Consiglio Nazionale delle Ricerche

CNR IRET
Istituto di Ricerca sugli Ecosistemi Terrestri

CNR IRET Conference

February, 18th-19th, 2025

CNR Headquarters, Piazzale Aldo Moro, Roma

Book of Posters

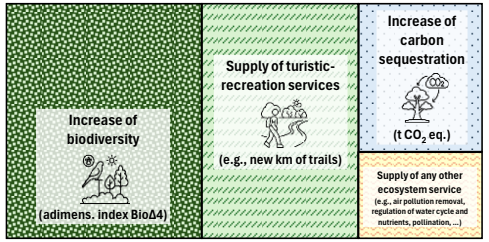
CNR IRET Conference Rome, February 18th-19th 2025

Certified sustainable forest and life cycle management to support the implementation of an ecosystem service-based crediting mechanism

Research context

- International certification schemes already exist to ensure that sustainable practices are implemented in forest restoration and conservation interventions
- Most popular examples of those schemes are the Programme for Endorsement of Forest Certification (PEFC) and the Forest Stewardship Council (FSC)
- Both PEFC and FSC allow the quantification and monitoring of Ecosystem Services (ES), but with different perspectives, creating market uncertainty and biases
- Environmental crediting based on ES is a promising solution to ensure a compromise between the need to protect and conserve natural capital, and the market demand to make business and earning out of (forest) ecosystems
- We illustrate and test here the implementation of a new crediting system to support the recovery and sustainable management of thousands of hectares in Italy owned by Catholic Church; developed credits are called "Laudato Si'" (CLSi')

Components of the *Credit Laudato Si'*



CLSi' calculation framework: parameters and rationale

1. Forest property under active management (*a*), in ha
2. Non-owned but actively managed forest (*b*), in ha
3. Income associated with the sale of timber extracted through improvement operations (*P*), in €
4. Costs for certification of ecosystem services (*C5*), in €
5. Costs for implementing the farm forestry plan and its management (*C5*), in €
6. Costs of forestry companies for interventions deducting the value of timber (*C5*), in €
7. Costs for administration and taxes (*C5*), in €
8. Costs for producing the paper and digital certificate (*C5*), in €
9. % increase in earnings to be sent to the Central Institute S.C. (*Δ%*), cross-ref. to n.15
10. Total duration of the active management and time span of intervention (T_n), in years (n = 5)
11. Annual maintenance cost of new trails and other generated infrastructure (*A1*), in €
12. Annual cost of auditing for certification (*A2*), in €
13. Annual cost of administrative and technical management, marketing and communication (assumed = 2% of implementation costs) (*A3*), in €
14. Rental or other management cost per *b* (*B*), in €
15. Profit to be sent to the Central Institute S.C. for clergy sustenance, health insurance for priests and energy efficiency of I.D.S.C. properties (*U*), assumed to be = 10% of total costs, in €

Box 1

Total project implementation costs

$$Y = \Sigma\, C5_i + [(A1 + A2 + A3 + B) \times T_n]$$

Profits for the I.D.S.C. (variable parameter, 10% of the costs)

$$U = Y \times \Delta\%$$

Number of generated credits per unit of area $N_{CLSi'} = (Y + U - P) / 50$, where 50 (euro) is assumed as hypothetic environmental credit cost parameter set by the I.D.S.C. on the basis of a market price analysis of carbon credits.

Case study results and interpretation

- CLSi' are quantified for three pilot areas of the Institute for the Support of the Clergy (I.D.S.C.) of Asti, in the Region of Piedmont, Italy
- The environmental cost-benefit balance in Box 1 represents the credits calculation model, based on combination between life cycle benefits and costs of forest interventions and future management
- Possible model improvements concern the biophysical assessment of the ES as a basis for a more representative and non-market influenced valuation model
- The I.D.S.C. is currently investigating strategies to sell credits according to principles of sustainable forest management and intervention (focus on biodiversity and recreational/social services, rather than 'just' carbon uptake)

Intervention areas and location	ES* of priority for interventions according to a PEFC-based forest management plan	Average C uptake, from on-site surveys (t CO_2/yr)	*Una Tantum* earnings (*P*)	Sub-total *Una Tantum* costs (= Σ *C5*$_i$)	Sub-totale annual costs, from 2nd year (= *A1+A2+A3*)	Total income for forest owners, excluding earnings (= *U*)	N_{CLSi} over project duration (T_n = 5 yrs)	N_{CLSi} over project duration, per hectare (T_n = 5 yrs)	Average value of the CLSi' per ha
AREA 1 (4.46 ha)  Municipality of Albugnano (AT), next to "Abbazia di Vezzolano"	· PRES: n/a · MRES: enhacement of biodiversity · CUES: recreational and educational services	0.00	7,848 €	78,780 €	86,628 €	9,376 €	2063	463	23,125 €
AREA 2 (1.12 ha)  Municipality of Albugnano (AT), next to "Monastero del Rul"	· PRES: n/a · MRES: enhacement of biodiversity; increase of carbon stock · CUES: n/a	21.80	1,082 €	23,103 €	24,207 €	2,502 €	550	491	24,575 €
AREA 3 (4.48 ha)  Municipality of Silvano d'Orba (AL), next to "Santuario di San Pancrazio"	· PRES: n/a · MRES: enhacement of biodiversity · CUES: n/a	14.30	5,225 €	24,235 €	29,474 €	3,101 €	682	152	7,614 €
Aggregated indicators (for 10.06 ha = *a*)		**36.10**	**14,155 €**	**126,118 €**	**140,309 €**	**14,979 €**	**3295**	**328**	**16,379 €**

* Ecosystem Services (ES) from CICES taxonomy: PRES (Provisioning services); MRES (Regulation & Maintenance services); CUES (Cultural services)

Further info: https://oxygenmap.green/

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Sap flow methods for assessing stomatal ozone uptake in Italian forest ecosystems

Andrea Viviano[1,2], Rioji Tanaka[3], Elena Paoletti[1,4], Elena Marra[1], Bárbara Baêsso Moura[1,4], Jacopo Manzini[1], Yasutomo Hoshika[1,4,*]

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[2]Dipartimento di Scienze e Tecnologie Agrarie, Ambientali e Forestali, Università degli Studi di Firenze, Via delle Cascine 5, 50144, Firenze, Italy.
[3]United Graduate School of Agricultural Science, Tokyo University of Agriculture and Technology, Fuchu, Tokyo 183-8509, Japan
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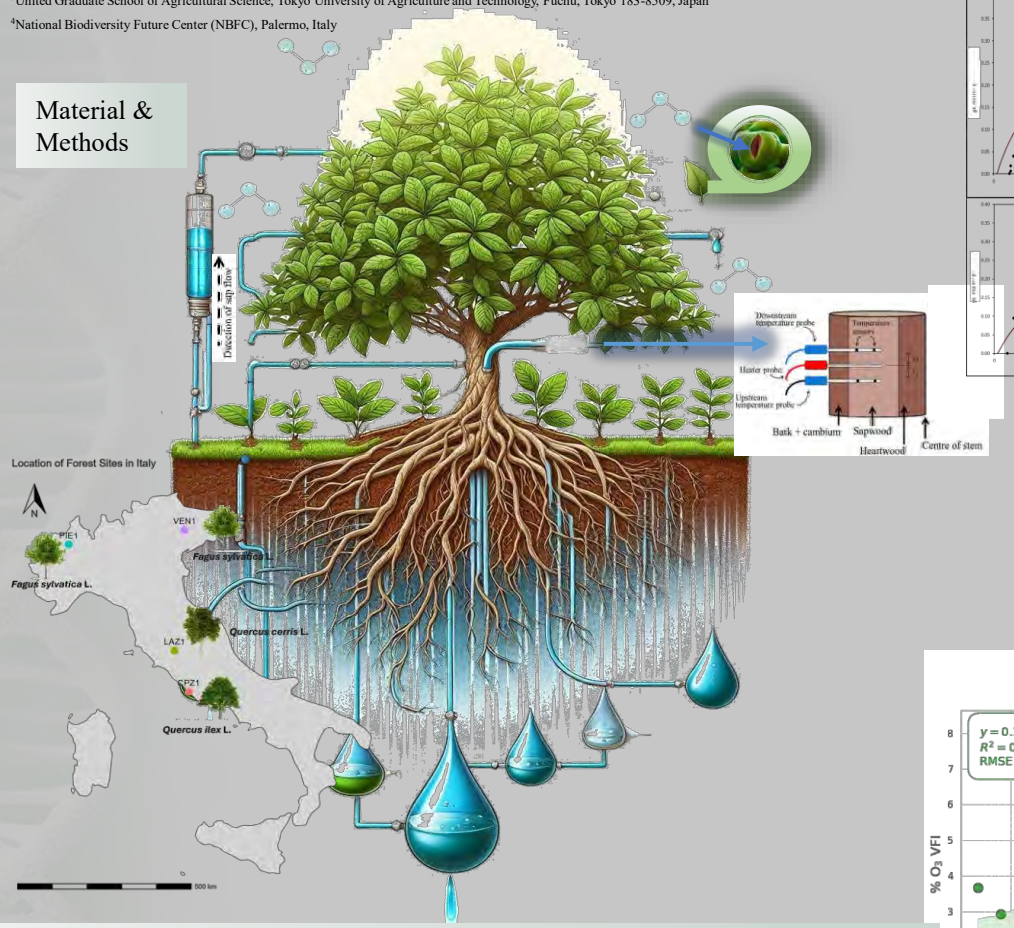
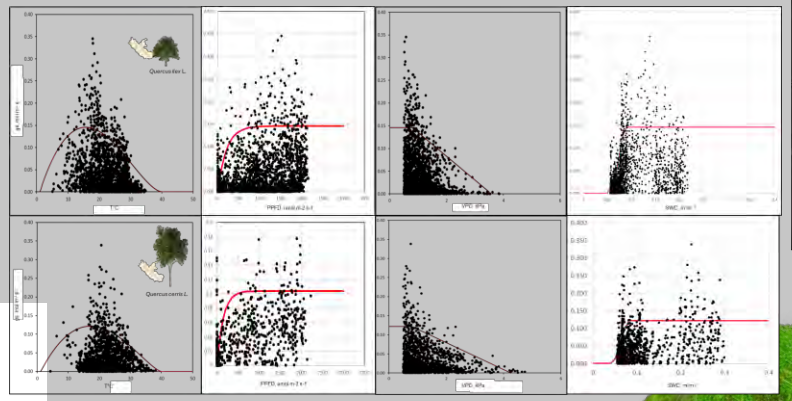
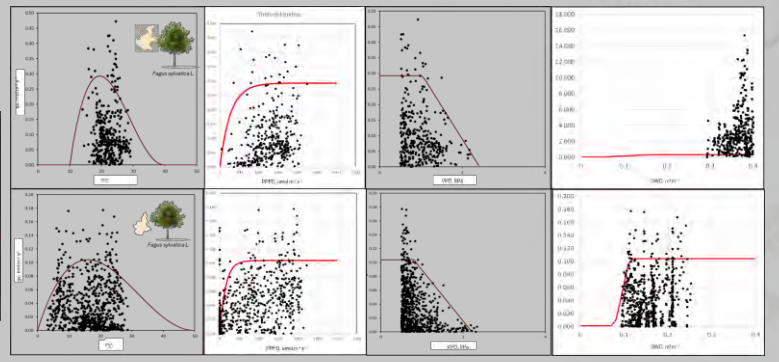
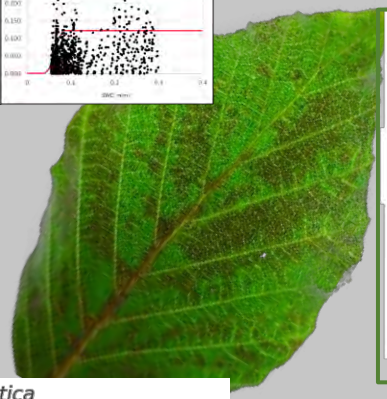
Material & Methods

