Regional Training and Study Tour on optimal irrigation management (12-16 June 2013– CIHEAM Bari, Italy)

Training module 3:
Safe reuse of non-conventional water resources in agriculture

Alessandro Gaetano Vivaldi

Associate Professor

Department of Soil, Plant and Food Sciences - University of Bari “Aldo Moro”

Office: Via Giovanni Amendola 165/A - 70126 Bari, Italy.

Cell: +39 3208889715

E-mail: gaetano.vivaldi@uniba.it

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Training module 3:

Reclaimed water treatment, standards, and reuse: Apulia Region context

Alessandro Gaetano Vivaldi

Associate Professor

Department of Soil, Plant and Food Sciences - University of Bari “Aldo Moro”

Office: Via Giovanni Amendola 165/A - 70126 Bari, Italy.

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- REGULATION
- WATER TREATMENTS
- CASE STUDIES

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European Regulation

Italian Decree

Regional Regulation

European Commission Water Reuse Regulation

The Water Reuse Regulations of the European Commission, discussed since 2015, were published in May 2020 in order to harmonize the minimum water quality and monitoring requirements for the safe reuse of treated urban wastewaters in agricultural irrigation (EU regulation 2020/741). Risk management provisions are included to assess and address potential health and environmental risks, as well as permitting requirements.

Irrigation water quality

Reclaimed water quality classes and irrigation techniques and permitted agricultural purposes

Crop category	Minimum reclaimed water quality class	Irrigation method
All food crops, including root crops consumed raw and food crops where the edible portion is in direct contact with reclaimed water	Class A	All irrigation methods allowed
Food crops consumed raw where the edible portion is produced above ground and is not in direct contact with reclaimed water	Class B	All irrigation methods allowed
	Class C	Drip irrigation only
Processed food crops	Class B	All irrigation methods allowed
	Class C	Drip irrigation only
Non-food crops including crops to feed milk- or meat-producing animals	Class B	All irrigation methods allowed
	Class C	Drip irrigation only
Industrial, energy, and seeded crops	Class D	All irrigation methods allowed

Source: JRC analysis.

Irrigation water quality

Classes of quality and quality parameters for reclaimed water in agriculture

Reclaimed water quality class	Indicative technology target	Quality criteria				
		E. coli (cfu/100 ml)	BOD_5 (mg/l)	TSS (mg/l)	Turbidity (NTU)	Additional criteria
Class A	Secondary treatment, filtration, and disinfection (advanced water treatments)	≤10 or below detection limit	≤10	≤10	≤5	*Legionella* spp.: ≤1,000 cfu/l when there is risk of aerosolization. Intestinal nematodes (helminth eggs): ≤1 egg/l when irrigation of pastures or fodder for livestock.
Class B	Secondary treatment, and disinfection	≤100	According to Directive 91/271/EEC	According to Directive 91/271/EEC	-	
Class C	Secondary treatment, and disinfection	≤1,000	According to Directive 91/271/EEC	According to Directive 91/271/EEC	-	
Class D	Secondary treatment, and disinfection	≤10,000	According to Directive 91/271/EEC	According to Directive 91/271/EEC	-	

Source: JRC analysis.

Monitoring and control

Minimum frequencies for monitoring of reclaimed water for irrigation purposes in agriculture.

Minimum monitoring frequencies				
Reclaimed water quality classes	**Total N**	**Total P**	**Salinity**	**Salmonella ssp.**
Class A **Class B** **Class C** **Class D**	Once a week or according to the Directive 91/271/CE	Once a week or according to the Directive 91/271/CE	Twice a month	Twice a month

Monitoring and control

Minimum frequencies for monitoring of reclaimed water for irrigation purposes in agriculture.

	Minimum monitoring frequencies					
Reclaimed water quality classes	***E. coli***	**BOD_5**	**TSS**	**Turbidity**	***Legionella* spp. (when applicable)**	**Intestinal nematodes (when applicable)**
Class A	Once a week	Once a week	Once a week	Continuous	Twice a month	Twice a month or frequency determined according to the number of eggs in wastewater.
Class B	Once a week	According to Directive 91/271/EEC	According to Directive 91/271/EEC	-		
Class C	Twice a month	According to Directive 91/271/EEC	According to Directive 91/271/EEC	-		
Class D	Twice a month	According to Directive 91/271/EEC	According to Directive 91/271/EEC	-		

Source: JRC analysis.

Risk assessment and management

Risk management includes the proactive identification and management of risks to ensure that refined water is safely used and managed and that there is no risk to the environment or to human or animal health. To that end, a risk management plan for the reuse of water shall be established on the basis of the following:

A- Description of the water reuse system

B- Actors and roles

C- Identification of hazards, environments and populations at risk

D- Methods of health and environmental risk assessment

Risk assessment and management

A- Description of the water reuse system

A detailed description of the system is the starting point for the complete characterization of the entire water reuse system and begins with the identification of the system boundary that must include the point of entry of urban and/or industrial wastewater in the wastewater treatment plant and the final uses of the reclaimed water. The description should contain all necessary data (dimension of WWTP, water parameters, technologies used, irrigation techniques, type of crops and soil, climate, etc.)

Risk assessment and management

B- Actors and roles

All actors involved and their roles and responsibilities must be identified for each element of the water reuse system. This should include the actors responsible for (i) the management of the WWTP, (ii) the transport and storage, where appropriate, and (iii) the final use.

Risk assessment and management

C- Identification of hazards, environments and populations at risk

All hazards (pollutants and pathogens) or hazards (missed treatments, accidental spills, contamination) shall be identified which originate from the water reuse system and may pose a risk to public health and/or the environment. Hazard that can affect humans, animals or environments should be identified (populations and exposed environments). These elements are necessary in order to be able to subsequently assess the environmental and health risks.

Risk assessment and management

D- Methods of health and environmental risk assessment

The environmental and health risk assessment shall be conducted taking into account the hazards previously identified and the potential exposure within the water reuse system. The risk assessment may be carried out using qualitative or semi-quantitative methods. Qualitative risk assessment is suggested as the most appropriate and economically feasible methodology. Quantitative risk assessment could be used for high risk projects and when sufficient data are available for their implementation. The health risk assessment assesses any risk to human and animal health, while the environmental risk assessment aims to determine whether the contaminants identified in the refined water affect the quality status of the environmental matrices.

ITALIAN DECREE

Current thresholds for irrigation reuse in some EU countries

Appendix A. Current thresholds for irrigation reuse in some EU countries. For Italy, the thresholds of D.M. 185/2003 are shown and in brackets the R.R. 08/2012 thresholds for total nitrogen and phosphorus

Analytical parameters	France	Greece	Italy	Portugal	Spain	New Regulation (EU)
Microbiological parameters						
Escherichia coli (cfu/100 ml)	250–10^5	5–200	10		0–10^4	≤10 (for quality class A); ≤100 (for quality class B); ≤1000 (for quality class C); ≤10,000 (for quality class D)
Faecal coliforms (cfu/100 ml)				100–10^4		
Total coliforms (cfu/100 ml)		2				
Legionella sp. (cfu/l)					0–10^3	≤1000 cfu/l where there is risk of aerosolization
Salmonella sp.			Absence		Absence	
Sulphate-reducing bacteria (log reduction)	2–4[c]					
Helminth eggs (intestinal nematodes) (eggs/l)				1	0.1	≤1 for irrigation of pastures or forage
F-specific bacteriophages (log reduction)	2–4[c]					
Physical-chemical parameters						
Total suspended solids (TSS) (mg/l)	15	2–35	10	60	5–35	≤10 (for quality class A); In accordance with Directive 91/271/EEC (Annex 1, Table 1) for class B, C, D,
Turbidity (NTU)	2-No limit				1–15	≤5 (for quality class A)
Biochemical oxygen demand (BOD) (mg/l)		10–25	20			≤10 (for quality class A); In accordance with Directive 91/271/EEC (Annex 1, Table 1) for quality class B, C, D
Chemical oxygen demand (COD) (mg/l)	60		100			
pH		6.5–8.5	6.0–9.5	6.5–8.4		
Electrical conductivity (EC) (dS/m)		3.0	3.0	1.0	3.0	
Total dissolved solids (TDS) (mg/l)		2000		640		
Sodium adsorption ratio (SAR)		12[a]	10	8	6	
Chlorides (mg/l)		350	250	70		
Total nitrogen (mg/l)		30	15 (35)		10[b]	
Total phosphorus (mg/l)		1–2	2 (10)		2[b]	
Bicarbonate (HCO_3)		500[c]				

[a] Depending on the value of EC.
[b] Only for recharge and aquifer for recreational uses.
[c] Minimum log reduction required.

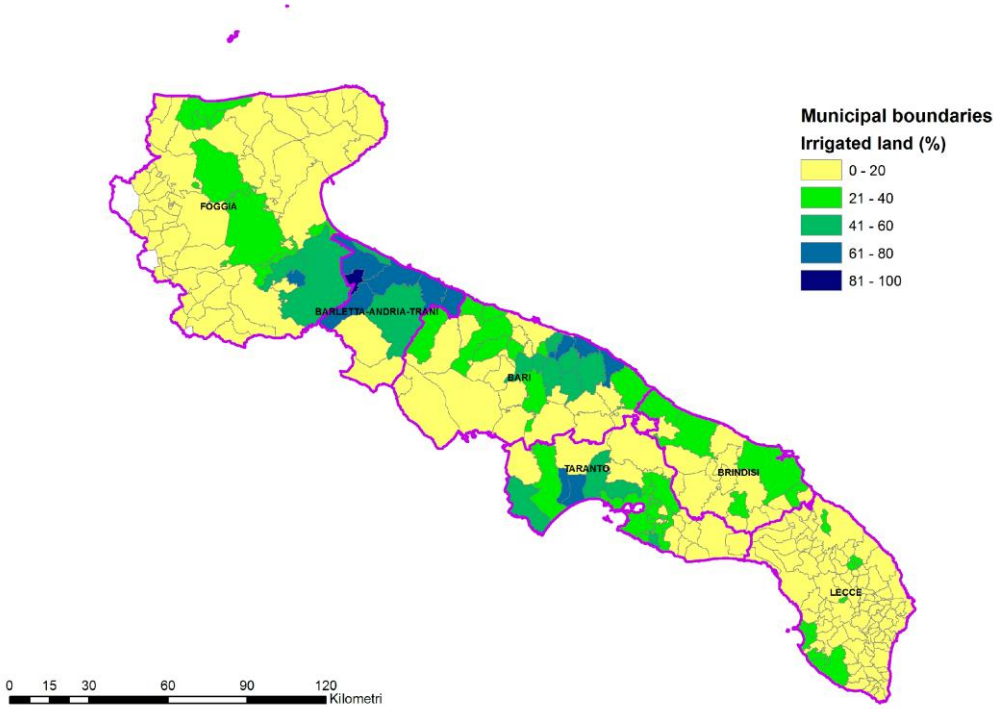
Regional wastewater reuse Regulation

Regione Puglia

REGOLAMENTO
REGIONALE PUGLIA 18 aprile 2012, n.8

Punto 3 Allegato: le regioni possono autorizzare limiti diversi da quelli riportati in tabella.

Parameters	Italian regulation	Apulia regulation
Fosforo	2 mg/L	10 mg/L
Azoto	15 mg/L	35 mg/L



Regional wastewater reuse regulation

Limiti per il riutilizzoParametri	Unità di misura	Valori limite
SEZIONE 1		
Solidi sospesi totali	mg/l	10
BOD_5	mg/l	20
COD	mg/l	100
Escherichia coli **Nota 1**	UFC/100 ml	10 su 100 ml (80% dei campioni) 100 (valore puntuale massimo)
Salmonella		assente
SEZIONE 2		
pH		6 ÷ 9,5
SAR		10
Materiali grossolani		assenti
Conducibilità elettrica	µS/cm	3.000
Alluminio	mg/l	1
Arsenico	mg/l	0,02
Bario	mg/l	10
Berillio	mg/l	0,1
Boro	mg/l	1
Cadmio	mg/l	0,005
Cobalto	mg/l	0,05
Cromo totale	mg/l	0,1
Cromo VI	mg/l	0.005
Ferro	mg/l	2
Manganese	mg/l	0,2
Mercurio	mg/l	0,001
Nichel	mg/l	0,2
Piombo	mg/l	0,1
Rame	mg/l	1
Selenio	mg/l	0,01
Stagno	mg/l	3
Tallio	mg/l	0,001
Vanadio	mg/l	0,1
Zinco	mg/l	0,5
Cianuri totali (CN)	mg/l	0,05
Cloro attivo libero	mg/l	0,2
Solfuri (come H_2S)	mg/l	0,5
Solfiti (come SO_3)	mg/l	0,5
Solfati (come SO_4)	mg/l	500
Cloruri	mg/l	250
Fluoruri	mg/l	1,5
Fosforo totale **Nota 2**	mg/l	2 (10)
Azoto totale **Nota 2**	mg/l	15 (35)
Azoto ammoniacale (NH_4)	mg/l	2
Grassi ed oli animali/vegetali	mg/l	10
Oli minerali **Nota 3**	mg/l	0,05
Fenoli totali	mg/l	0,1
Pentacloro fenolo	mg/l	0,003
Aldeidi totali	mg/l	0,5
Tetracloro etilene, tricloro etilene (somma delle concentrazioni dei parametri specifici)	mg/l	0,01
Benzene	mg/l	0,5
Benzo(a)pirene	mg/l	0,00001
Solventi organici aromatici totali	mg/l	0,01

Tabella 4

Parametri	Frequenza di campionamento minima
SEZIONE 1	
Solidi sospesi totali	bi-settimanale
BOD_5	bi-settimanale
COD	bi-settimanale
Escherichia coli	bi-settimanale
Salmonella	bi-settimanale

Tabella 4

Parametri	Frequenza di campionamento minima
SEZIONE 2	
pH	bi-settimanale
SAR	mensile
Materiali grossolani	giornaliera
Conducibilità elettrica	bi-settimanale
Alluminio	annuale
Arsenico	semestrale
Bario	annuale
Berillio	annuale
Boro	semestrale
Cadmio	semestrale
Cobalto	annuale
Cromo totale	semestrale
Cromo VI	semestrale
Ferro	annuale
Manganese	annuale
Mercurio	semestrale
Nichel	annuale
Piombo	semestrale
Rame	annuale
Selenio	annuale
Stagno	annuale
Tallio	annuale
Vanadio	annuale
Zinco	annuale
Cianuri totali (CN)	semestrale
Cloro attivo libero	semestrale
Solfuri (come H_2S)	mensile
Solfiti (come SO_3)	mensile
Solfati (come SO_4)	mensile
Cloruri	mensile
Fluoruri	mensile
Fosforo totale	bi-settimanale
Azoto totale	bi-settimanale
Azoto ammoniacale (NH_4)	bi-settimanale
Grassi ed oli animali/vegetali	semestrale
Oli minerali	semestrale
Fenoli totali	annuale
Pentacloro fenolo	annuale
Aldeidi totali	annuale
Tetracloro etilene, tricloro etilene	annuale
Benzene	annuale
Benzo(a)pirene	annuale
Solventi organici aromatici totali	annuale
Solventi organici azotati totali	annuale
Tensioattivi totali	annuale
Pesticidi clorurati	annuale
Pesticidi fosforati	annuale
Altri pesticidi totali	annuale
Trialometani	annuale
Solventi clorurati totali	annuale
Litio	annuale
Molibdeno	annuale

Current situation

The regional regulation will be replaced by the Italian Drought decree signed in April 2023

