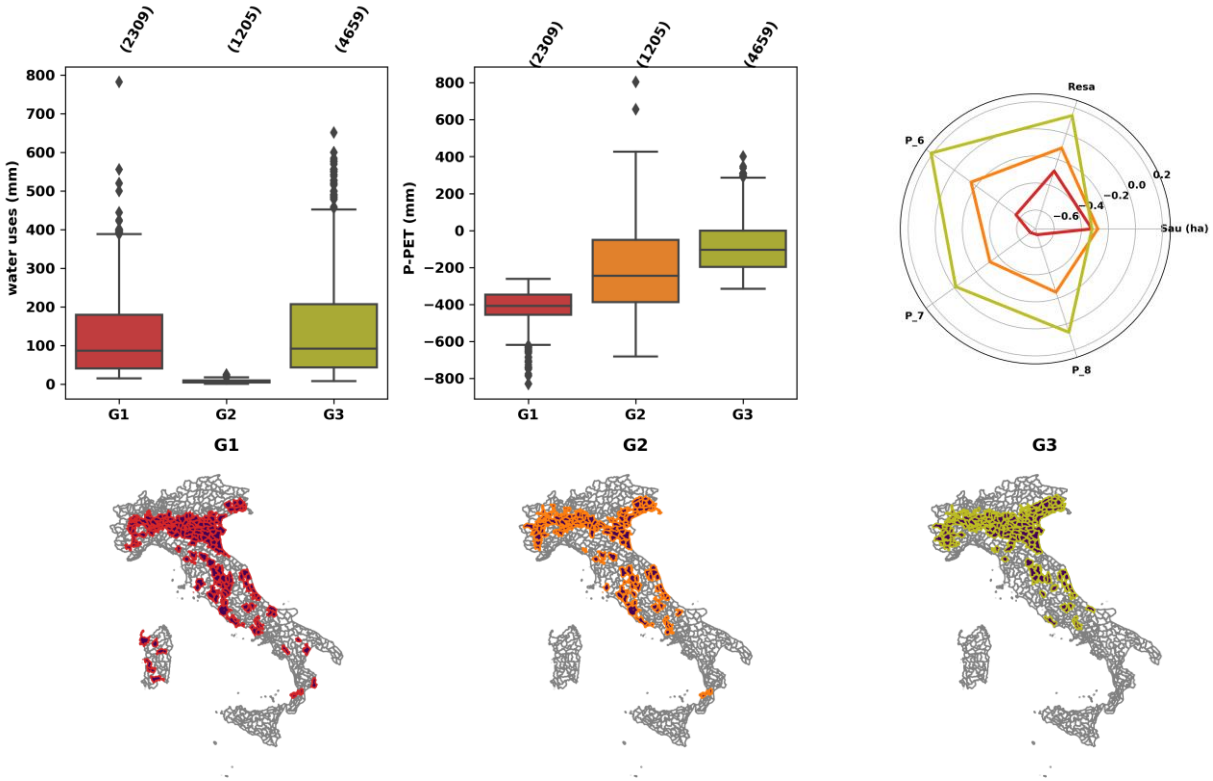
Figure:
P – PET + Water uses* (regional averages)
Mais ibrido
*Water uses are converted into mm equivalent



(farm level) cluster analysis for data filtering

- Hierarchical Clustering (dendrogram): grouping observations with similar water uses and P-PET balance over April-Sep.
- Select the cutting point (-----)
- Profile the clusters





Water uses to seasonal conditions regression: results

Random Forest Regression Analysis

- **Objective**: Predict *Water Uses* using climatic and water balance indicators as input features.
- **Target Variable**: *Water Uses*
- **Input Features**: (12 inputs)
  - Monthly climate-water balance metrics: *P-PET_6*, *P-PET_7*, *P-PET_8* (June, July, August)
  - Monthly potential evapotranspiration: *PET_6*, *PET_7*, *PET_8*
  - Seasonal aggregate metrics:
    - *P-PET_678* (June–August water balance)
    - *P_678* (total precipitation, June–August)
    - *PET_678* (total evapotranspiration, June–August)
  - Seasonal metrics for sowing period: *P_sem* (precipitation), *Bal_sem* (water balance), *PET_sem* (evapotranspiration)
- **Model**: Random Forest Regression
  - Helps capture complex, non-linear relationships in the data
  - Reduces risk of overfitting with ensemble averaging
  - **Evaluation**: k-fold Cross Validation applied for reliable performance assessment

Specie	All data R^2 (size)	worst cluster left out R^2 (size), ex G	1st best cluster R^2 (size), G	2th best cluster R^2 (size), G
Mais ibrido	0.32 (8173)	0.39 (6968), G2	0.42 (4659), G3	0.34 (2309), G1
Mais a maturazione cerosa	0.35 (3342)	0.42 (2835), G2	0.44 (1318), G3	0.41 (1517), G1
Soja	0.17 (2751)	0.19 (1774), G1	0.30 (1071), G3	0.25 (703), G2
Erba medica	0.39 (2440)	0.37 (2044), G2	0.40 (1068), G3	0.30 (958), G1
Vite per vino di qualità	0.29 (3963)	0.38 (3535), G1	0.33 (624), G2	0.29 (1837), G3
Olivo per olive da olio	0.45 (2297)	0.35 (2028), G4	0.47 (429), G3	0.23 (482), G2
Melo	0.42 (3620)	0.57 (3366), G1	0.61 (2278), G3	0.49 (1088), G2
Pomodoro da industria	0.26 (1118)	0.50 (679), G3	0.53 (197), G2	0.31 (482), G1
Patata comune	0.21 (1528)	0.25 (1366), G3	0.26 (257), G1	0.24 (1109), G2
Arancio	0.42 (2140)	0.45 (1477), G1	0.38 (939), G3	0.36 (538), G2
Pesco	0.42 (1921)	0.36 (1455), G2	0.37 (377), G3	0.32 (1078), G1
Prato polifita	0.49 (1373)	0.55 (978), G1	0.55 (316), G3	0.48 (662), G2

Thank you for your attention

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