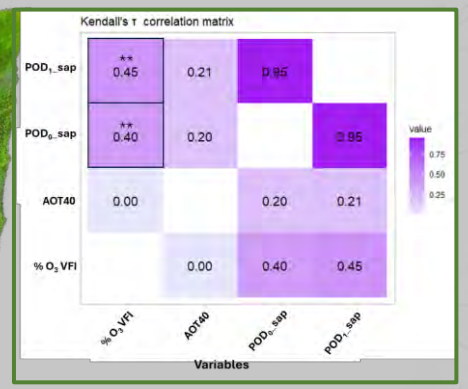


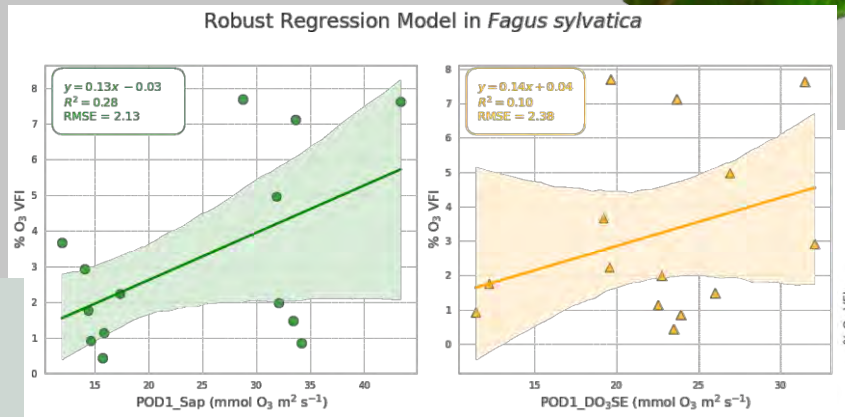
Results

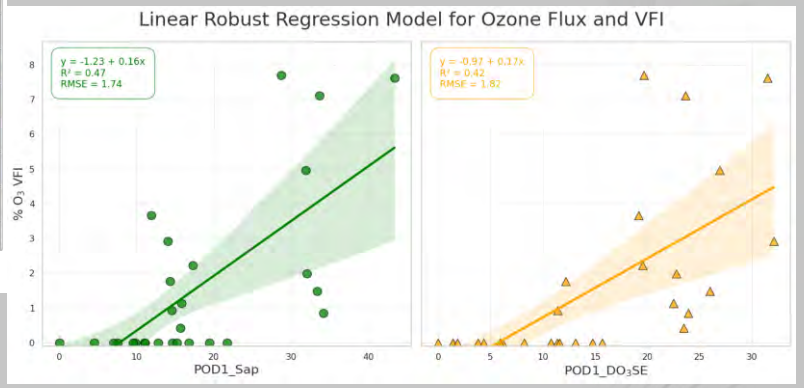












Aims

I. Estimate the maximum stomatal conductance (g_{max}) from sap flow data;
II. Identify the most accurate indices for correlating visible foliar damage with O_3 uptake metrics,
III. Compare our sap flow-based POD_y index (POD_y_sap) with the standard DO_3SE model parameters-derived POD_y index (POD_y_do3se).

We predicted that PODy_sap would be more sensitive in explaining visible foliar damage compared to PODy indices calculated using the literature-based ICP gmax.

Andrea Viviano

CNR IRET Conference Rome, February 18th-19th 2025

Peat forming mosses (*Sphagnopsida*) for peatland's preservation, phytoremediation and pollution biomonitoring

A. Di Palma[1,2], E. Pallozzi[1,2], G. Sgrigna[1], I. Kazuki[3], C. Calfapietra[1,2]

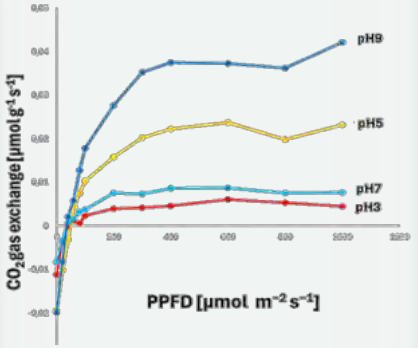
[1]CNR-IRET, Italy; [2]NBFC, Italy; [3]JAEA, Japan

Environmental archives

- Climate changings
- Paleobotany
- Atmospheric depositions

Pollution biomonitoring with native/cloned moss

- PMs, metals, PAHs and radioactive dusts
- Bioindication and bioaccumulation

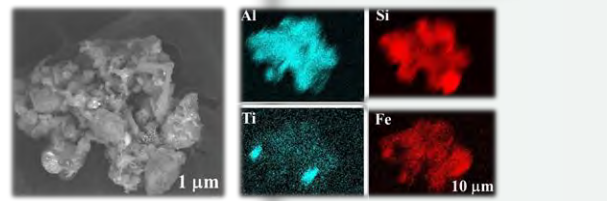


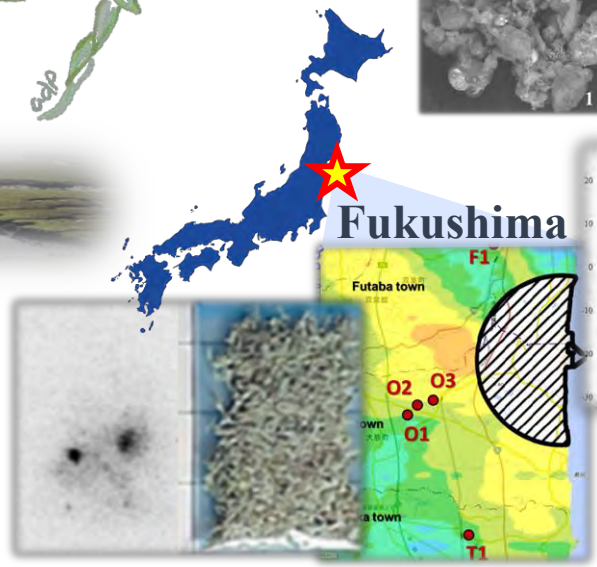
Peatland efficiency as function of:

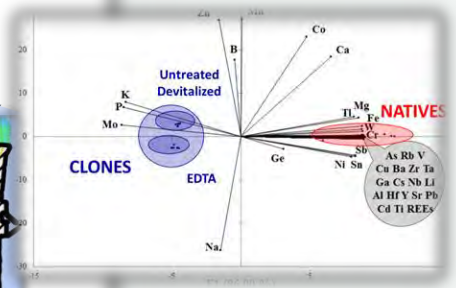
- pH
- water content
- T °C
- Subgenus traits

Metal in vitro adsorption as function of:

- pH
- $[Me]^{2+}$
- time







Anna Di Palma

Advancing Agroforestry Innovation in Europe: the role of IRET in the AF4EU project

Enrico Petrangeli, Cinzia Pellegrini, Francesca Chiocchini, Marco Ciolfi, Marco Lauteri, Pierluigi Paris

Agroforestry Business Model Innovation Network (AF4EU) is an EU-funded project that promotes agroforestry in Europe through the development of a multi-actor approach linked to interactive and innovation-driven expanded agroforestry networks: the Regional Agroforestry Innovation Networks (RAINs).