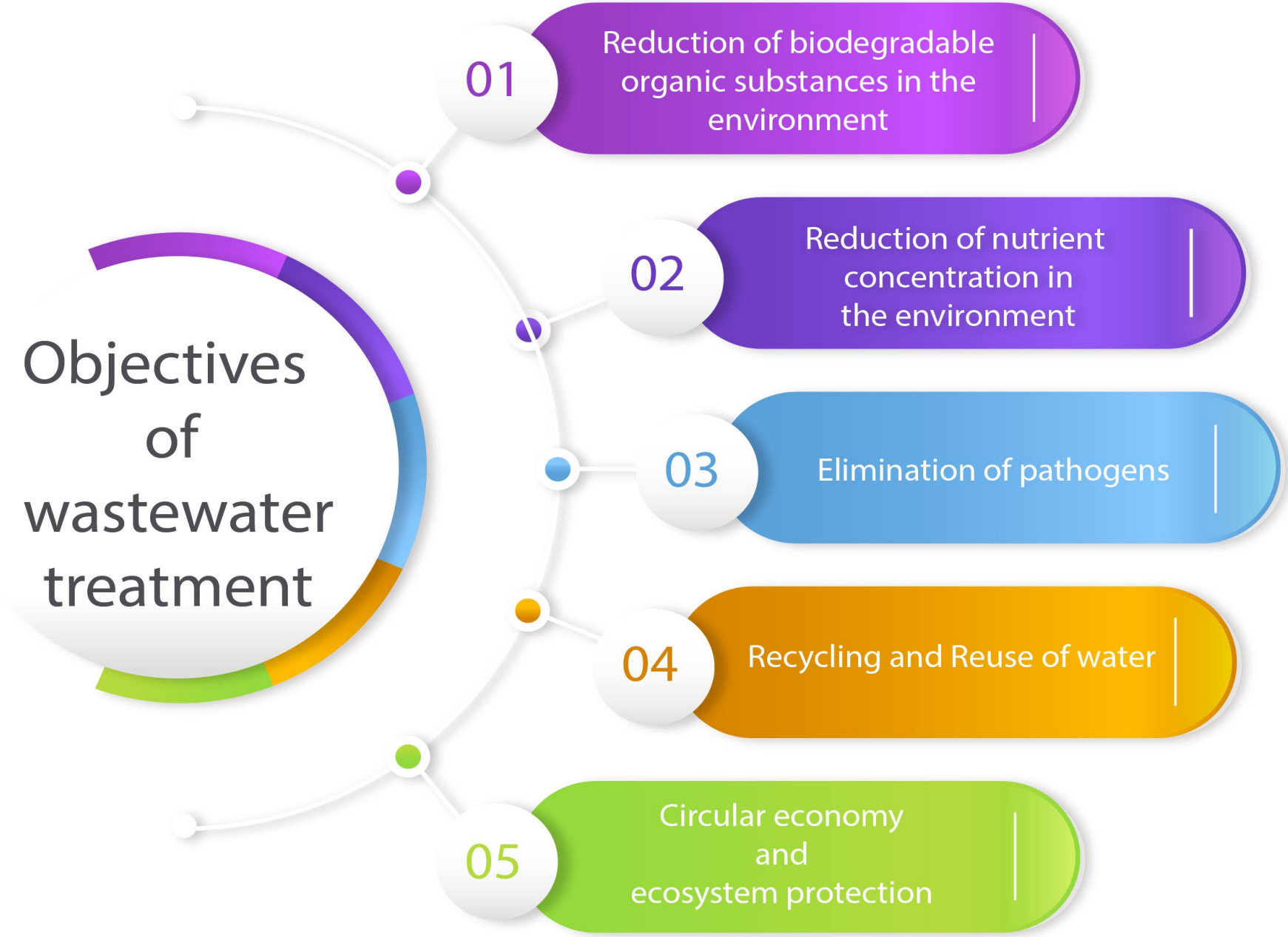
European Regulation 2020 (2023)

Italian Decree 2003

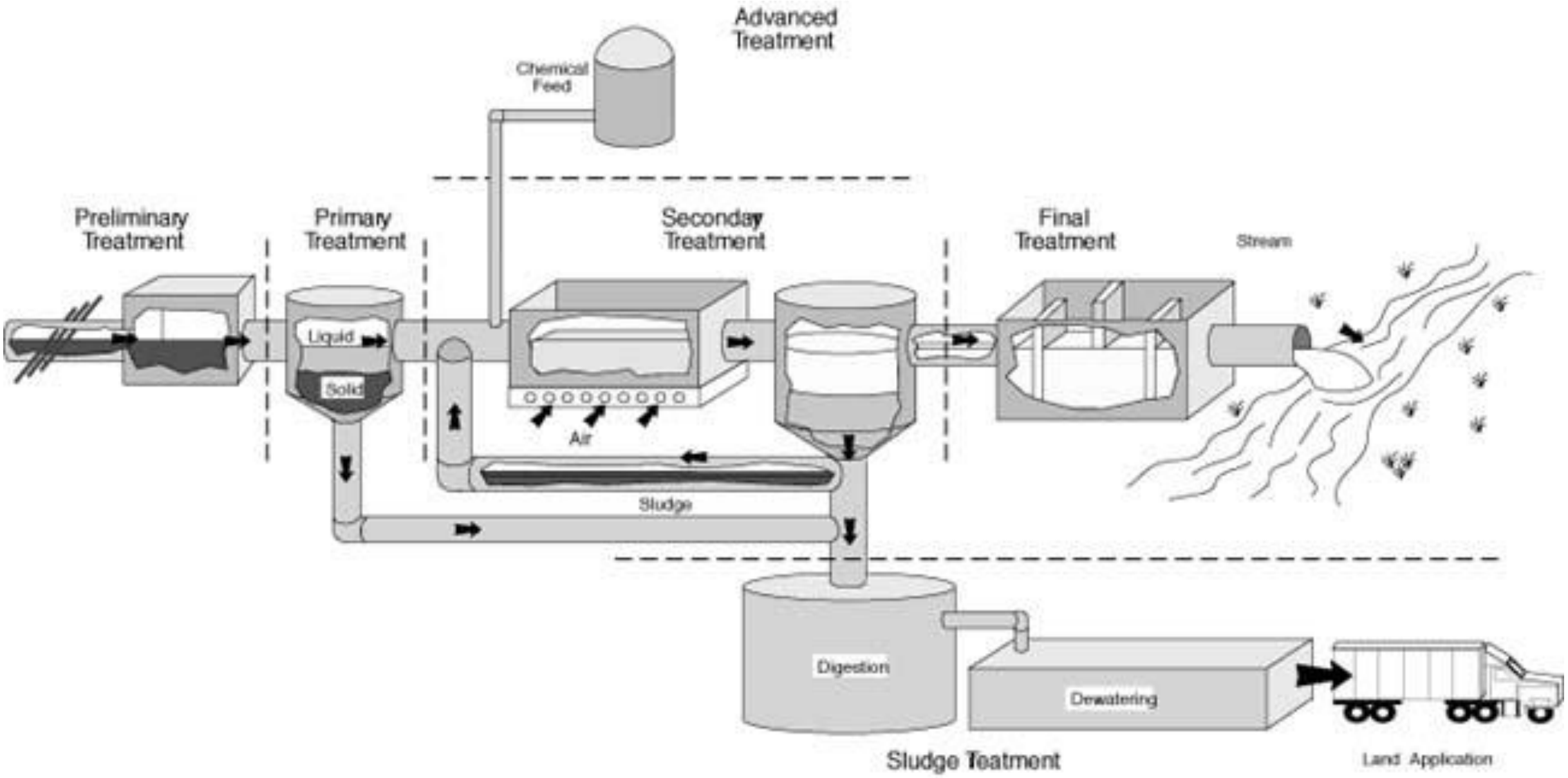
Regional Regulation 2012

- REGULATION
- WATER TREATMENTS
- CASE STUDIES

Wastewater treatment process



Wastewater treatment process

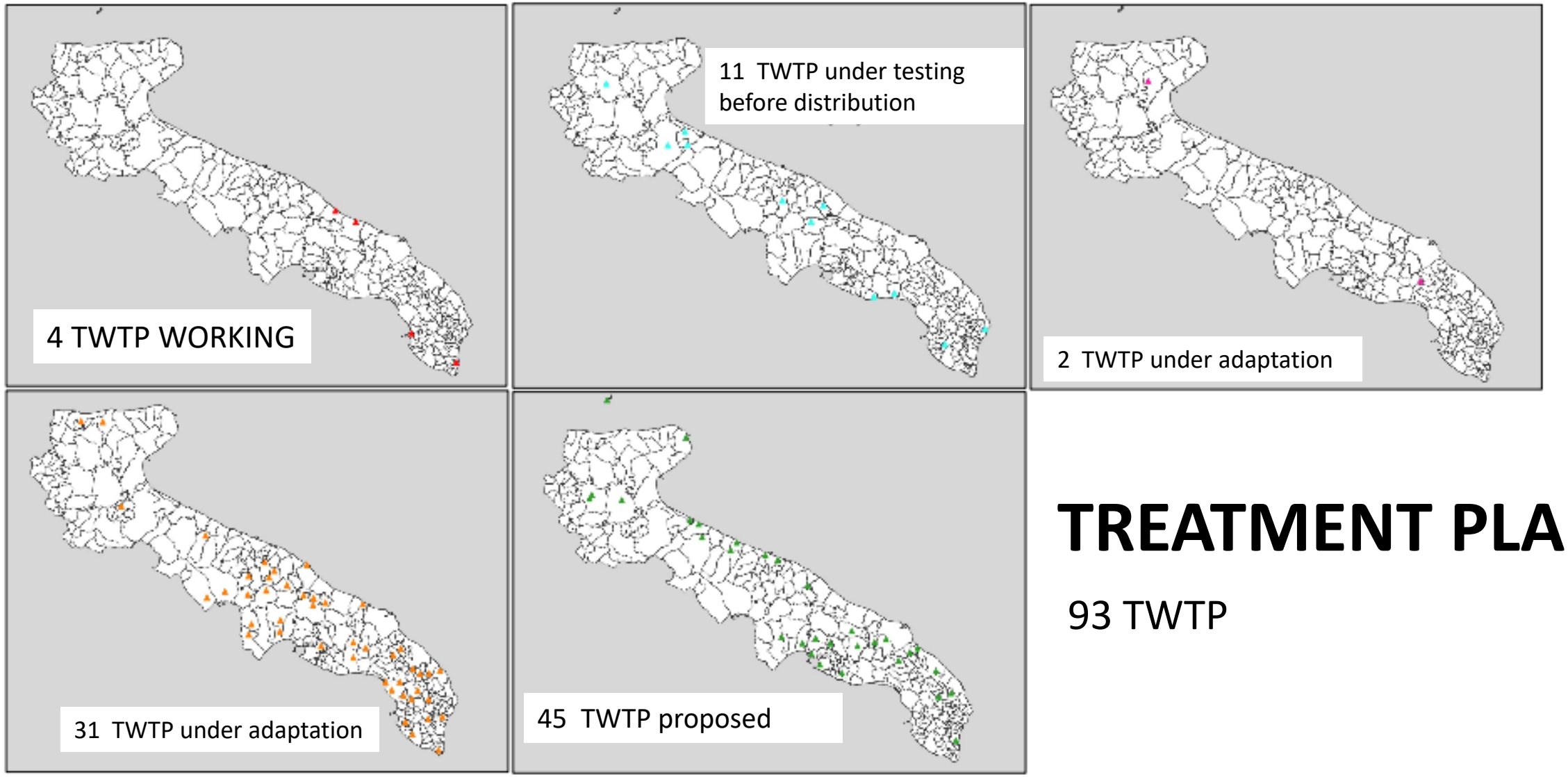


Different wastewater reuse in Apulia region

In Apulia, the reuse could satisfy approximately 12% of the water requirement in agriculture

- REGULATION
- WATER TREATMENTS
- CASE STUDIES

Apulia Region



TREATMENT PLANTS

93 TWTP

TRINITAPOLI


TRINITAPOLI

Water sources

Freash water (FW) control

Ultrafiltration185/2003 (RW)

Quantity and Quality of fruits

- Yield (kg)
- Fruit numbers
- Total soluble solid (°Brix)
- Titratable acidity (g/l)
- Total phenols (mg ac.gallico/100 g pf)
- Antioxidant capacity (mg Trolox/100 g pf)
- Glucose (g Glucose/100 g (490 nm))

Soil analysis

- Electrical conductivity of soil saturated paste
- Organic matter
- CaCO3 %
- P Olsen
- N Kjeldhal

Harvest date

I-II-III Harvest
2012-2013-2014

Chemical characteristics of water sources

Parameter	FW	RW	*t-test*
pH	7.73 ± 0.20	7.51 ± 0.21	ns
EC (dS m^{-1})	0.63 ± 0.03	1.39 ± 0.10	*
SAR	1.51 ± 0.24	2.99 ± 0.39	*
F^- (mg l^{-1})	0.99 ± 0.52	1.61 ± 1.12	*
Cl^- (mg l^{-1})	37.08 ± 7.16	161.46 ± 23.18	*
NO_3^- (mg l^{-1})	2.80 ± 1.97	1.32 ± 1.16	*
PO_4^{3-} (mg l^{-1})	0.54 ± 0.83	14.04 ± 8.56	*
SO_4^{2}- (mg l^{-1})	59.03 ± 13.30	99.35 ± 18.64	*
NH_4^+ (mg $^{-1}$l)	0.89 ± 0.99	40.87 ± 12.79	*
Na^+ (meq l^{-1})	2.02 ± 0.37	4.84 ± 0.44	*
K^+ (mg l^{-1})	6.12 ± 3.29	27.66 ± 5.27	*
Ca^{2+} (meq l^{-1})	2.89 ± 0.64	4.01 ± 0.58	*
Mg^{2+} (meq l^{-1})	0.75 ± 0.37	1.36 ± 0.45	*

Mean content (n = 27) * Statistically significant at $P < 0.05$ level of significance.

Fruits

Fruit quality parameters: soluble solid content (SSC. ∘Brix). titratable acidity (TA.%). pH. Firmness (F. kg cm^{-2}). Colour (CO. h°) and maturity index (MI. SSC·TA^{-1} ratio) in three harvests period (2012, 2013 and 2014) for each treatment (FW: Fresh Water; RW: Reclaimed Water) of nectarine trees. Each point is the average ± SE of the 180 fruit measurements performed in twelve inner trees per treatment. * Statistically significant at $P < 0.05$ level of significance.

	2012		*t*-test	2013		*t*-test	2014		*t*-test
	FW	RW		FW	RW		FW	RW	
SSC	18.33 ± 0.10	19.80 ± 0.10	*	15.64 ± 0.10	15.93 ± 0.20	*	16.39 ± 0.60	15.50 ± 0.50	ns
TA	8.18 ± 0.10	7.89 ± 0.10	*	6.52 ± 0.10	6.12 ± 0.10	*	4.18 ± 0.20	4.73 ± 0.30	*
pH	3.77 ± 0.02	3.83 ± 0.01	*	3.89 ± 0.03	3.96 ± 0.02	*	4.31 ± 0.10	4.18 ± 0.02	*
F	5.19 ± 0.02	5.15 ± 0.01	*	5.54 ± 0.10	5.52 ± 0.12	ns	5.36 ± 0.10	5.06 ± 0.05	*
MI	2.24 ± 0.01	2.51 ± 0.04	*	2.41 ± 0.20	2.6 ± 0.40	ns	4.15 ± 0.30	4.43 ± 0.20	*

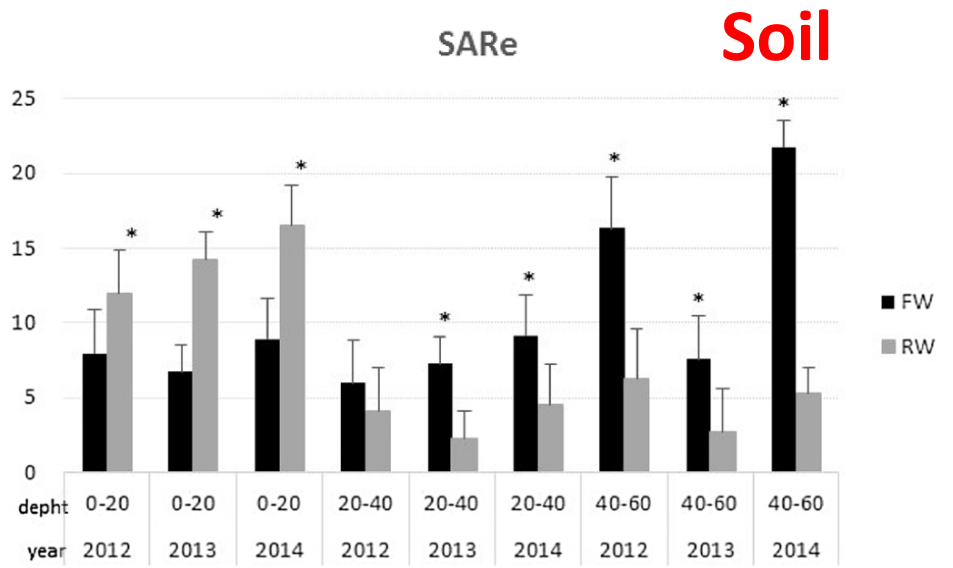


Fig. 2. Sodium adsorption ratio (SARe) measured in soil gravimetric samples during 2012, 2013 and 2014 in the two irrigation treatments (FW fresh water, black histogram; and RW reclaimed water, grey histogram) and three different depths (0–20, 20–40, 40–60 cm). Each column is the annual average of 12 measurements (4 samples per irrigation treatment and three times per year). * Statistically significant at $P < .05$ level of significance.