The AF4EU consortium: 12 partners and five national associations from 10 different European countries.

Three "Lighthouse RAINs", reflects the agroforestry in countries of the Continental – Boreal, Mediterranean and Atlantic regions. IRET is acting to establish a methodological framework for construction of the new RAINs

The Italian RAIN bases on the stakeholder community (farmers, extenders, multipliers, researchers and policy makers) acting within the Bolsena Lake Biodistrict

Within this framework. IRET elaborates the guidelines to identify (1) the RAIN management procedures; (2) the RAINs governance structure, (3) the role and activities of the Innovation Broker, (4) the involvement of actors/stakeholders in each RAIN, (5) the composition, objective and timing for each RAIN workshop and (6) the thematic issues to be addressed by validating and extending the most promising land management innovations collected in AFINET towards the development of business models

Poster Presenter Enrico Petrangeli

Consiglio Nazionale delle Ricerche

CNR IRET

CNR IRET Conference

Rome, February 18th-19th 2025

«GReen ENgineering solutions: a new LIFE for SEdiments And Shells»

S. Doni, E. Peruzzi, C. Macci, I. Rosellini, M. Di Leo, C. Vitone, M. Mali, R. Petti, G. Masciandaro

Background

DREDGED SEDIMENTS

CER (EWC) 170505
WASTES FROM DREDGING ACTIVITY – SLUDGES

In Europe the volume of **potentially contaminated** dredged sediments is estimated at 200 million cubic meters per year

SHELLS

CER (EWC) 020103
WASTES FROM AGRICULTURE, HORTICULTURE, **AQUACULTURE,** FORESTRY, HUNTING AND FISHING

The global production of marine bivalves is approximatively 15 million tons per year. Many of the shells are disposed of illegally

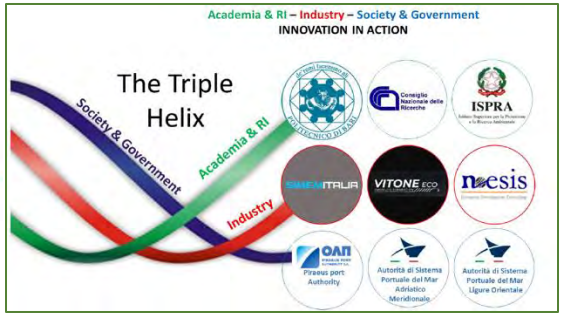
GREENLIFE4SEAS project

Start: 01/10/23 - End: 01/10/28

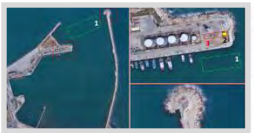
Total amount: € 3.930.225

Greenlife 4 seas
GREen ENgineering solutions: a new LIFE for SEdiments And Shells

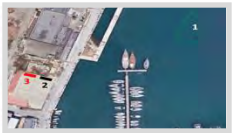
Co-funded by the European Union



PROJECT LOCATION



Barletta Port



Bari Port

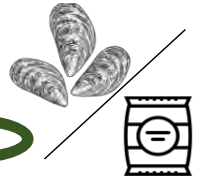
La Spezia Port

Piraeus Port

OBJECTIVE

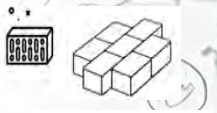
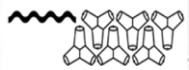
In-situ recovery and reuse of dredged **sediments** and **shells**, as **secondary raw materials** for the realisation of **sustainable and innovative by-products for building sector**, through an optimised **mixing technology**

Dredging sediment

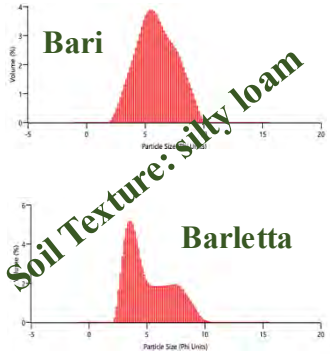


Shell powder

Stabilized sediment

- paving blocks 
- breakwater blocks 
- mass stabilization 

Sediment characterization



	Bari	Barletta
pH	8,61	8,89
Electrical Conductivity (dS m^{-1})	55,0	34,9
Total Nitrogen (%)	0,14	0,20
Total Organic Carbon (%)	1,12	3,27
C/N ratio	8	16
Total Phosphorus (mg kg^{-1})	662	657
Cation Exchange Capacity (meq $100g^{-1}$)	22,5	13,7
Petroleum hydrocarbons (C>12) (mg kg^{-1})	**1242**	362

Remediation of contaminated sediments

eurovix BIOTECNOLOGIE PER LA VITA

selected microorganisms
organic nutrients
mineral salts
catalytic oligoelements
enzymatic components
natural growth factors

Landfarming process with bioactivators

Lab-scale — Pilot-plant

Monitoring of sediment decontamination

Serena Doni

Food Waste Valorization from Olive Oil Production Chains: New Applications in Regenerative Medicine

Silvia Romano[1,2], Umberto Galderisi[1], Raffaele Conte[2], Gianfranco Peluso[2,3], Anna Di Salle[2]

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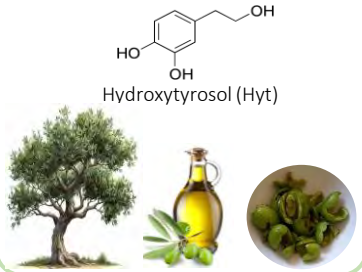
2. Research Institute on Terrestrial Ecosystems (IRET), National Research Council of Italy (CNR), Via Pietro Castellino 111, 80131 Naples, Italy.
3. Faculty of Medicine and Surgery, Saint Camillus International University of Health Sciences, Via di Sant'Alessandro 8, 00131 Rome, Italy.

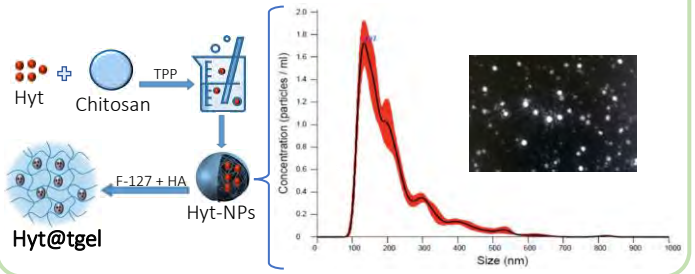
INTRODUCTION

Olive oil by-products are often discarded as waste, despite being rich in bioactive compounds. Reusing them for medical applications supports regenerative medicine, especially osteoarthritis treatment. One key compound, hydroxytyrosol, is a powerful antioxidant and anti-inflammatory that supports cartilage regeneration but has poor stability and bioavailability. To overcome these limitations, Hyt@tgel has been developed. It is an innovative drug delivery system, consisting of chitosan nanoparticles embedded in a thermosensitive hydrogel, which changes from liquid to gel at body temperature, allowing the targeted and prolonged release of Hyt into damaged joints.

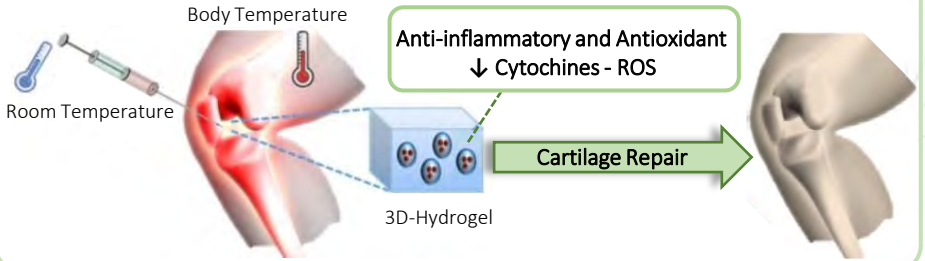
Sources of Bioactive Molecule



Drug Delivery System: Synthesis and Characterization

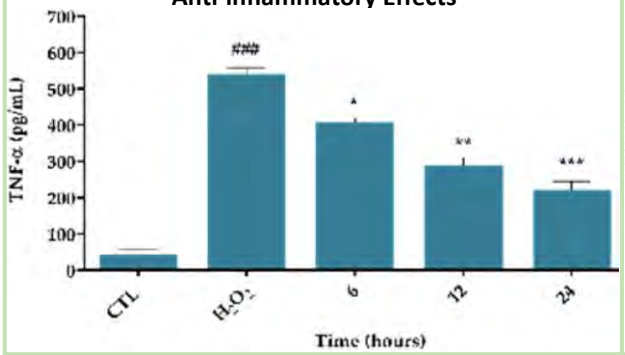


Biological Activity

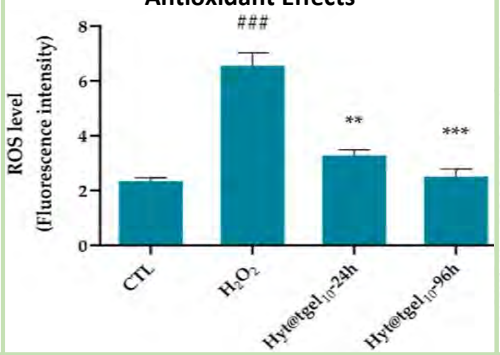


RESULTS

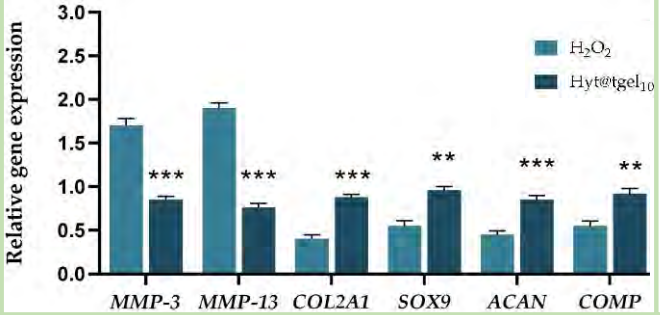
Anti-inflammatory Effects



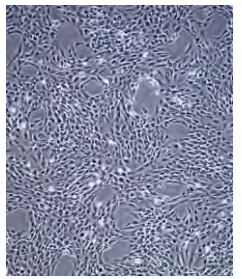
Antioxidant Effects



Regulation of Osteoarthritis-related Gene Expression with Inhibition of Degenerative Processes



↑ Chondrocyte viability ↓ Senescence



CONCLUSION

Hyt@tgel offers an innovative and eco-friendly osteoarthritis treatment, integrating agriculture, biotechnology, and healthcare to enhance patient benefits and reduce environmental impact. Repurposing agri-food by-products represents a crucial step toward a more sustainable future. By promoting a more efficient circular economy, this approach minimizes waste and maximizes the use of natural resources, paving the way for a healthier planet and a more sustainable healthcare system.

Silvia Romano

CNR IRET Conference

Rome, February 18th-19th 2025

Functional Plant-Based Beverage Fortified with Hazelnut Cuticle Polyphenols: Antioxidant and Phenolic Content Characterization

Fabrizia Sepe, Raffaele Conte, Sabrina Margarucci, Ezia Costanzo, Orsolina Petillo, Gianfranco Peluso, Loredana Marcolongo, and Anna Calarco

Research Institute on Terrestrial Ecosystems (IRET), CNR, Via Pietro Castellino 111, 80131 Naples, Italy; fabriziasepe@cnr.it

INTRODUCTION

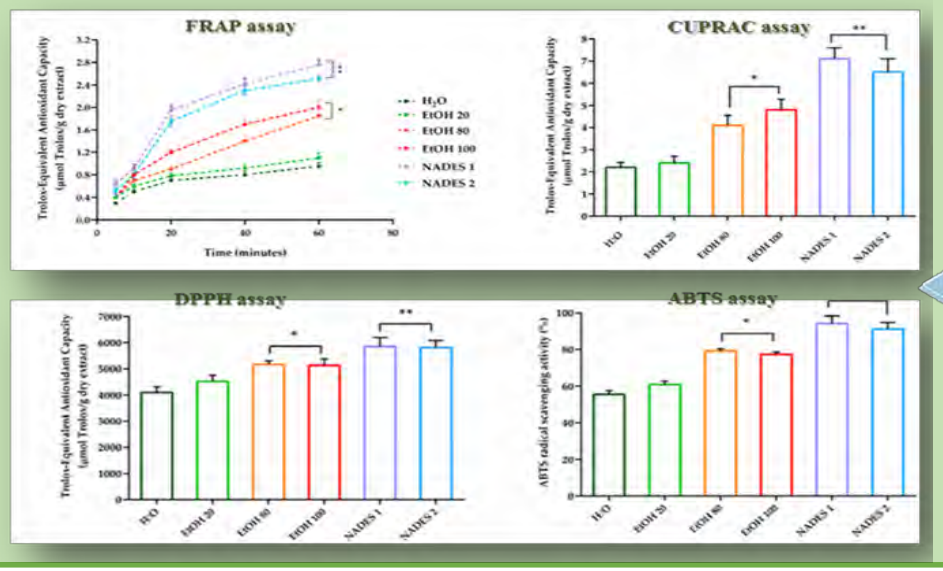
Roasted hazelnut cuticles, a by-product of nut processing, are an underutilized yet exceptionally rich source of dietary fibers as well as of natural antioxidants owing to the presence of phenolic compounds. The aim of this study was to assess the feasibility of using the polyphenol-enriched extract as an aqueous phase in the production of vegetable milk for enhancing its nutritional value and antioxidant properties.

RESULTS

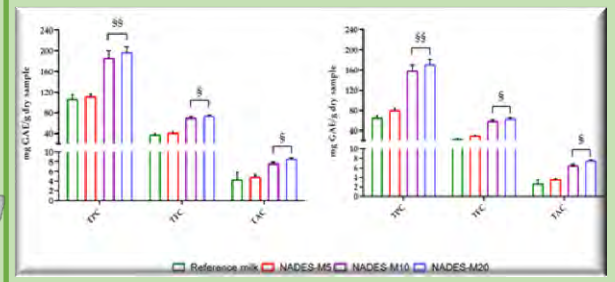
1) Synthesis and characterization

Molar Ratio (ChCl:HBD)	Synthesis Temperature (°C)	TPC (mg GAE/g)
1:2	60	160.88 ± 14.27
1:3	80	147.56 ± 13.11

2) Antioxidant activity



3) Fortified beverage



4) Organoleptic Property

CONCLUSION

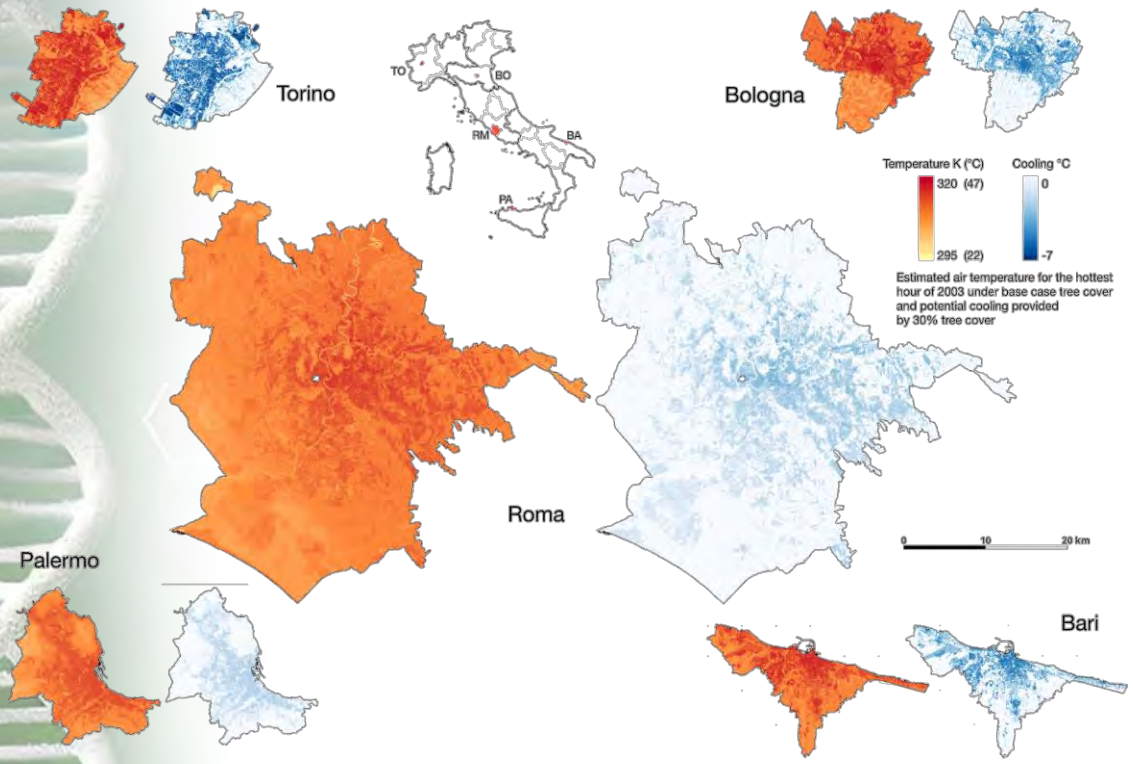
In conclusion, this study demonstrates the potential for sustainable valorization of hazelnut cuticles, through their incorporation as NADES extracts in plant-based milk, providing an innovative solution to reduce food waste while catering to consumer demand for nutritionally enriched and eco-friendly products.