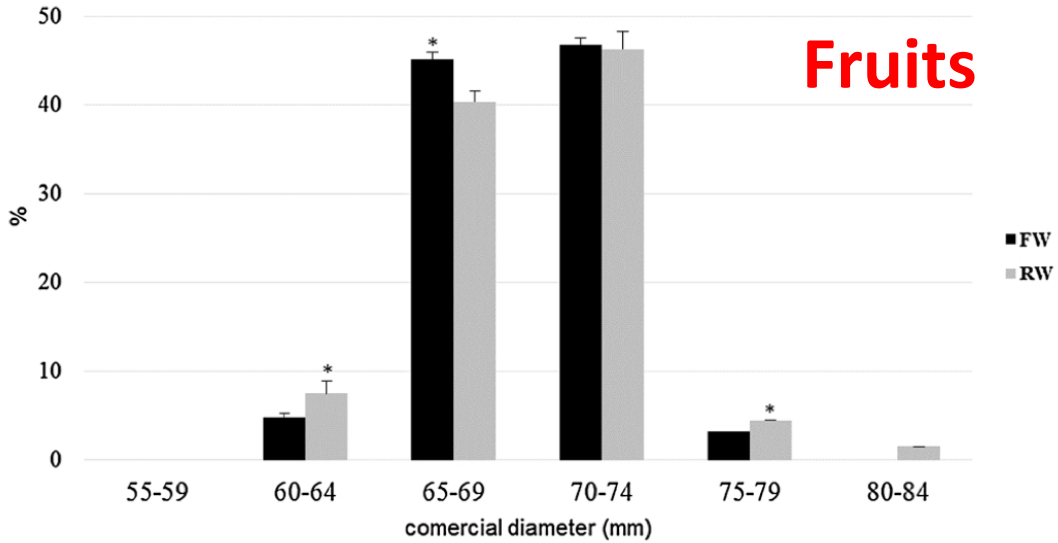
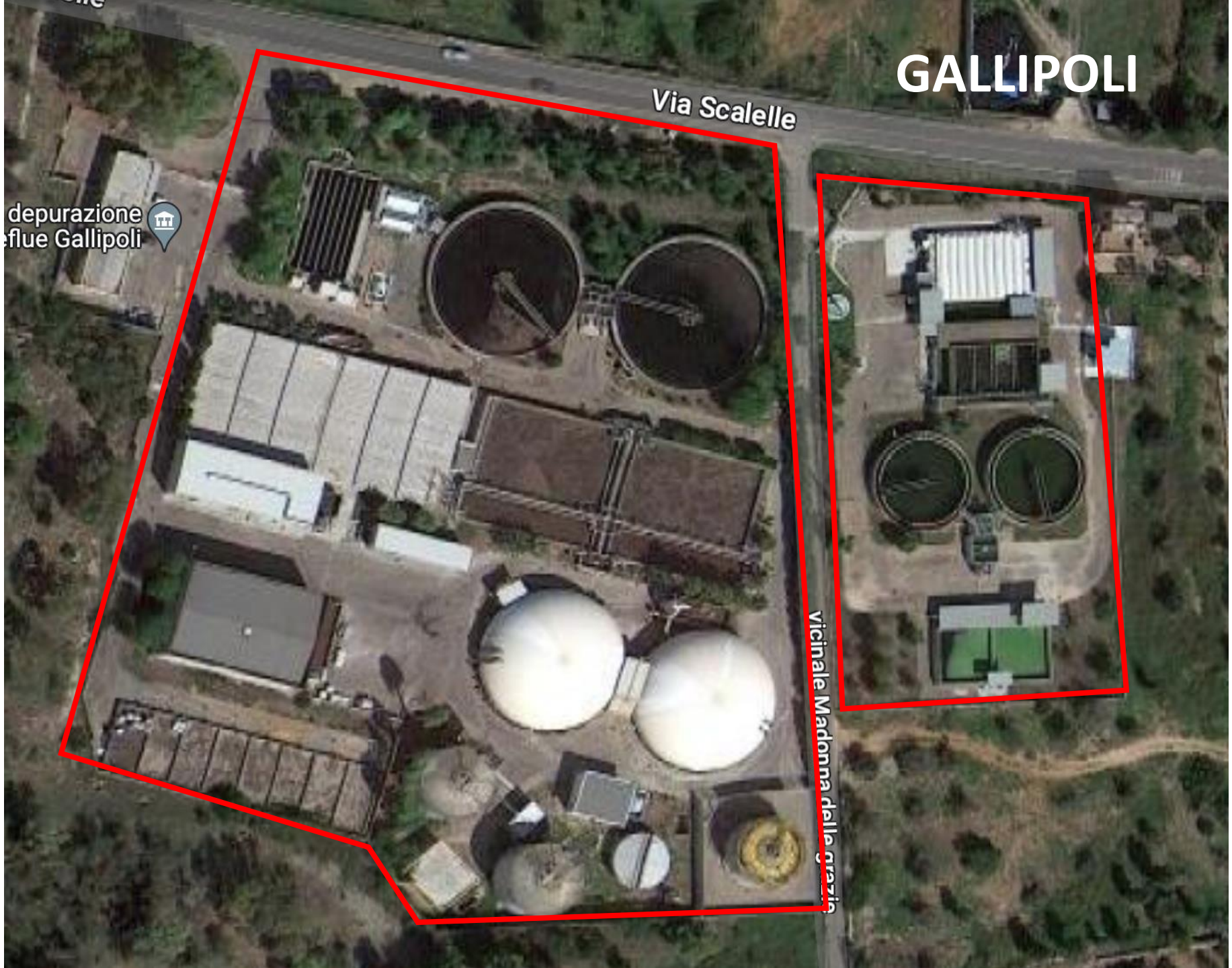


Fig. 3. Fruits commercial diameter classes (mm), as mean of 2012, 2013 and 2014, in the two irrigation treatments (FW fresh water, black histogram; and RW reclaimed water, grey histogram). Each column is the annual average of 180 measurements (60 samples per irrigation treatment and three years). * Statistically significant at $P < .05$ level of significance.

FASANO

FASANO


GALLIPOLI
Via Scalelle
depurazione
flue Gallipoli
vicinale Madonna delle grazie

Tertiary water treatment plant

Continuously monitoring system of $NH4^+$ NO_3^-, K, Ec, pH, T

UV treatment or reaction with peracetic acid

Filtration

Phosphates precipitation

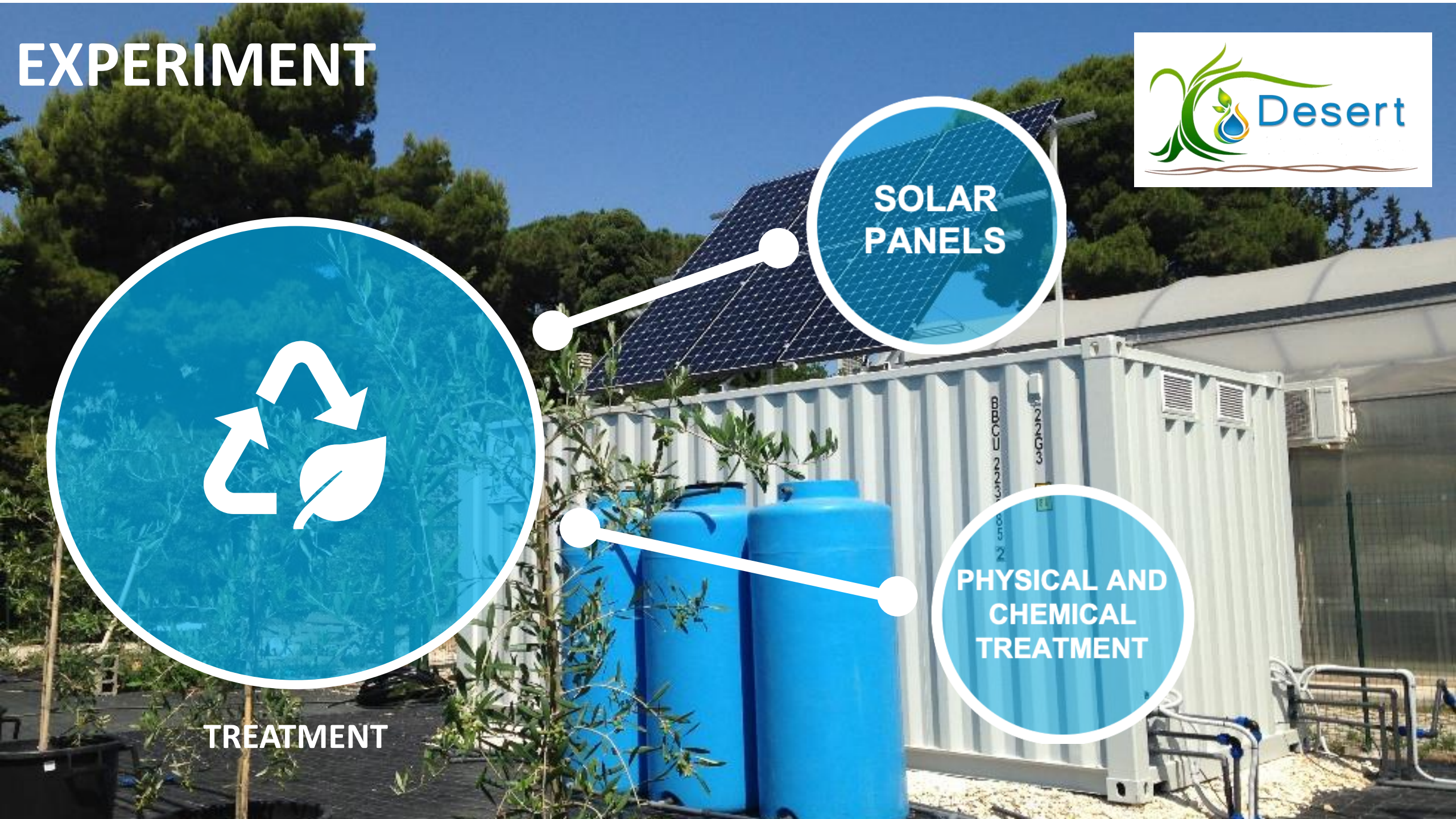
Mixing water and reagents

Reagent injection for Phosphates precipitation

Phosphates monitoring

Secondary treated wastewater

EXPERIMENT



TREATMENT

SOLAR PANELS

The integrated water treatment system + Fertigation will work autonomously, that is, we will produce the energy that we will consume whenever we have sun.

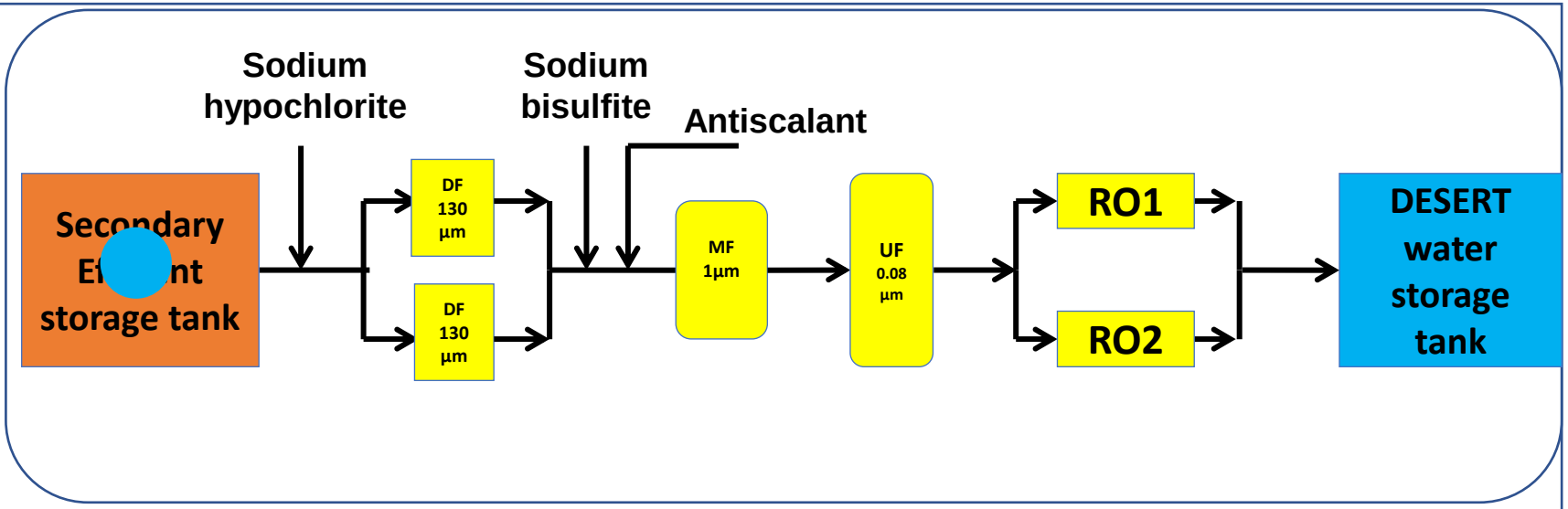
The solar energy system consists of:

- **Solar panels.** 6-10 solar panels, composed of 72 polycrystalline cells, 327 W and 6.46 A. = 3270 W peak and 64.6 A.

- **Inverter.** Solar charge controllers, solar energy inverters and electronic regulators.

- **Batteries.** The energy produced are stored in 4 batteries of 12 vdc and 220 A / h. = 48 Vdc and 220 A / h.