Fabrizia Sepe

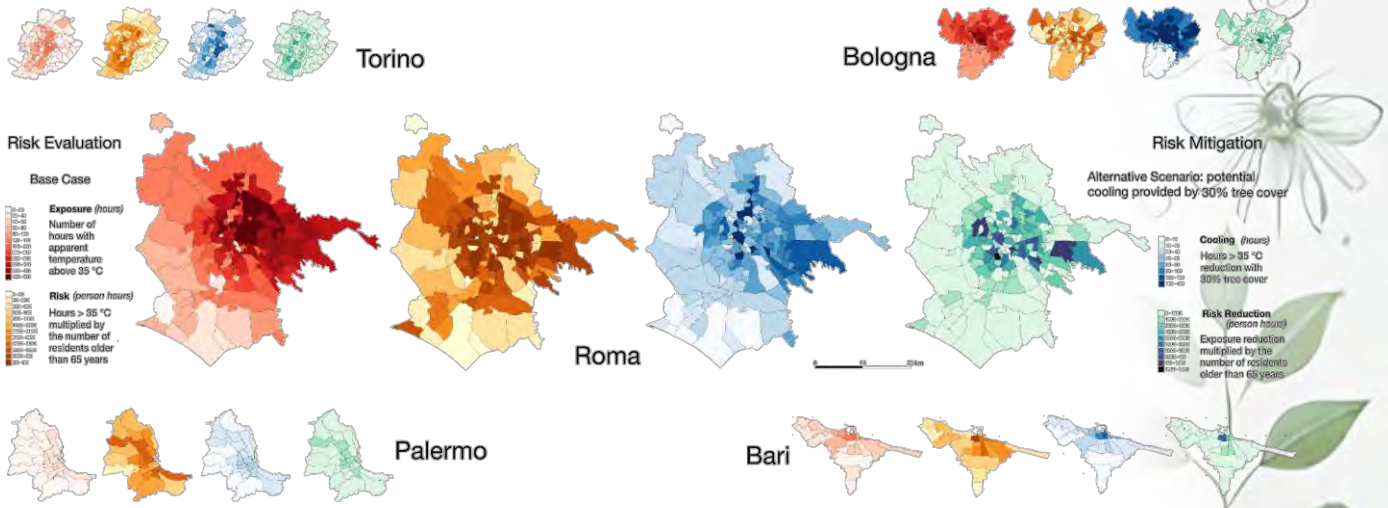
Leveraging Urban Tree Cover to Combat Heatwaves: Modeling Intensity, Duration, and Mortality in Italian Cities

T.A. Endreny, F. Chiocchini, A. Endreny, C. Calfapietra, M. Ciolfi

Cities are increasingly adopting nature-based solutions (NbS) to reduce the impacts of heatwaves, and there is a growing need for tools to support the strategic design and management of these solutions. This study used the i-Tree Cool Air soil-vegetation-atmosphere transfer model to assess how increasing urban tree cover enhances evaporative cooling, thus reducing exposure to heatwaves and associated mortality. This study simulated heatwave events and heatwave degree days (a measure of intensity and duration) for 10 Italian cities (Bari, Bologna, Bolzano, Cagliari, Firenze, Genova, Palermo, Roma, Torino, and Verona) during the entire summer of 2003, with hourly time steps.



Two scenarios were modeled: a base case and an alternative scenario in which tree cover was increased to meet a minimum target of 30%, aligning with European goals. In the base case, heatwave events and excess mortality among individuals aged 65 and older were estimated for each city, with data distributed across neighbourhoods based on heatwave degree days and the size of the elderly population.



The alternative 30% tree cover scenario resulted in an average reduction of 40% in both heatwave degree days and excess mortality, with cooling benefits derived from evapotranspiration of water that would have otherwise been runoff in the base case. This modeling approach can help to prioritise where to implement NbS for maximum impact.

This study received funding support from the National Biodiversity Future Centre and was supported by a sabbatical leave for TE from SUNY ESF to CNR IRET.

Francesca Chiocchini

Effects of the Byproduct of tomato processing on Aging in *Drosophila melanogaster*

Maria Rosaria Carillo[1,2], Filomena Anna Digilio[1,3]

The **aim** of this work is the study of aging utilizing products derived from tomato-industrial waste in the model organism *Drosophila melanogaster*

Growing interest in sustainable and natural solutions

Reducing oxidative stress. Potential effects on preventing age-related diseases

Combatting free radicals

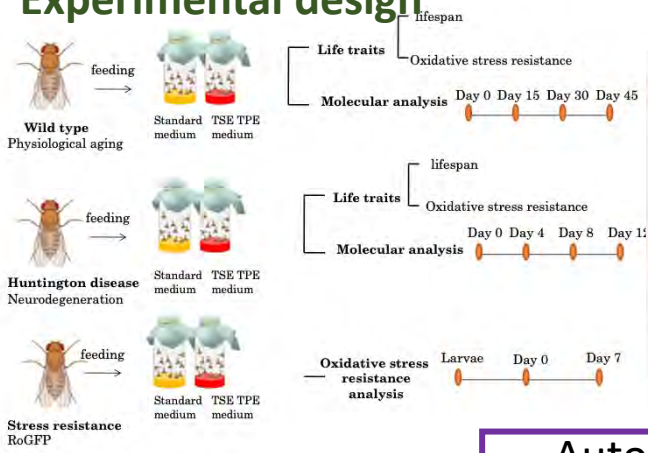
Bioactive compounds

Polyphenols flavonoids

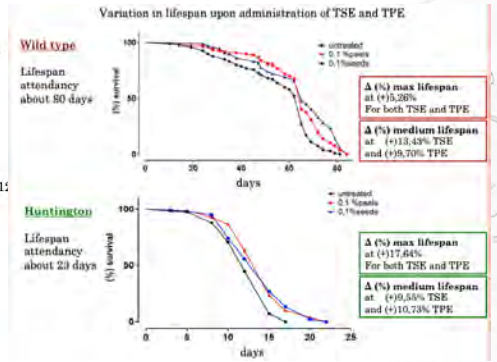
Study Models

Efficacy tested on cellular and animal models

Experimental design

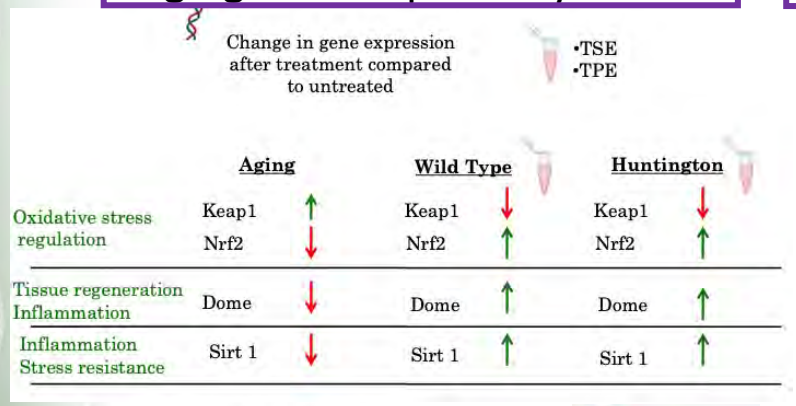


Lifespan

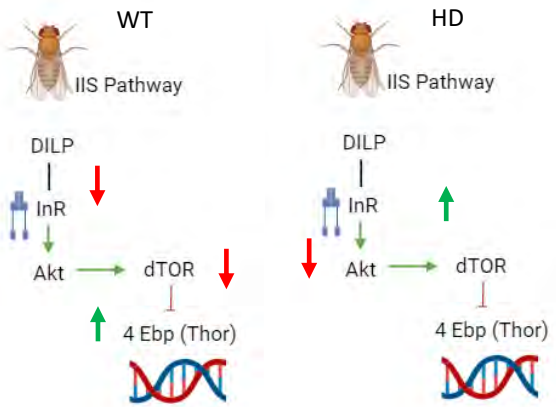


Molecular analysis

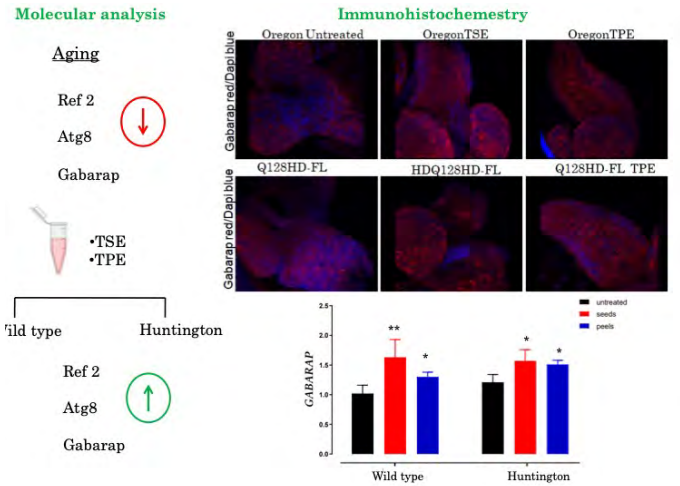
Aging related pathways



Insuline pathway regulation (IIS)



Autophagy regulation



F.Anna Digilio

Biohydrogen production by immobilized photosynthetic microorganisms

FOSSIL FUELS

Finite in supply, cause **land degradation** and **release of greenhouse gases** and **pollutants**.

BIOLOGICAL H_2

produced by photosynthetic microorganisms:

- **Environmentally friendly** properties
- Achievement of **carbon neutrality**
- **Extremely combustible**
- Its combustion yields only **water** as byproduct

Among the strategies that could be explored to improve biological H_2 production efficiency, the immobilization of cells could be particularly effective.