EXPERIMENT

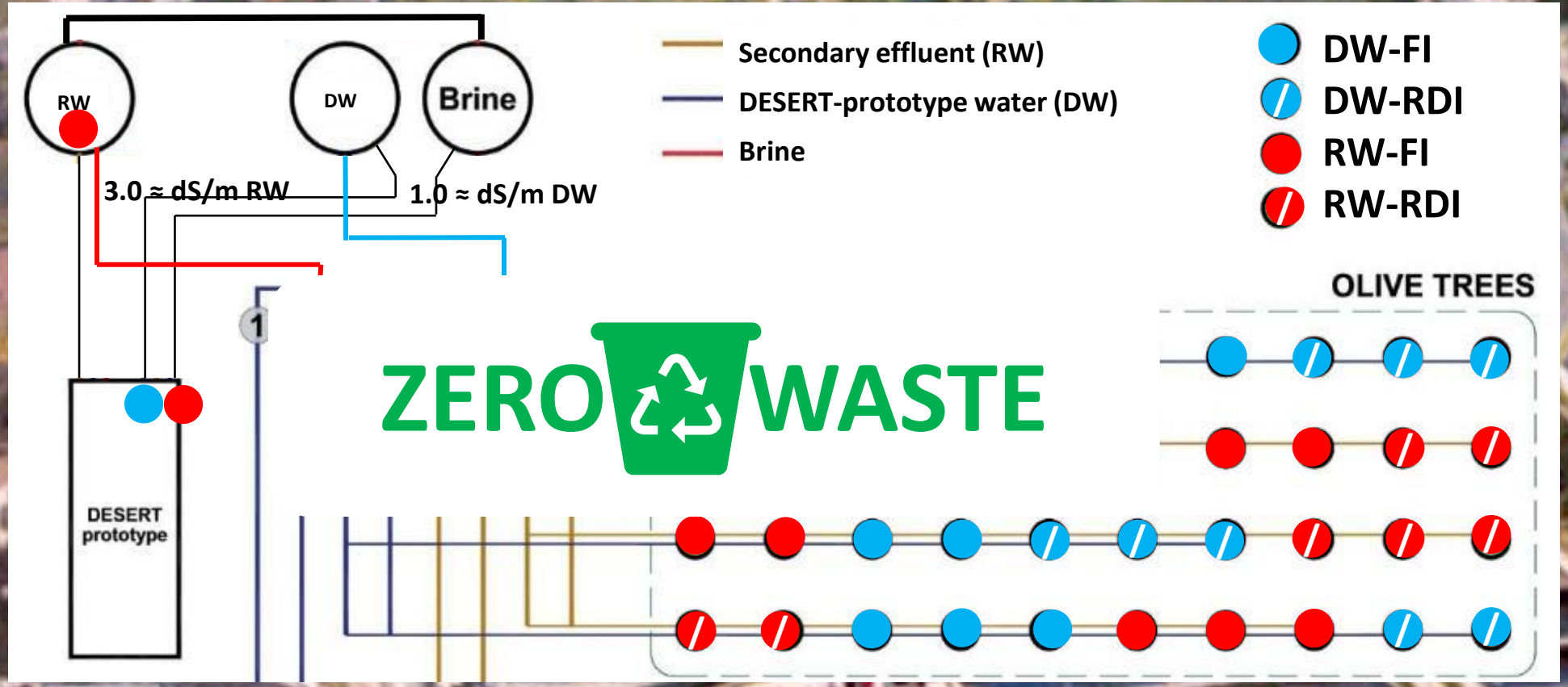


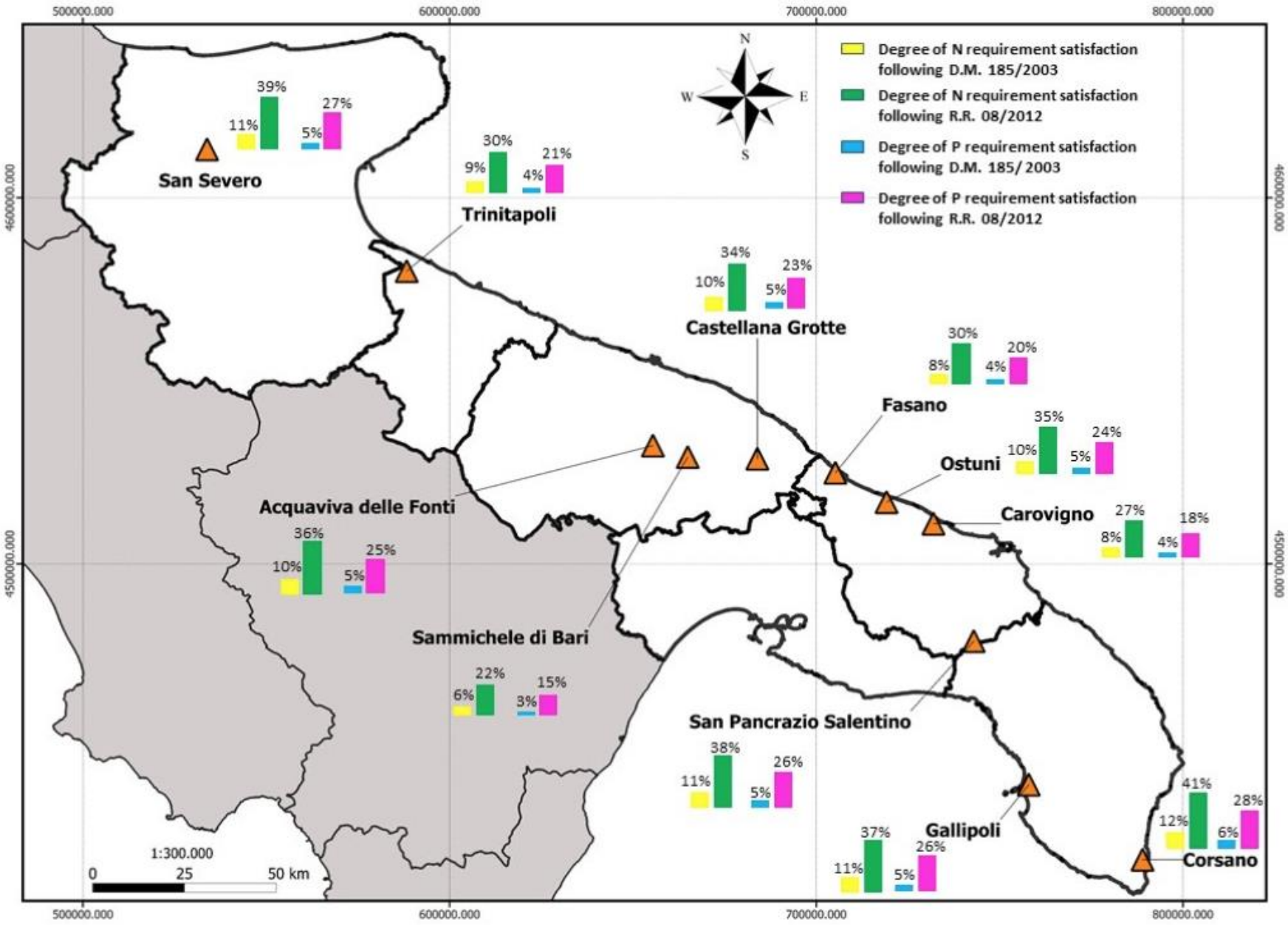
PHYSICAL AND CHEMICAL TREATMENT

EXPERIMENT

WATER SOURCE

Bari secondary treatment plant





OLIVES

N: 6-41%

P: 3-28%

K: 20-40%

Vineyards

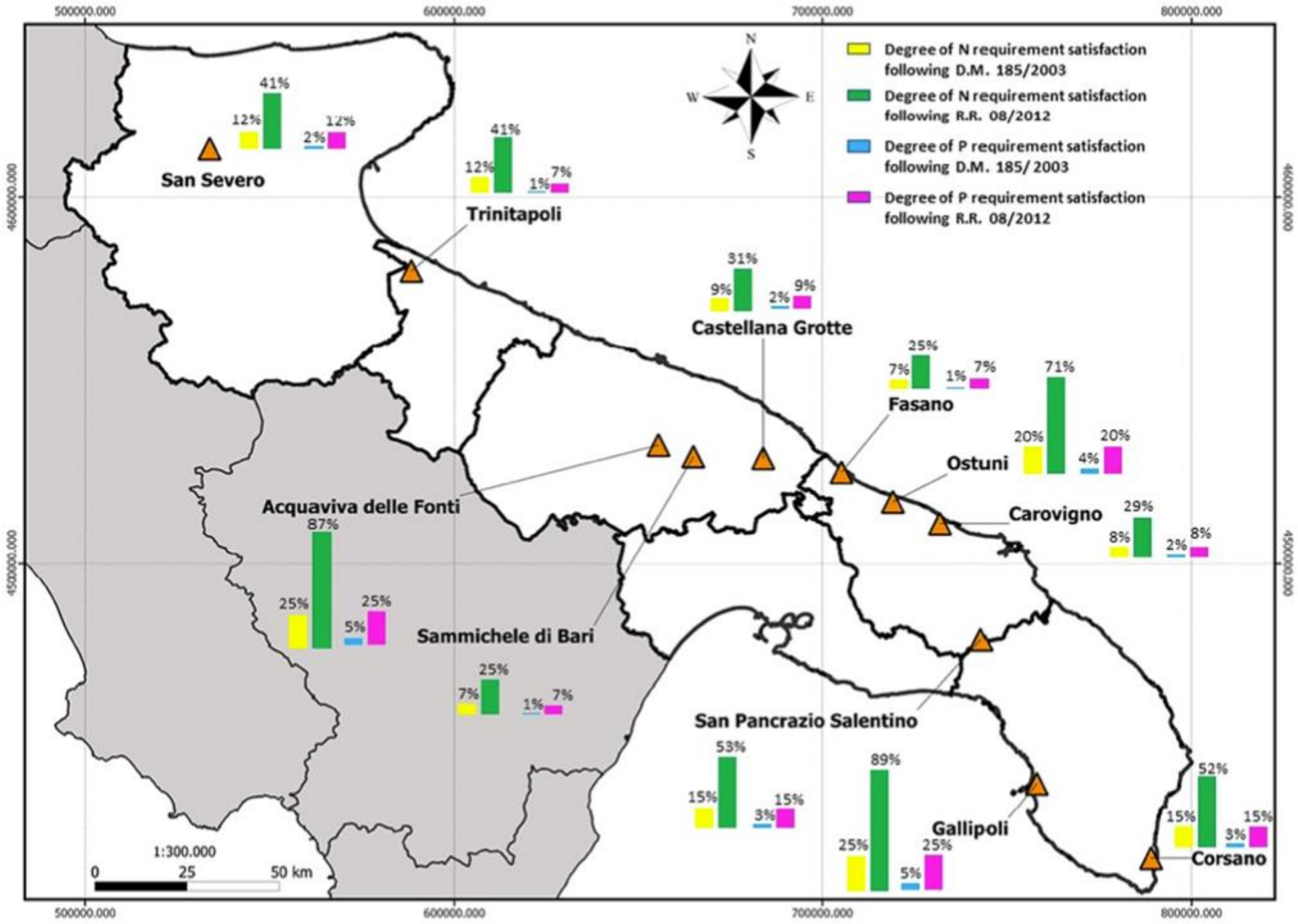


Fig. 4. Map of nitrogen (N) and phosphorous (P) recovery for the service areas cropped with wine grapes and irrigated with reclaimed water (RW) within the selected pilot districts. The map indicates N and P contributions compliant with concentration limits for reclaimed water application allowed by the national legislation (D.M. 185/2003) and by the regulations enforced in the Apulia Region (R.R. 08/2012).

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Training module 3:

A user-friendly tool for a sustainable reuse of reclaimed water in agriculture

Alessandro Gaetano Vivaldi

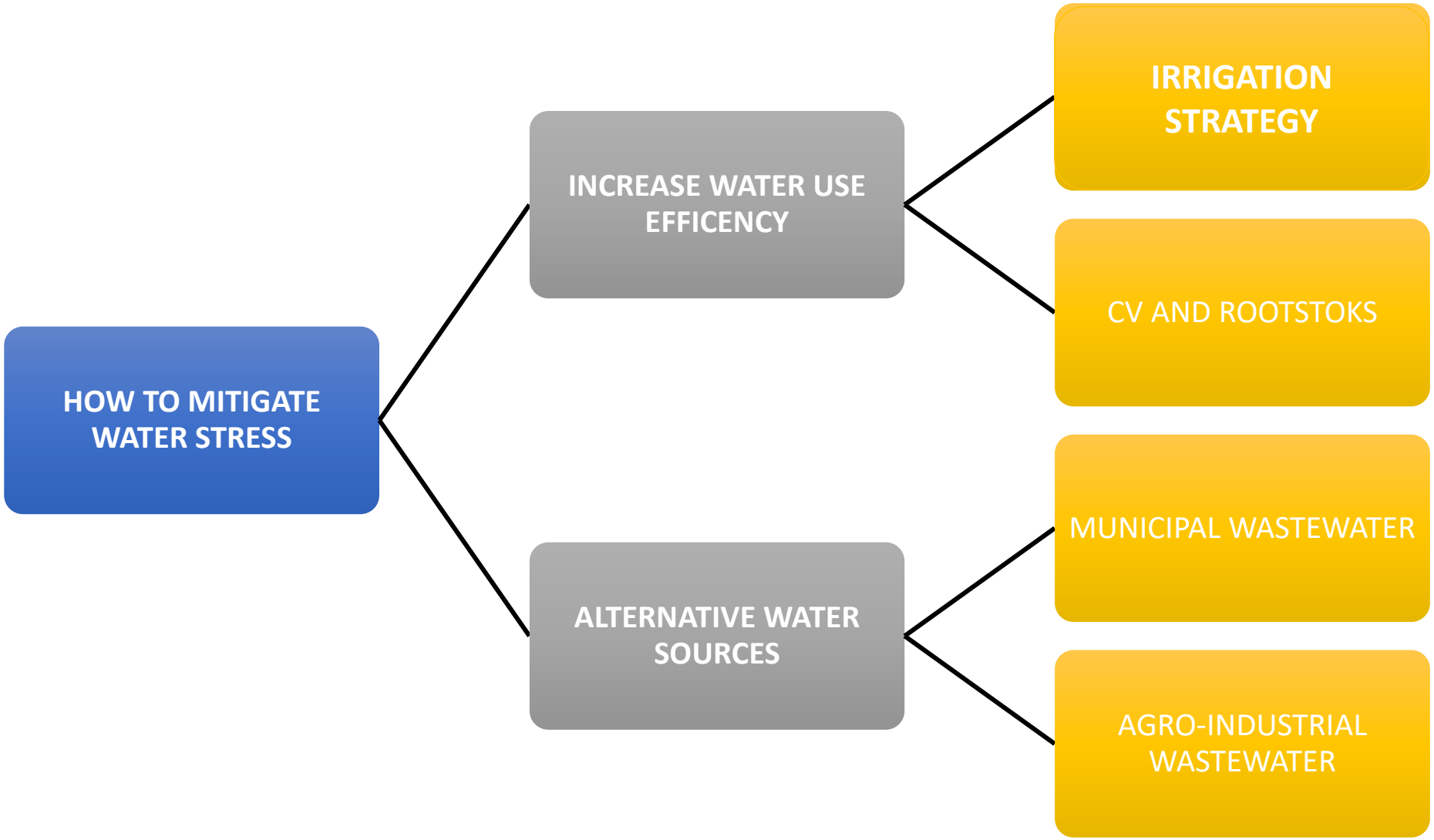
Associate Professor

Department of Soil, Plant and Food Sciences - University of Bari “Aldo Moro”

Office: Via Giovanni Amendola 165/A - 70126 Bari, Italy.

Cell: +39 3208889715

E-mail: gaetano.vivaldi@uniba.it


HOW TO MITIGATE WATER STRESS
INCREASE WATER USE EFFICENCY
ALTERNATIVE WATER SOURCES
IRRIGATION STRATEGY
CV AND ROOTSTOKS
MUNICIPAL WASTEWATER
AGRO-INDUSTRIAL WASTEWATER

Xylella fastidiosa in Apulia region has killed millions of tress

New orchards need more water

Consortium Riubsal project

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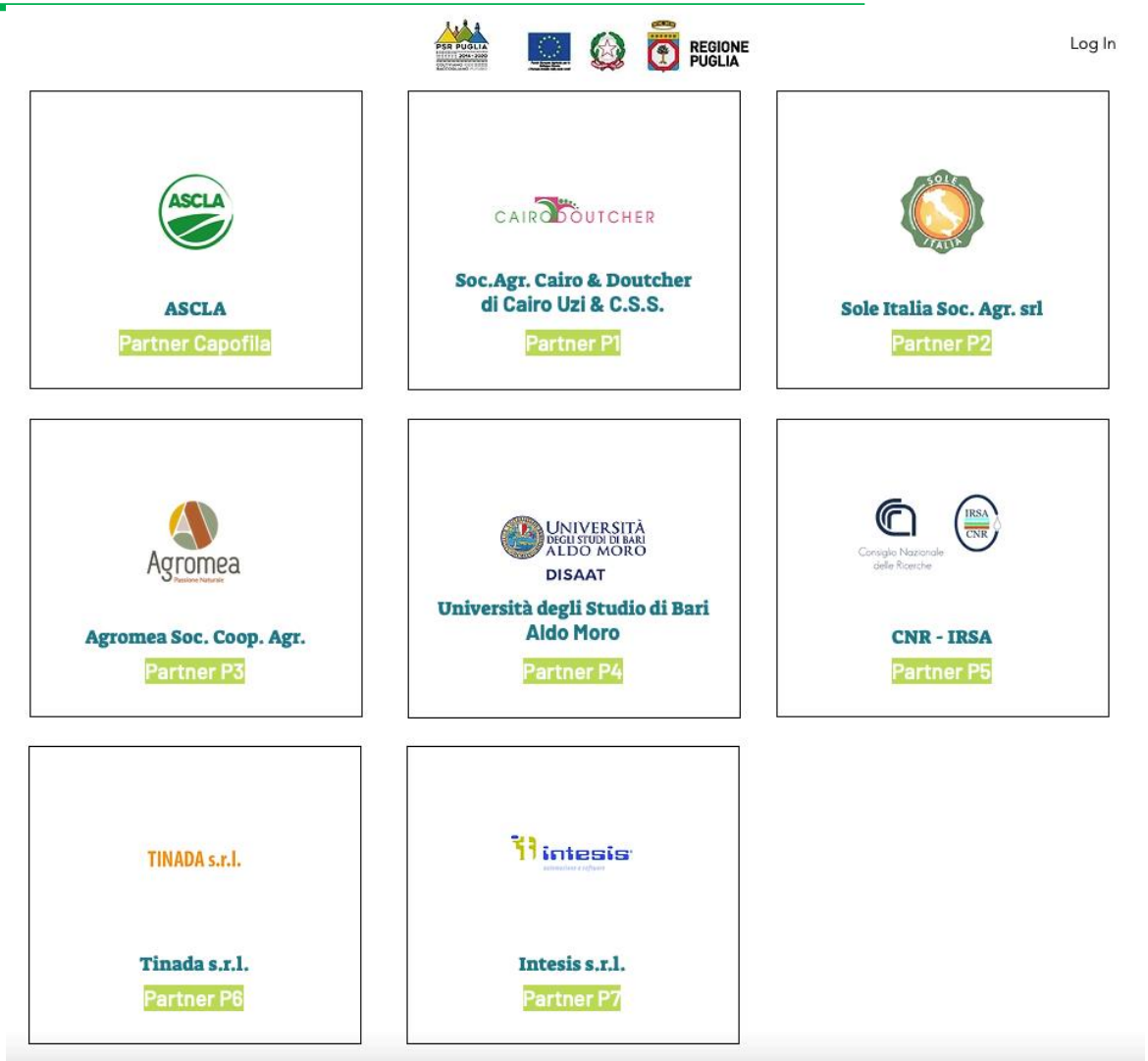
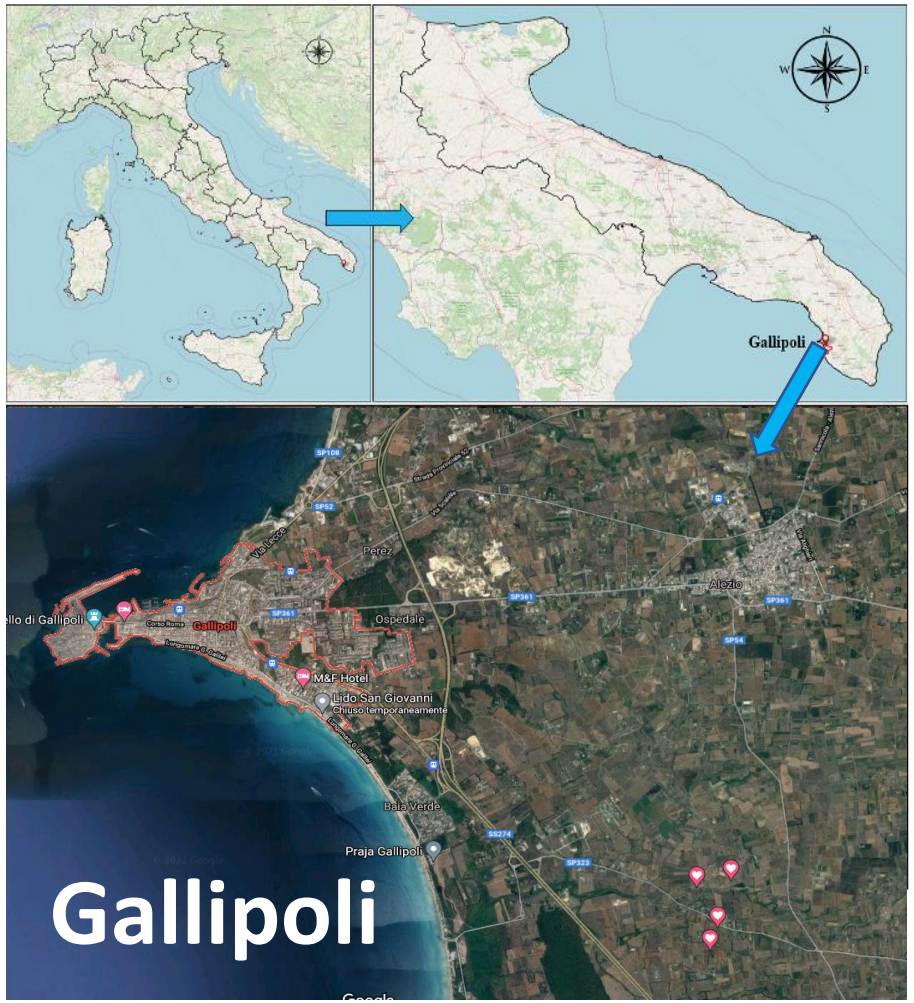
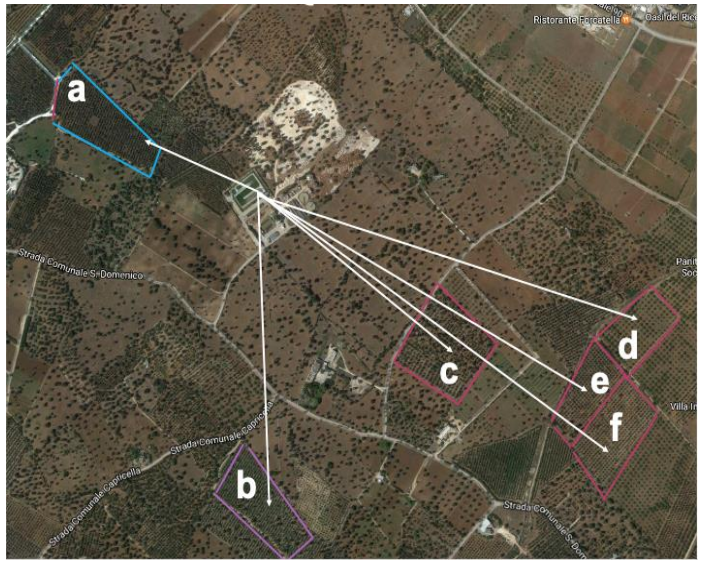
P6 - TINADA S.R.L. Bisceglie (BT)
P7 - INTESIS S.R.L. Bari (BA)



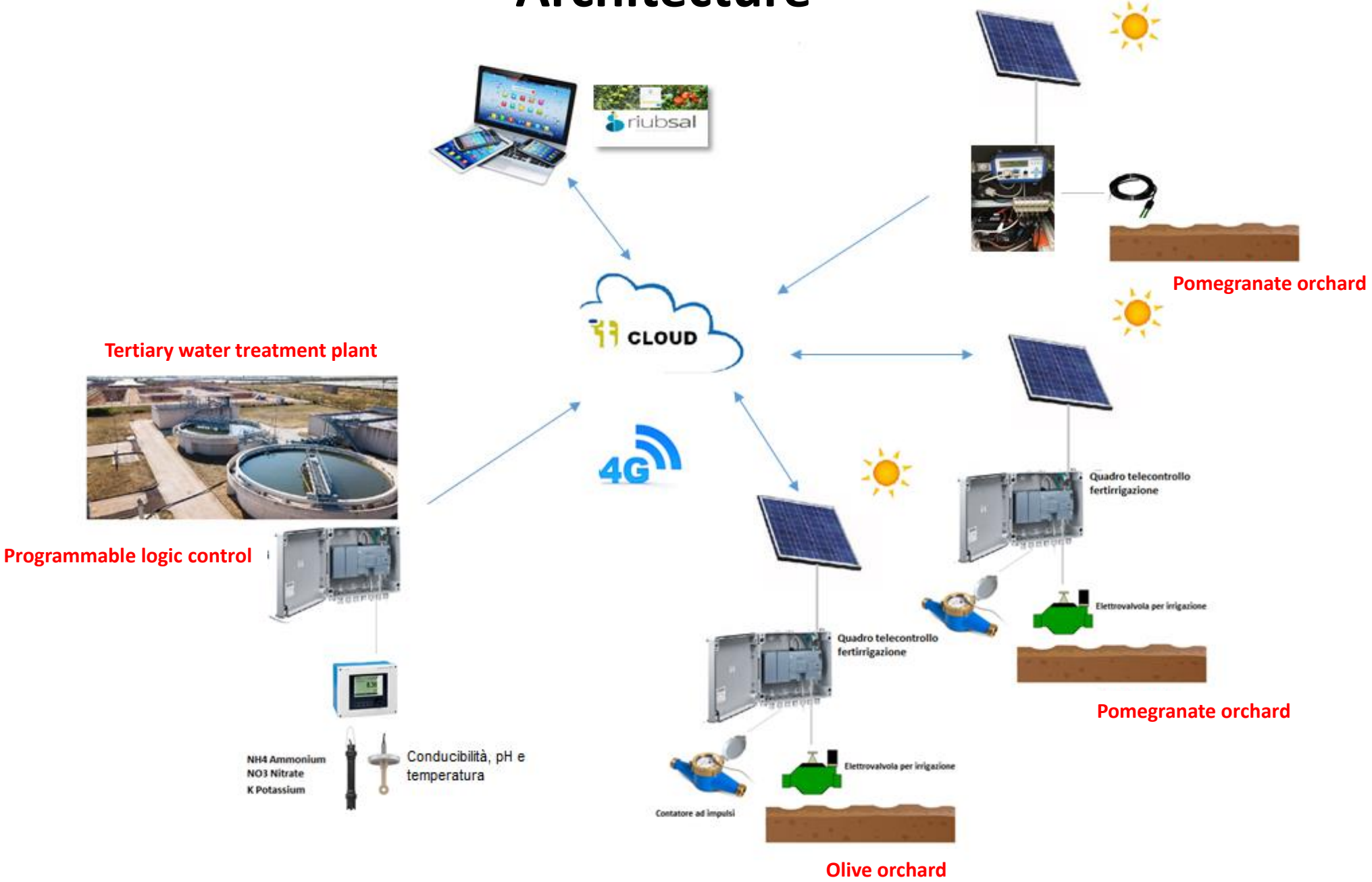




Tertiary wastewater treatment plant


Via Scalelle
depurazione
eflue Gallipoli
vicinale Madonna delle grazie

Architecture



HOME

IMP. AFFINAMENTO GALLIPOLI

2022/10/30 11:19:41

AMMONIO NH4+ (mg/l)	1,49
POTASSIO K (mg/l)	45,99
NITRATI NO3- (mg/l)	87,21
CONDUCIBILITA' (uS/cm)	2237,33
PH	7,18
TEMPERATURA (°C)	22,75

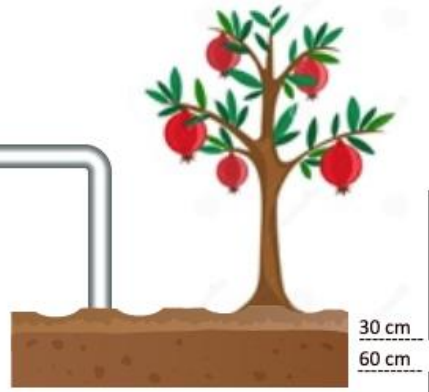
AZOTO N (mg/l)	21,20
POTASSIO K2O (mg/l)	37,25
FOSFORO P2O5 (mg/l)	1,06

VALVOLA

CHIUSA

MISURA PORTATA

0,00 l/s



CAMPO MELOGRANO

2022/10/30 11:19:41

SENSORE 1 - SENSORE 3 - SENSORE 5

TEMPERATURA (°C)	18,20	18,30	18,70
UMIDITA' (RH%)	24,00	24,00	23,00
CONDUCIBILITA' (uS)	704,00	693,00	319,00

TEMPERATURA (°C)	18,70	18,90	19,20
UMIDITA' (RH%)	24,00	21,00	26,00
CONDUCIBILITA' (uS)	417,00	291,00	332,00

SENSORE 2 - SENSORE 4 - SENSORE 6

VALVOLA

CHIUSA

MISURA PORTATA

0,00 l/s

CAMPO ULIVETO LECCINO

2022/10/30 11:19:41

Olive orchard

Pomegranate orchard

Fertigation scheduling

- **Control:** Irrigation TWW + Fertigation 100%
- **Riubsal:** Irrigation TWW + Fertigation Riubsal

CONTROLLO FERTIRRIGAZIONE

- English | UNIBA

HOME

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FOSFORO P2O5 (mg/l)	1,06

VALVOLA — CHIUSA

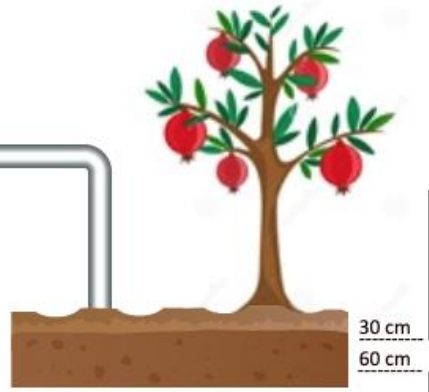
MISURA PORTATA — 0,00 l/s

NH_4^+: 1-3 mg L^{-1}

NO_3^-: 17 - 47 mg L^{-1}

K: 25-30 mg L^{-1}

Ptot: 1-3 mg L^{-1}



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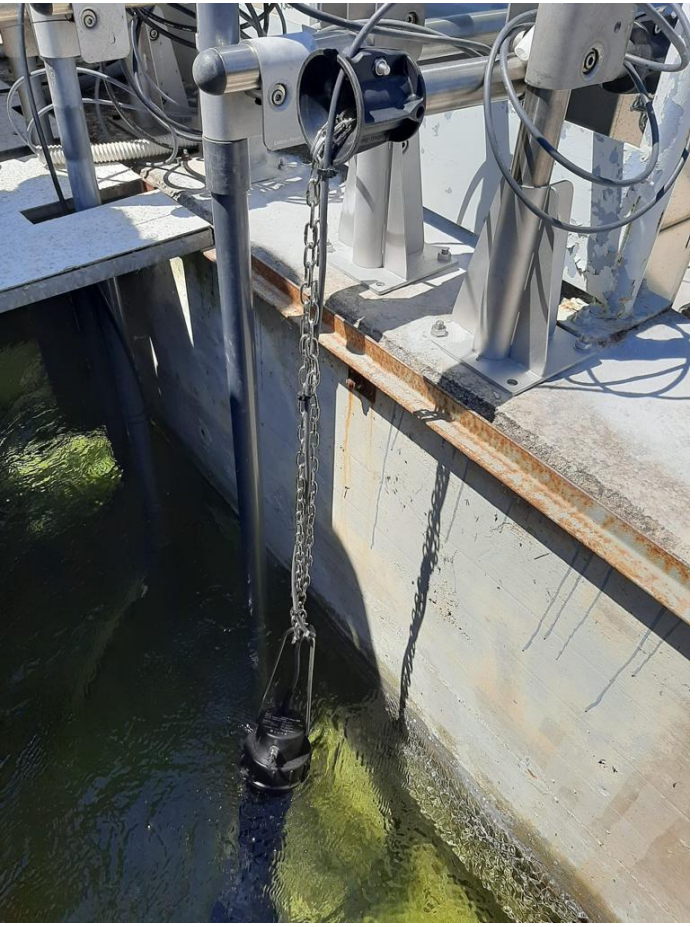
VALVOLA — CHIUSA