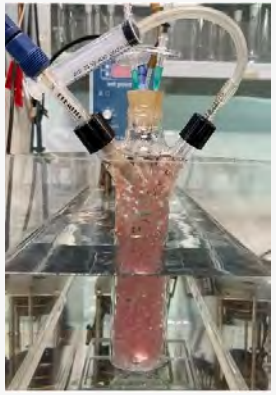
Immobilization process

Increase:

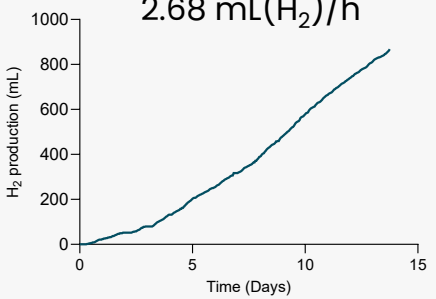
- **Product recovery**, cell harvesting, medium replacement
- Volumetric cell density
- Homogeneous distribution of cells
- Light conversion efficiency
- Cells' resistance to various environmental stresses

Cells **immobilized** in 2% w/v calcium alginate

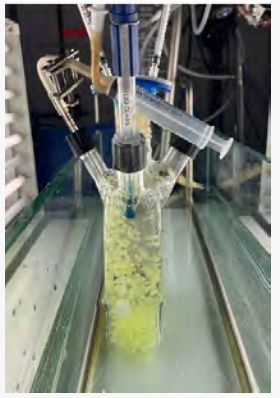
***Rhodopseudomonas* palustris**
– Purple non sulfur bacterium –
Cylindrical 220 mL photobioreactor



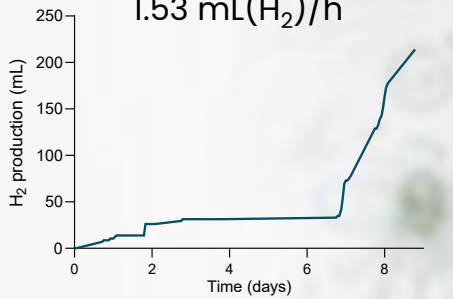
H_2 produced 868 mL
Average productivity
2.68 mL(H_2)/h



Chlorella vulgaris
– Microalgae –
Flat 600 mL photobioreactor



H_2 produced 214 mL
Average productivity
1.53 mL(H_2)/h



GC analysis of the gas produced by the culture (PerkinElmer Clarus 500)

The ability of the immobilized cells to produce H_2 in two photobioreactors was tested
Further research is necessary to improve the industrial and commercial feasibility of H_2 production by photosynthetic microorganisms

Acknowledgements:
European Union's Horizon research and Innovation program No 101093150

LIBRA
European Innovation Council

Raffaella Zampieri

CNR IRET Conference Rome, February 18th-19th 2025

Plant-derived extracellular vesicles: an innovative delivery system and a source of natural bioactive compounds

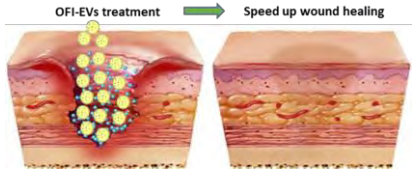
Sorur Yazdanpanah[1,2], Umberto Galderisi[1], Anna Valentino[2], Gianfranco Peluso[2,3], Mauro Finicelli[2]

[1]Department of Experimental Medicine, University of Campania "Luigi Vanvitelli", Via Santa Maria di Costantinopoli 16, 80138 Naples, Italy.
[2]Research Institute on Terrestrial Ecosystems (IRET), National Research Council of Italy (CNR), Via Pietro Castellino 111, 80131 Naples, Italy.
[3]Faculty of Medicine and Surgery, Saint Camillus International University of Health Sciences, Via di Sant'Alessandro 8, 00131 Rome, Italy.

Introduction

Plant-derived extracellular vesicles (P-EVs) are emerging as promising agents for delivering bioactive compounds, playing a key role in intercellular communication. They can effectively deliver a wide range of cargoes, including proteins, lipids, nucleic acids (noncoding RNAs, DNA, mRNA), and other bioactive compounds. P-EVs exhibit a remarkable range of biological activities, showing both preventive and therapeutic potential in alleviating various pathological conditions. Their ability to efficiently deliver both exogenous and endogenous bioactive molecules to mammalian cells, combined with their low cytotoxicity, makes them promising candidates for developing novel therapeutic strategies across multiple diseases.

In this study, EVs were extracted from Opuntia ficus-indica fruit (OFI-EVs) and analyzed for their particle size distribution, concentration, and bioactive molecule composition to evaluate their potential role in chronic wound healing.

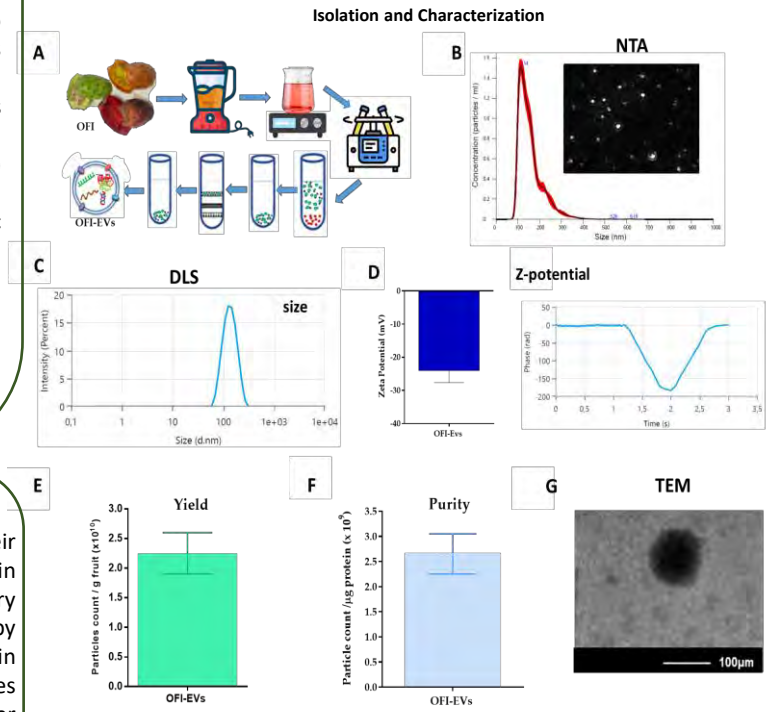


Conclusion

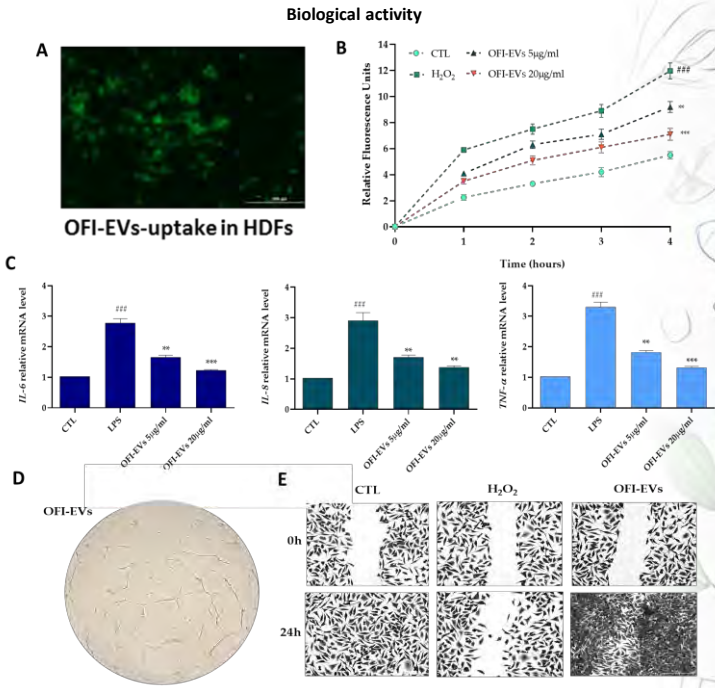
OFI exhibits health-promoting and wound-healing properties. Despite their desirable biological properties, many natural products face limitations in crossing the stratum corneum to reach wounds. However, modern delivery techniques improve the effectiveness of natural bioactive products by enhancing their permeability and bioavailability, overcoming challenges in penetrating the stratum corneum for wound healing. This study emphasizes the therapeutic potential of OFI-EVs, which facilitate intercellular communication and effectively deliver bioactive molecules to target cells. OFI-EVs reduce inflammation and oxidative stress, accelerating the healing of chronic skin wounds.

Results

Pro-inflammatory cytokine OFI-EVs exhibited biocompatibility and protective effects in an in vitro chronic wound model by reducing inflammation and oxidative stress. They downregulated (IL-6, IL-8, TNF-α) in LPS-stimulated human leukemia monocytic cell line (THP-1) and enhanced cellular antioxidant defenses. Additionally, they promoted wound healing by stimulating the migration and new angiogenesis of human dermal fibroblast (HDFs) and of Human Umbilical Vein Endothelial cells (HUVEC). These findings suggest that OFI-EVs could serve as a natural candidate for healing chronic wound.



(A) Schematic illustration of OFI-EVs isolation procedure. (B) Size distribution using nanoparticle tracking analysis. (C,D) Size distribution, Zeta potential using dynamic light scattering. (E,F) Production yield and purity of OFI-Evs (G) Transmission electron microscopy image of isolated OFI-EVs.



(A) Semi-quantitative analysis of PKH67-EVs fluorescence intensity (B) ROS release using cellular ROS assay kit (H2DCFDA). (C) IL6, IL8, and TNFα analyzed by qRT-PCR in THP-1 cells. (D) Optical images of HUVECs tubes. (E) Representative images of wound closure.