MISURA PORTATA — 0,00 l/s

CAMPO ULIVETO LECCINO

2022/10/30 11:19:41

Sensors



Digital ammonium, nitrate and potassium sensor ISEmax CAS40D - Ion-selective thecnology

- **Measurement range**

Ammonium:
0.1 to 1000 mg/l (NH4-N)
Nitrate:
0.1 to 1000 mg/l (NO3-N)
Potassium:
1 to 1000 mg/l

- **Process temperature**

2 °C to 40°C (36 to 100 °F)

- **Process pressure**

400 mbar (160 in H2O) max. permitted overpressure

•Nitrate and ammonium measured directly without the need for expensive sample conditioning
•Optional potassium and/or chloride measurement compensates for cross sensitivities and ensures reliable measuring results
•Low maintenance thanks to automatic flushing unit
•Installed directly on the basin rim, no measuring container or sample-conveying pump required
•Easy handling due to storage of sensor-specific data
•Determination of ammonium load (pH-compensated)

Water pH and temperature

Digital conductivity sensor Indumax CLS50D

•**Measurement range**
2µS/cm to 2000 mS/cm

•**Process temperature**
PEEK: max. 125°C (max. 260 °F)
PFA: max. 110°C (max. 230 °F)

•**Process pressure**
PEEK: max. 21 bar (max. 304.5 psi)
PFA: max. 17 bar (max. 246.5 psi)

Phosphax sc Phosphate analyser, Outdoor, 1 - 50 mg/L PO_4-P, 2-channel, 115-230 VAC - Image 1 of 5
(1 - 50 mg/L PO_4-P)

The measurement is made using a photometer with automatic zero-compensation that enables accuracy and stability in the measurement range

4-channel transmitter Liquiline CM444

The Liquiline CM444 transmitter allows you to connect up to 4 Memosens sensors of your choice from over 12 measurement parameters. It offers automatic sensor recognition, flexible expandability, and standardized spare parts with all other devices of the Liquiline platform.

PLC Siemens Simatic s71200

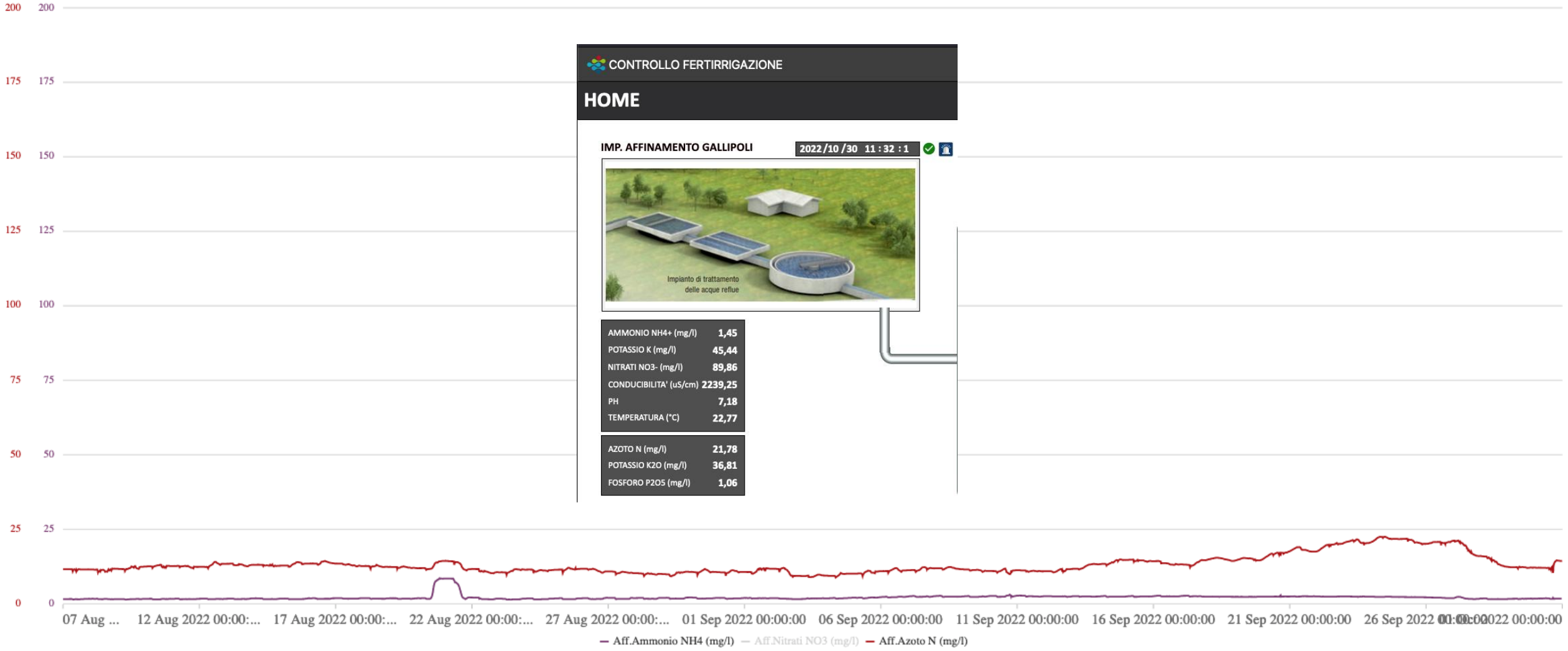
CONTROLLO FERTIRRIGAZIONE

- English | UNIBA

TREND

VIEW | MANAGE TRENDS | MANAGE PENS | MANAGE PERMISSIONS

Trend: Concentrazione N, NO3, NH4 | Interval: 07 August 2022 - 30 September 2022 | A- A+ | Quality | Scale | Configure | Excel | PDF | PNG | Print



CONTROLLO FERTIRRIGAZIONE

HOME

IMP. AFFINAMENTO GALLIPOLI 2022/10/30 11:32:1

AMMONIO NH4+ (mg/l)	1,45
POTASSIO K (mg/l)	45,44
NITRATI NO3- (mg/l)	89,86
CONDUCIBILITA' (uS/cm)	2239,25
PH	7,18
TEMPERATURA (°C)	22,77

AZOTO N (mg/l)	21,78
POTASSIO K2O (mg/l)	36,81
FOSFORO P2O5 (mg/l)	1,06

Azienda Aree Omogenee Concimi Fasi Fenologiche Controllo Fertirrigazione Benvenuto! Disconnetti

Dati Azienda

Azienda	Nome	Superficie (ha)	MC Distribuiti
Universita degli studi di Bari	Oliveto-Leccino (2021) Riubsal	1	Contatore Oliveto

Dati Coltura

Gruppo	Specie	Fase Ciclo	Produzione Attesa (t/ha)
Arboree	Olivo olive, legno e foglie	Piena Produzione	10

Caratteristiche del suolo

Fosforo - P2O5 (ppm)	Sabbia (%)	Calcare Attivo (g/kg)	Calcare Totale(%)	Azoto Totale (g/kg)
38	52	0	6,25	2,04
Potassio - K2O (ppm)	**Argilla (%)**	**Classe Tessitura**	**Attività Vegetativa**	**Sostanza Organica (%)**
40	34	Franco	Non Definita	1,18
Profondità (cm)	**Limo (%)**	**Ubicazione**	**Drenaggio**	**C/N**
40	14,0	Pianura Limitrofa a Zone Urbanizza	Normale	3,36

Andamento Meteo		Pratiche Agronomiche		
Precipitazioni in mm dal 1/10 al 31/01	Precessione	Apporto Ammendanti	N Anno Precedente (kg/ha)	Frequenza
250	Nessuna precessione	Nessuno	0	Saltuario

Indietro

Fertigation plan

Azienda Aree Omogenee Concimi Fasi Fenologiche Controllo Fertirrigazione Benvenuto! Disconnetti

Appezzamento: [Oliveto-Leccino (2021) Convenzionale] Fase Fenologica: Ingrossamento Drupa [01 settembre - 31 ottobre] dell'anno: 2022	N (kg/ha)	P2O5 (kg/ha)	K2O (kg/ha)
Piano di Fertilizzazione	70,5	16,8	70,7
Contributo H2O [01 settembre - 30 ottobre]	4,6	0,4	10,1
Contributo Concime [01 settembre - 30 ottobre]	0	0	0
Bilancio Reale	65,9	16,4	60,6
	Difetto	Difetto	Difetto

Previsione fino a fine fase	Valori Medi					N (kg/ha)	P2O5 (kg/ha)	K2O (kg/ha)
	N (mg/l)	P2O5 (mg/l)	K2O (mg/l)	MC fino fine fase				
Contributo H20	5.0	10.0	22.0			5	10	22
								Calcola

Suggerimento Fertilizzazione (Bilancio Reale - Previsionale)	N (kg/ha)	P2O5 (kg/ha)	K2O (kg/ha)
	60,9	6,4	38,6

CONTROLLO FERTIRRIGAZIONE

HOME

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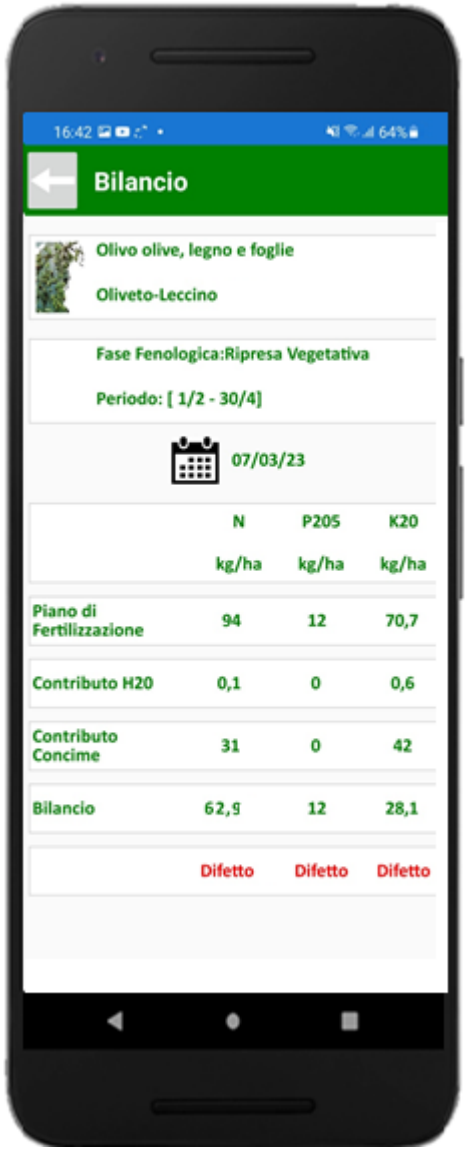
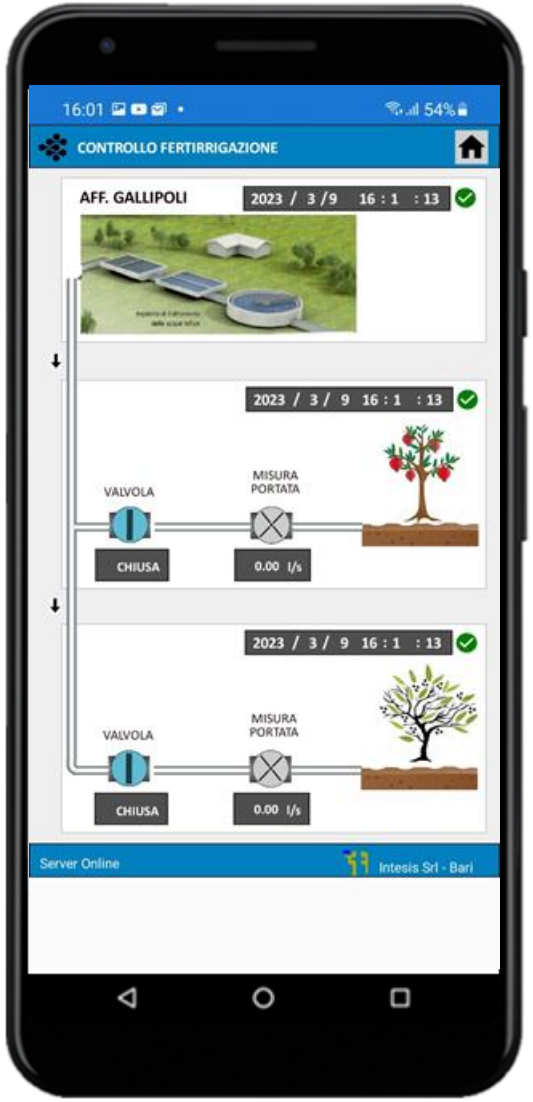
Fertigation plan