Sorur Yazdanpanah

CNR IRET Conference Rome, February 18th-19th 2025

Qualitative X-ray fluorescence spectroscopy characterization of ground electronic waste

Muzzini V.G.[1], Iori V.[2], Spinelli V.[3], Pinzari F.[4], Donati E.[4], Astolfi M.L.[5], Persiani A.M.[3], Mazzonna M.[4], Ceci A.[3]

1 Research Institute on Terrestrial Ecosystems-National Research Council (CNR-IRET), 2 Institute of Agricultural Biology and Biotechnology-National Research Council (CNR-IBBA), 3 Department of Environmental Biology, Sapienza University of Rome, 4 Institute for Biological Systems-National Research Council (CNR-ISB), 5 Department of Chemistry, Sapienza University of Rome

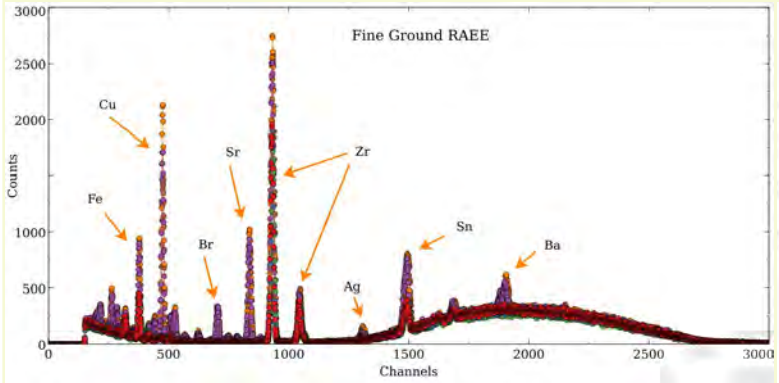
Introduction and Aims

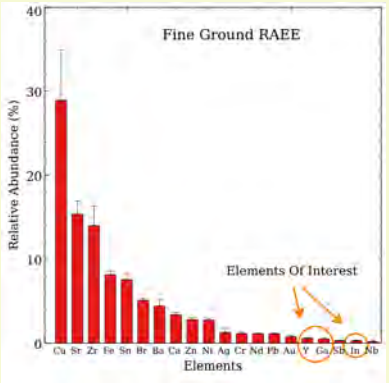
Efficient recovery of critical strategic elements from electronic waste (e-waste) is crucial to meeting rising global demand. In this context, fungi offer a promising, nature-based approach to recovering target elements from e-waste. Effective recovery strategies, however, depend on characterizing the elemental composition of the ground e-waste. The XRF technique works by exciting a sample with high-energy X-rays, resulting in the emission of characteristic secondary X-rays from the material, which display peaks corresponding to different elements and their respective concentrations. In this study, XRF technique was employed to identify the elemental composition of ground e-waste samples fractionated by particle size.

Materials and Methods

In this study, multi-metal substrates obtained from ground electronic devices and supplied by B.T.T. Italia S.r.l., a private company specializing in e-waste recycling, were subjected to granulometric separation through sieving (**1** - x > 2.80 mm; **2** - 2.80 mm > x > 710 µm; **3** - 710 µm > x > 125 µm; **4** - x < 125 µm). Each fraction was then characterized by XRF spectroscopy, using Leit adhesive carbon tabs of 25 mm diameter, to assess composition and element enrichment across the fractions. The **X-ray source** operated at 60 kV and 0.4 mA with a beam diameter of just over 10 mm on the sample. An energy-dispersive X-ray fluorescence (EDXRF) detector was positioned to directly capture the energies of the X-rays emitted by the sample. The acquisition time was set to 300 s to improve the signal-to-noise ratio.

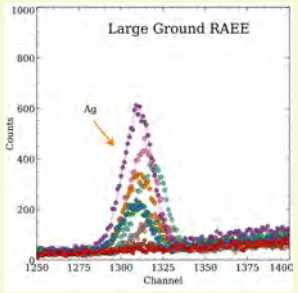
The results indicated an abundance of Cu, Sr, Zr, Fe, Sn, Br, Ba, Zn, and Ni. In addition, the analysis of the **finest-grained** sample revealed trace amounts of Ga, Y, and In, elements of particular interest.





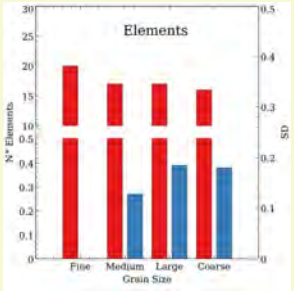
Acknowledgements
PRIN 2022 PNRR Project funded by European Union – NextGeneration EU, Mission 4, Component C2 - CUP B53D23032140001- Project Prot. P2022ENEWL - Title "Fungal interaction with metals (FUN METALS): transformation and mechanisms for biorecovery". We also thank B.T.T. Italia S.r.l. for the provided material.

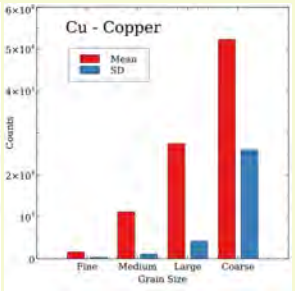
The varying intensity and signal variability of samples with **Large** granulometry are exemplified by the **silver** peak.



Results & Conclusions

As expected, larger particle size reduces the ability to identify **Elements**, increasing variability between samples. Furthermore, while signal intensity (counts) of the identified elements increases (**Mean, Cu-Copper**), so does the variability of the mean value (**SD, Cu-Copper**) across all samples of the same granulometric size





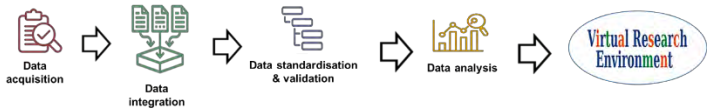
The XRF technique combined with the EDXRF detector has proven to be highly effective, allowing rapid and simultaneous identification of elements within the sample. Granulometric analysis indicated that the fine fraction is optimal for identifying elements in the ground sample. Conversely, larger particle sizes, despite offering a higher signal-to-noise ratio, introduced greater variability into the measurements.

Valerio G. Muzzini

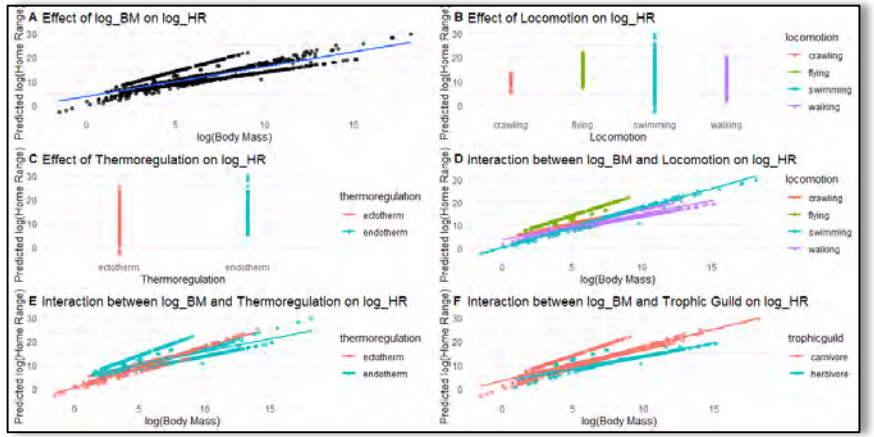
Integrating species traits and environmental dynamics to predict spatial behaviour and climate change impacts on vertebrates

A comprehensive understanding of how species traits and external factors interact to shape dynamics of space use behaviour could help clarify key factors driving the strategies of energy requirements, fitness and life expectancy. In an era of rapid climate and environmental changes, predicting biological responses and consequences to such changes become critical to addressing current challenges and ensuring species' long-term preservation. To address these points, we followed a **two-steps** approach:

Aim: To investigate the ***home range~body size*** *and* ***maximum longevity~body size*** relationships, and the relative influence of various biological/ecological factors, such as habitat type, thermoregulation, trophic behaviour and mobility, in home range and lifespan variation across taxa.



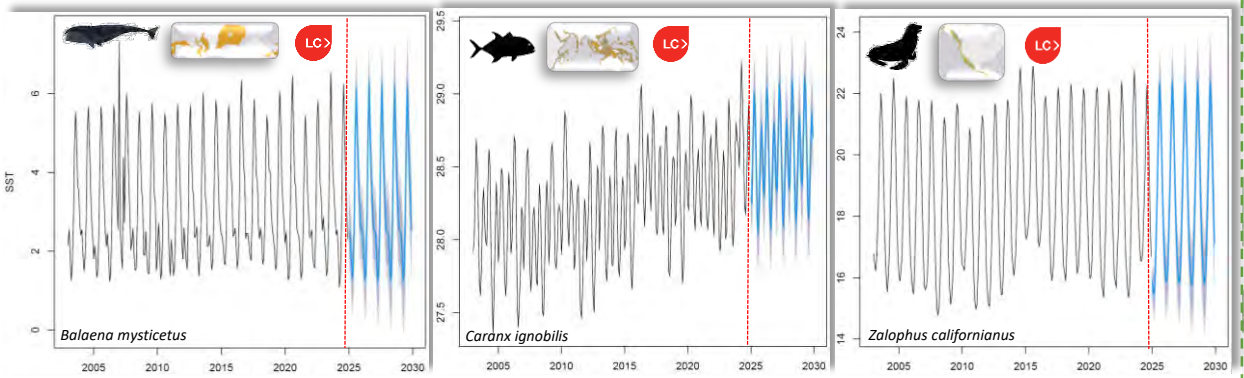
Dataset: 1164 species spanning fish, reptiles, mammals and birds from around the globe.



Aim: To test an **analytical workflow** to analyse the ***variation in mean temperatures***, as a proxy for global warming, across species' distribution ranges and building future scenario of how these changes may evolve.

Methods: We used remotely sensed images of sea/land temperature from MODIS products and applied a SARIMA prediction model to forecast the evolution of temperatures on vertebrate species' distribution range polygons (IUCN source) of the dataset from step 1.

Ouput: We built a temperature time series for each species from **2003** to **2024** and projected them into the future (up to **five years**) to predict potential changes likely to occur in the species' range.



This twice, not-mutually exclusive approach, facilitates comprehensive estimates of home range and maximum longevity relationships with both intrinsic and extrinsic factors and allows to understand the impact of climate change to biodiversity organization and conservation.