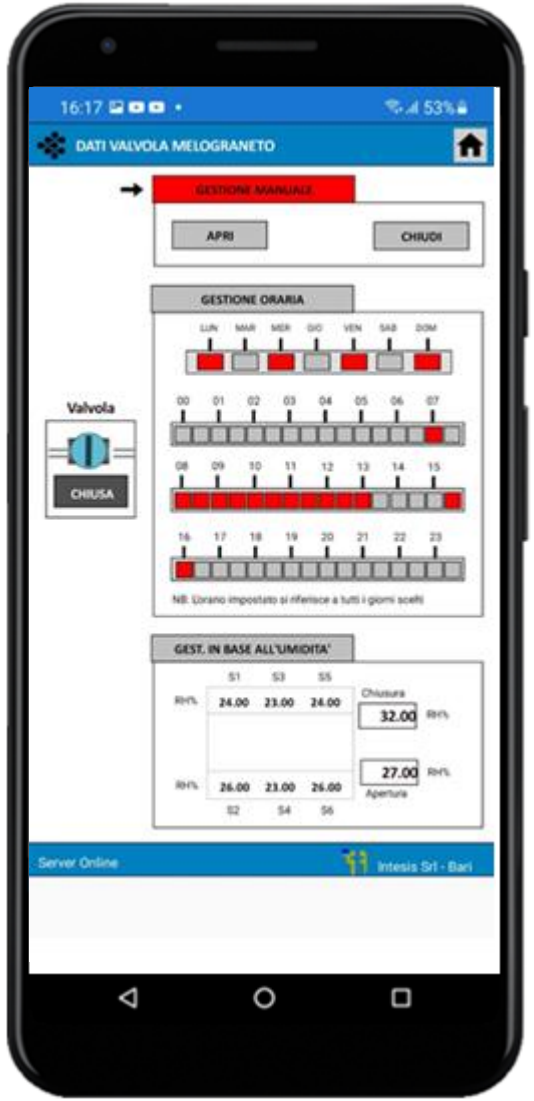
APP Mobile

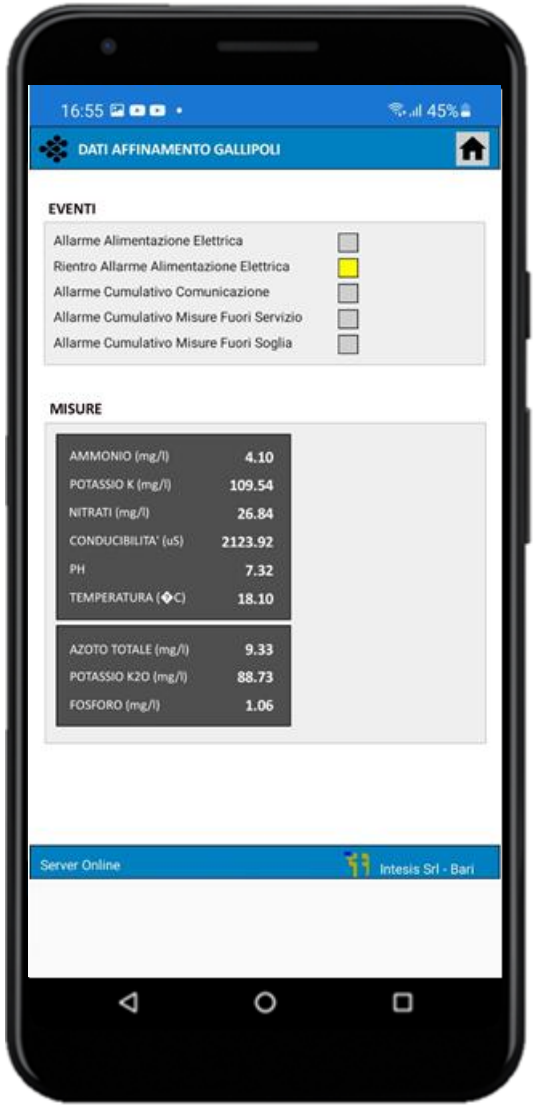


App mobile
IFertigaiton scheduling

APP Mobile





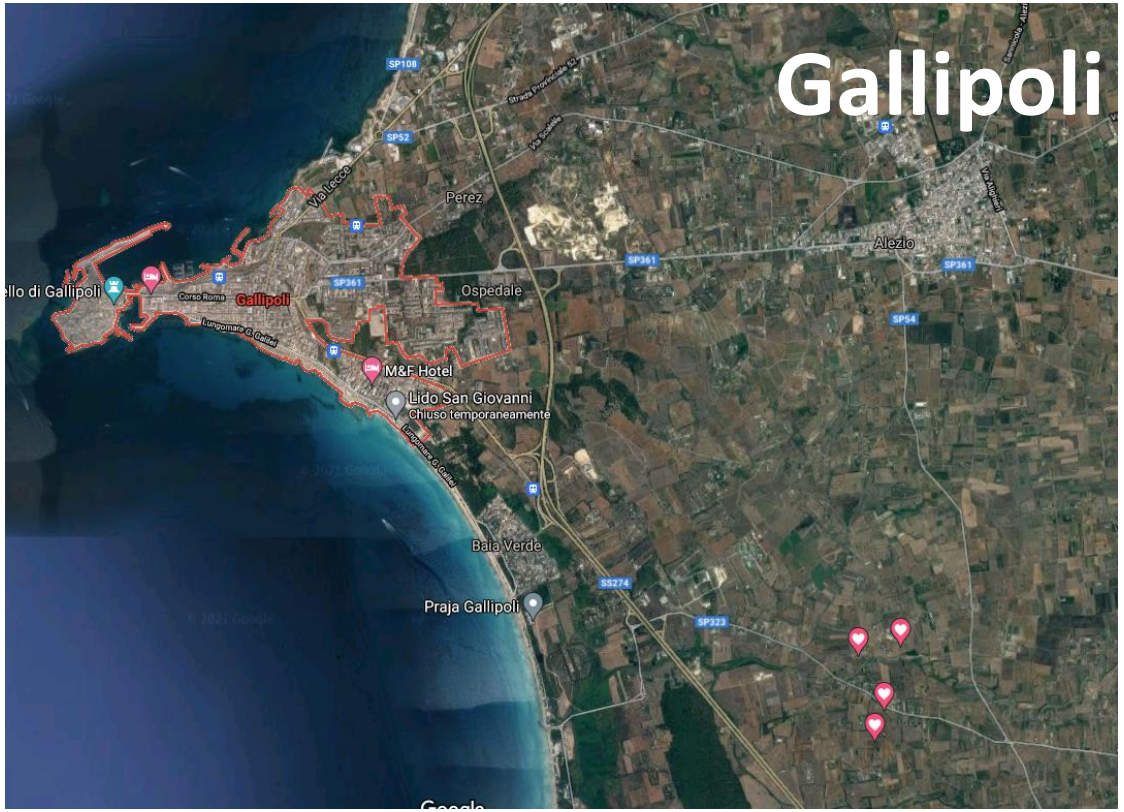


App mobile
Irrigation scheduling

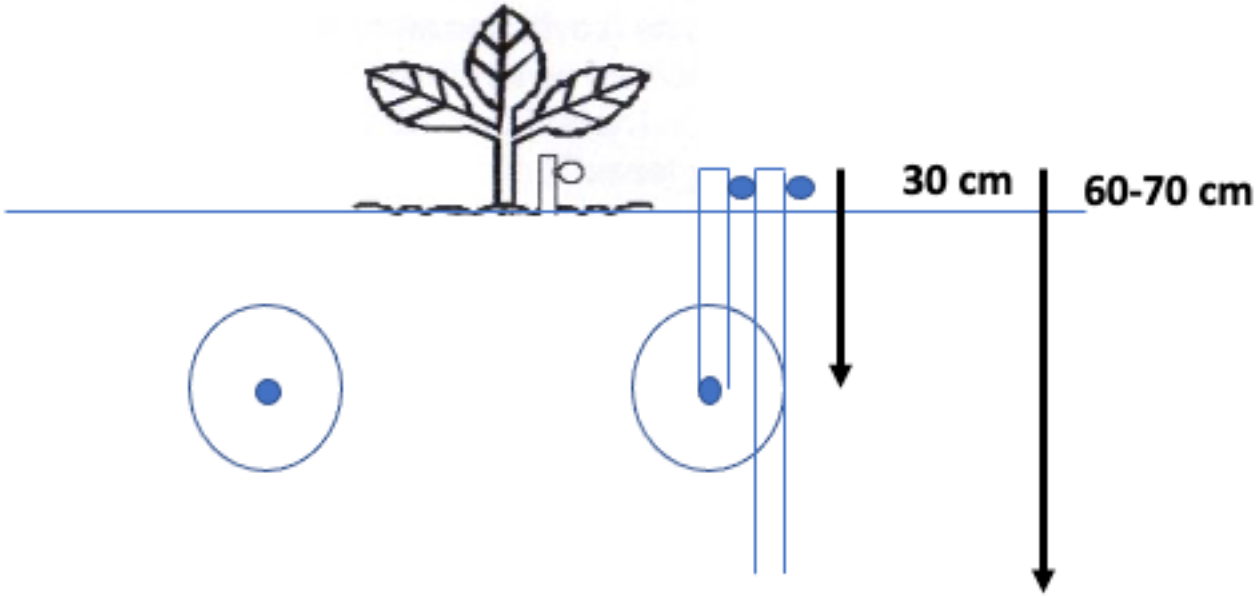
RIUBSAL project

riubsal
GESTIONE DELLE RISORSE IDRICHE

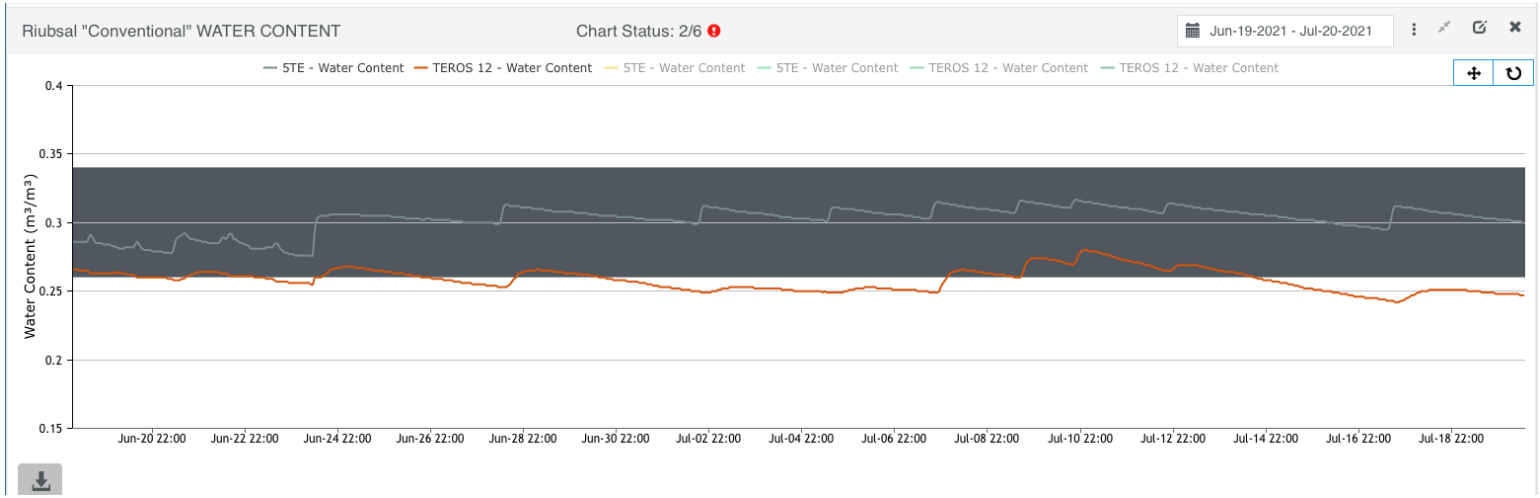
https://www.riubsal.it



Soil monitoring sensors - Affordable and easy to install



RIUBSAL project



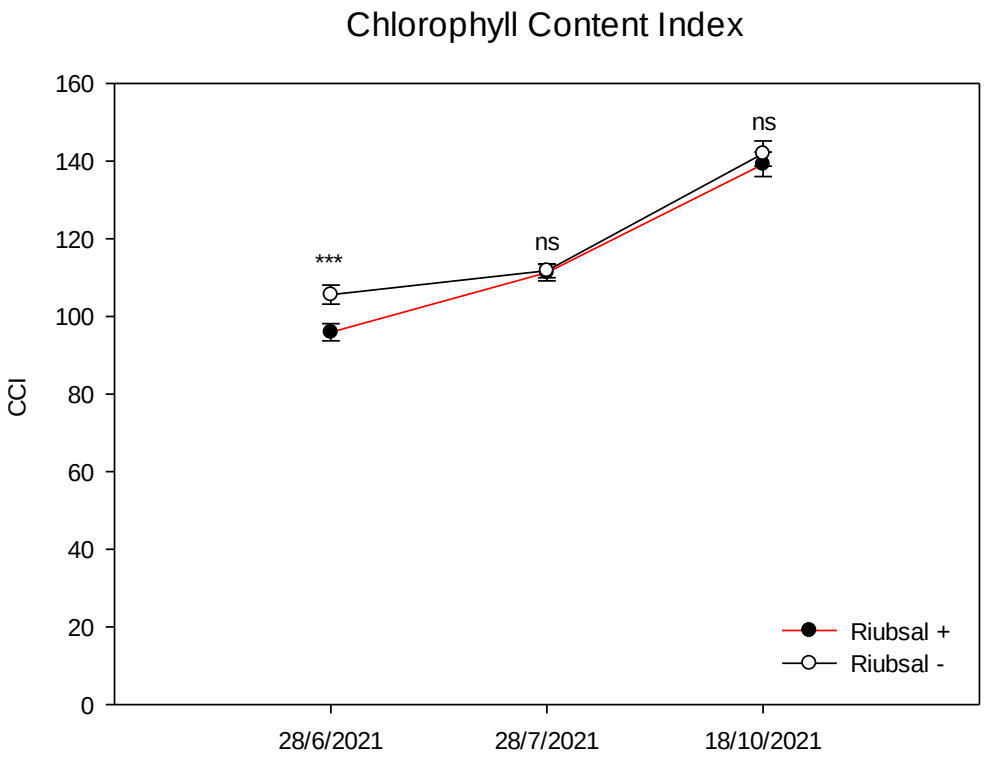
Soil moisture monitoring

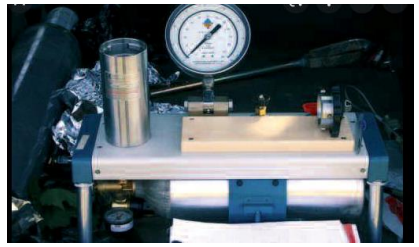
Irrigation scheduling

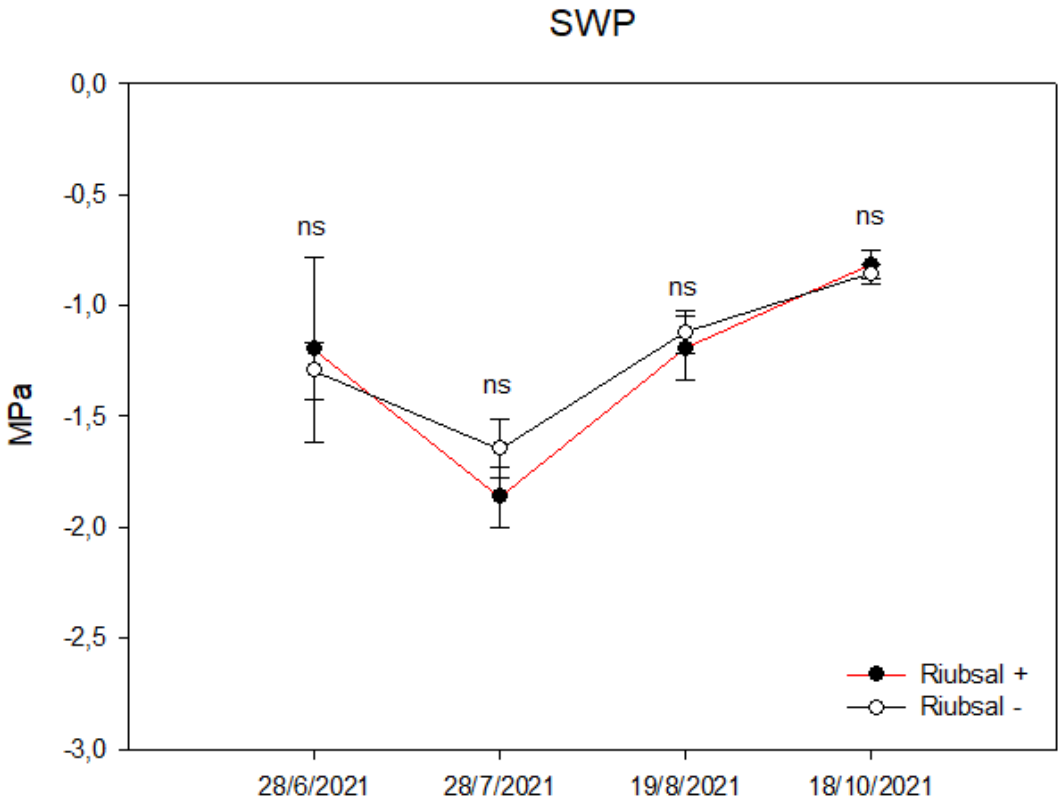
The soil moisture was kept at a range of 34-26 % Θ and at a recharge point (RP) of 15% in the FI regime within the DSS system.

Subsurface irrigation - 20%

RIUBSAL







Electron Transport Rate(µmol m-2*s-1)

Data	Riubsal +	Riubsal -	p-value
GIUGNO	112,98	94,96	0,33
LUGLIO	82,26	87,08	0,54
AGOSTO	82,66	80,24	0,77
SETTEMBRE	40,7872	39,1272	0,8
OTTOBRE	48,56	54,11	0,33

Net Photosyntesis (µmol m-2*s-1)

	Riubsal +	Riubsal -	p-value
GIUGNO	5,1881	5,2068	0,98
LUGLIO	6,4745	6,3389	0,83
AGOSTO	8,2861	9,0955	0,49
SETTEMBRE	7,3724	7,2821	0,88
OTTOBRE	8,9896	8,631	0,53

Stomatal conductance (mol m-2*s-1)

	Riubsal +	Riubsal -	p-value
GIUGNO	0,03956	0,05783	0,17
LUGLIO	0,09331	0,08644	0,56
AGOSTO	0,11335	0,12041	0,7
SETTEMBRE	0,1252	0,1179	0,53
OTTOBRE	0,211732	0,223189	0,48

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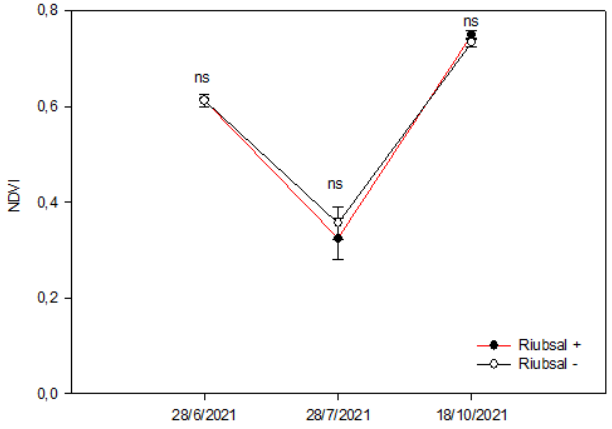
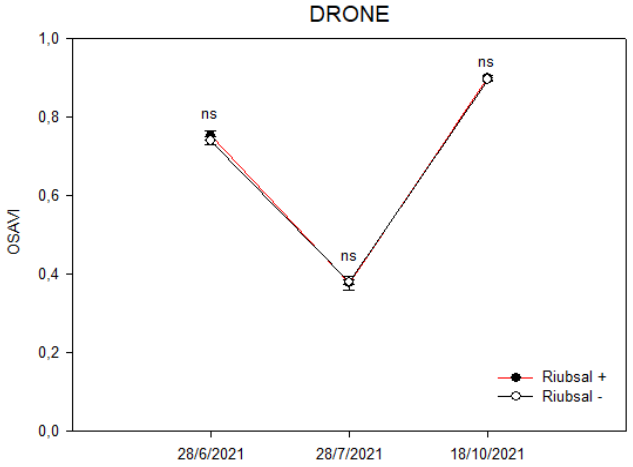
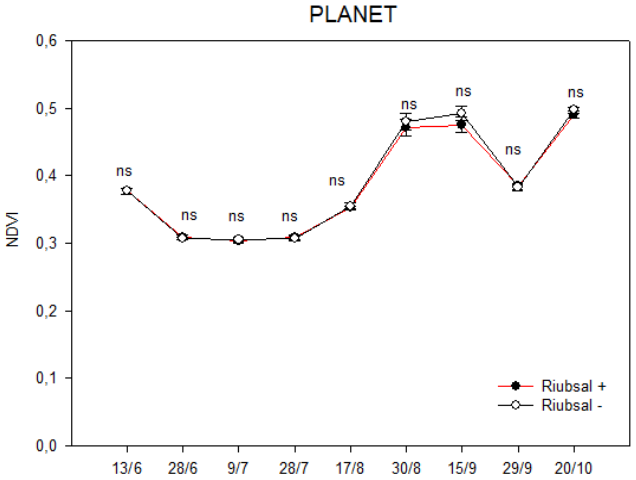
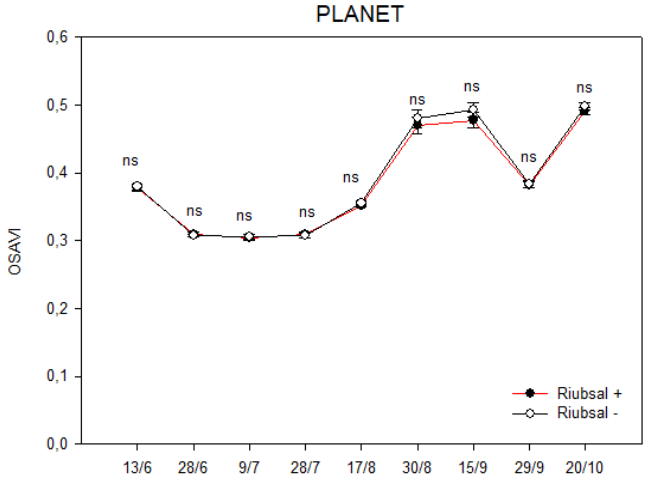
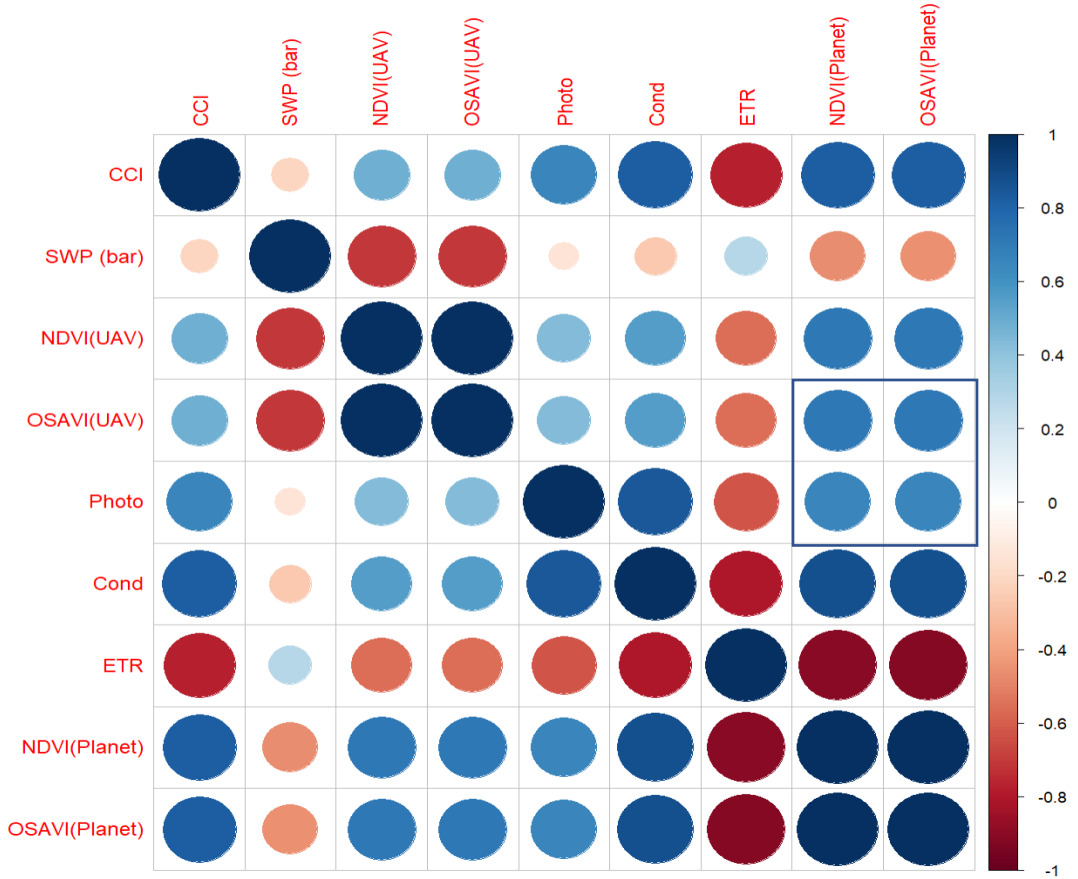
DRONE

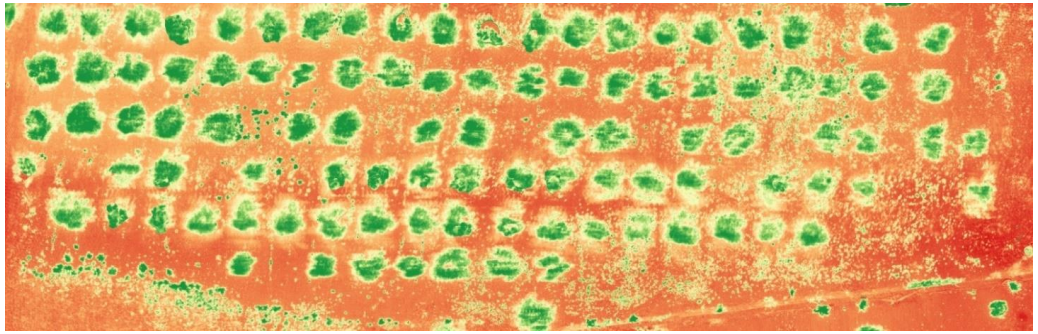


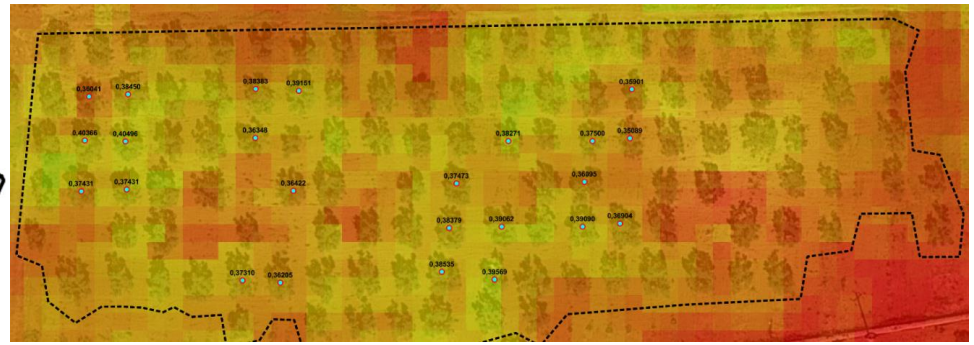




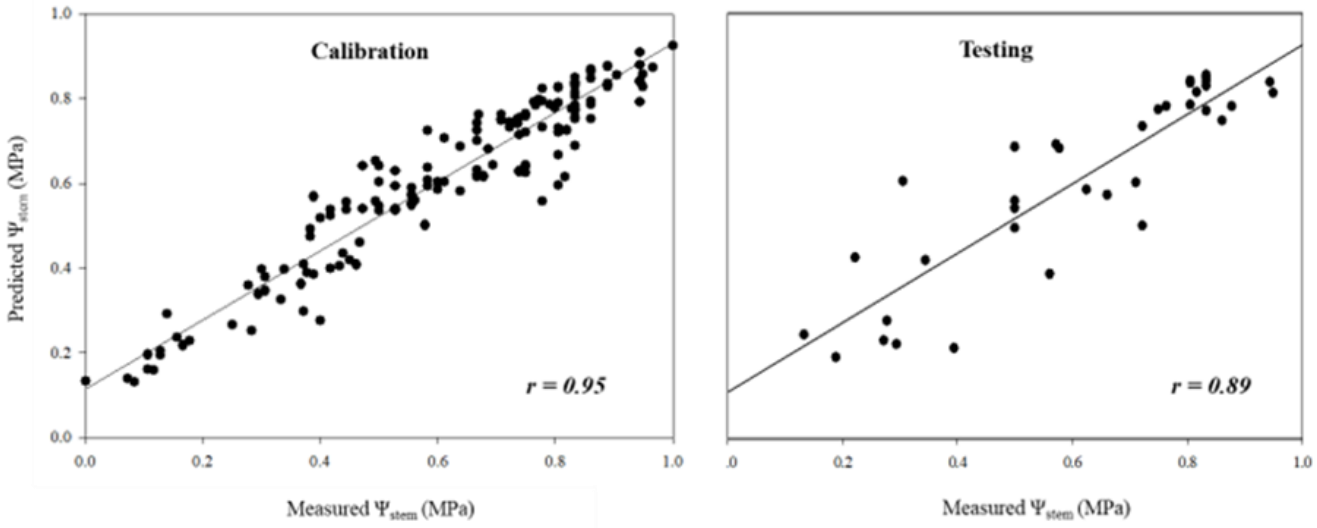


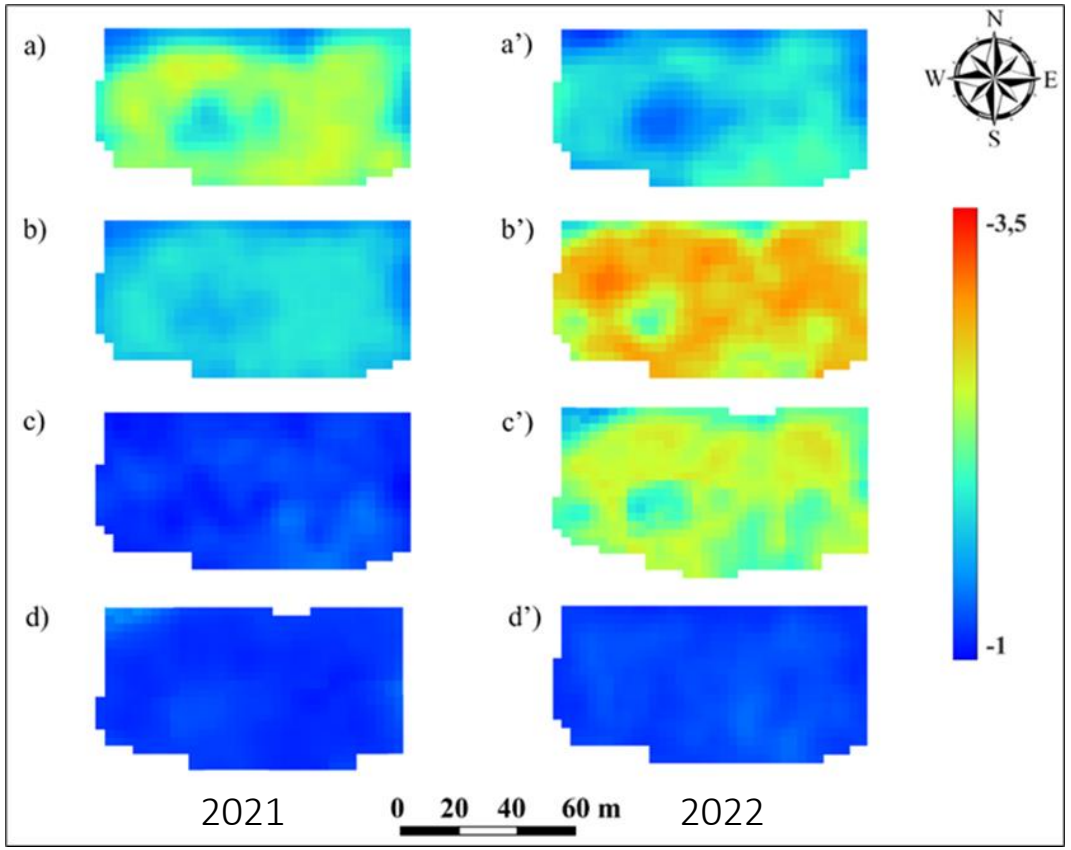






Predicvtive maps of Stem water potential by using Planet Scope satellite platform





Random Forest, (PBs) as predicotrs, we obtained a robust model

Predictive map→ high correlation between Ψstem measured and estimated :

- Calibration test, r = 0,95
- Validation test→ r = 0,89

clideo.com

OLIVES cv LECCINO 8 x 7 – 176 trees per ha – 25 years old

TWO TREATMENTS
- **CONTROL:** RW + Fertigation 100%
- **Riubsal :** RW + Fertigation Riubsal

POMEGRANATE cv WONDERFULL ONE 5 x 2.5 m– 2 years old

TWO TREATMENTS
- **CONTROL:** RW + Fertigation 100%
- **Riubsal :** RW + Fertigation Riubsal

TREATMENTS	Olivo Yield q/ha	Pomegrante yield q/ha
RIUBSAL	81.46 ± 20.7	70.1 ± 20.1
CONTROL	80.30 ± 17.1	65.1 ± 11.0
T.test	n.s.	n.s.

1800 m³/ha in 2022

Olive orchard

N - 17 %

P - 5 %

K - 33 %

2900 m³ /ha in 2022

Pomegranate orchard

N - 40 %

P - 3 %

K - 70 %

Thank you for your attention

Alessandro Gaetano Vivaldi

Associate Professor

Department of Soil, Plant and Food Sciences - University of Bari “Aldo Moro”

Office: Via Giovanni Amendola 165/A - 70126 Bari, Italy.

Cell: +39 3208889715

E-mail: gaetano.vivaldi@uniba.it

www.riubsal.it