ITINERIS

Monti, F., Semeraro, T., Titocci, J., Liberatore, L., Basset, A. (2025). Integrating species traits and environmental dynamics to predict spatial behaviour and climate change impacts on vertebrates. CNR IRET Conference, 18-19/02/2025, Rome.

Flavio Monti

Consiglio Nazionale delle Ricerche
CNR IRET Istituto di Ricerca sugli Ecosistemi Terrestri

CNR IRET Conference Rome, February 18th-19th 2025

HIC SUNT LUPI

Monitoring and Management of Wolves in Salento

Stakeholder Engagement & Awareness

28 meetings and **4** workshops to foster dialogue among stakeholders for wolf coexistence.

Smart tools for conservation

Our ***citizen science*** and field support apps ensure transparent and FAIR data management with *eScience* tools.

Field Monitoring & Camera Trapping

Over **120** hectares surveyed, **55** camera traps deployed, and **97** videos recorded providing valuable insights into wolf presence, behaviour, and habitat use.

The ***HIC SUNT LUPI*** project applies rigorous scientific methods to monitor wolf populations and study their diet, ensuring informed conservation strategies

Insights from Camera Traps

6 wolf packs identified and **4** reproductive events documented.

Diet Analysis for Conservation

86 samples collected to reveal predator-prey dynamics, aiding ecosystem balance and livestock protection.

F. De Leo , P. Ciucci, P. Colangelo, E. Mori, I. Rosati, D. Raho, E. Solano, F. Cozzoli

Francesco De Leo

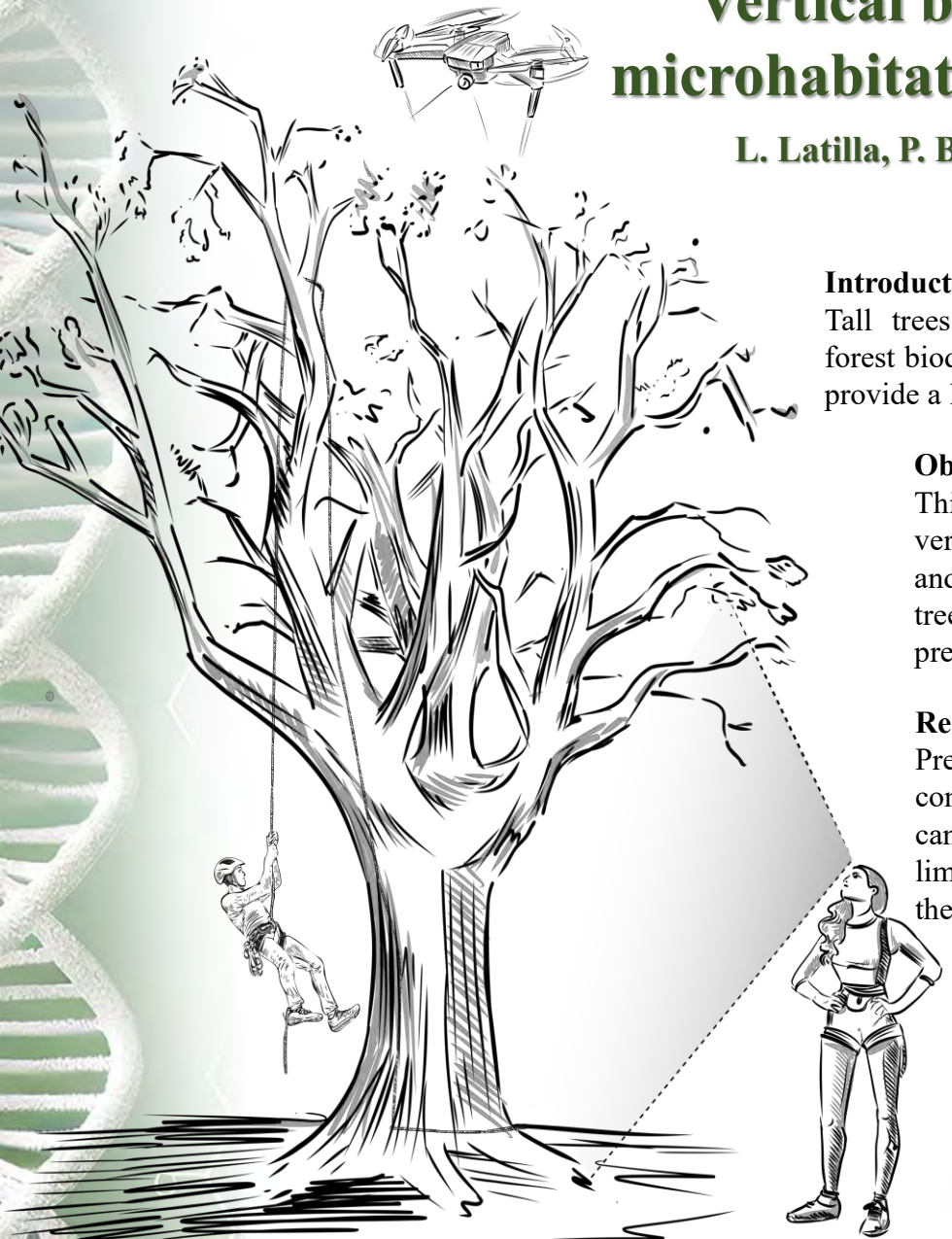
CNR IRET Conference

Rome, February 18th-19th 2025

Vertical biodiversity: a study of tree crown microhabitats through tree climbing and drones

L. Latilla, P. Bertolotto, S. Carloni, F. Sicuriello, B. De Cinti
IRET-CNR, Montelibretti

Il Progetto LIFE SPAN (LIFE19 NAT/IT/000104) è finanziato all'interno del programma LIFE dell'Unione Europea



Introduction

Tall trees host numerous microhabitats essential for forest biodiversity. However, ground-based observations provide a limited view of vertical biodiversity.

Objectives and Methodology

This study examines the relationship between vertical biodiversity observed from the ground and that detected through direct canopy access via tree climbing techniques, aiming to develop predictive models.

Results

Preliminary data obtained in Cansiglio forest reveal a high concentration of cavities, deadwood, and bird nests in the upper canopy. Tree climbing provides detailed observations but is limited to a small sample of trees. To overcome this limitation, the study will test the use of drones.

Conclusions

Integrating ground observations and drone technology will enable a more comprehensive analysis of vertical biodiversity, supporting forest conservation and management.

Examples of vertical biodiversity: microhabitats

Leonardo Latilla

CNR IRET Conference

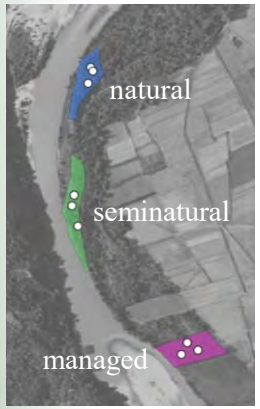
Rome, February 18th-19th 2025

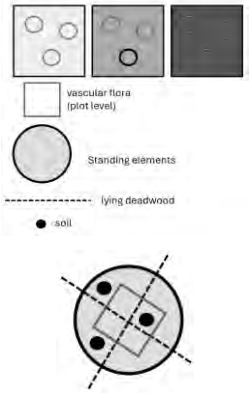
Determinants of vascular species diversity on poplar natural and semi-natural woodlands: a stand scale approach

Giovanni Trentanovi[1*], Anna Corli[2,3], Francesca Vannucchi[1,3], Silvia Traversari[1,3], Simone Orsenigo[2,3], Pier Mario Chiarabaglio[4], Francesco Chianucci[4], Carlo Calfapietra[1,3], Andrea Scartazza[1,3], Maria Laura Traversi[1], Luca Cristaldi[5], Alessio Giovannelli[1,3]

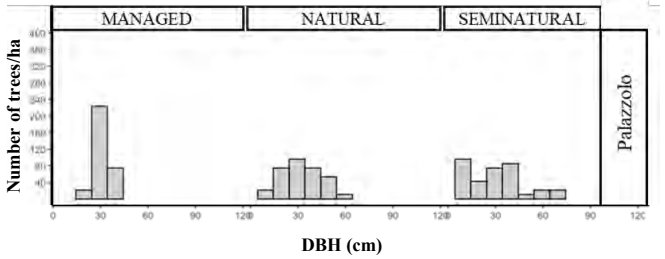
[1] Istituto di Ricerca sugli Ecosistemi Terrestri – Consiglio nazionale delle Ricerche (IRET-CNR); [2] Dipartimento di Scienze della Terra e dell'Ambiente, UNIPV; [3] NBFC, National Biodiversity Future Center; [4] CREA - Centro di ricerca Foreste e Legno; [5] Ente di gestione delle Aree Protette del Po piemontese.

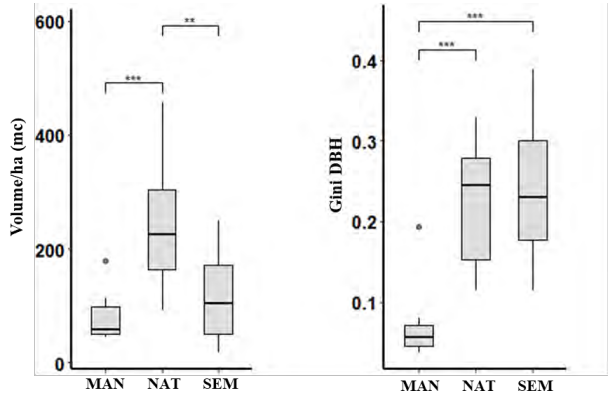
Study area and sampling design



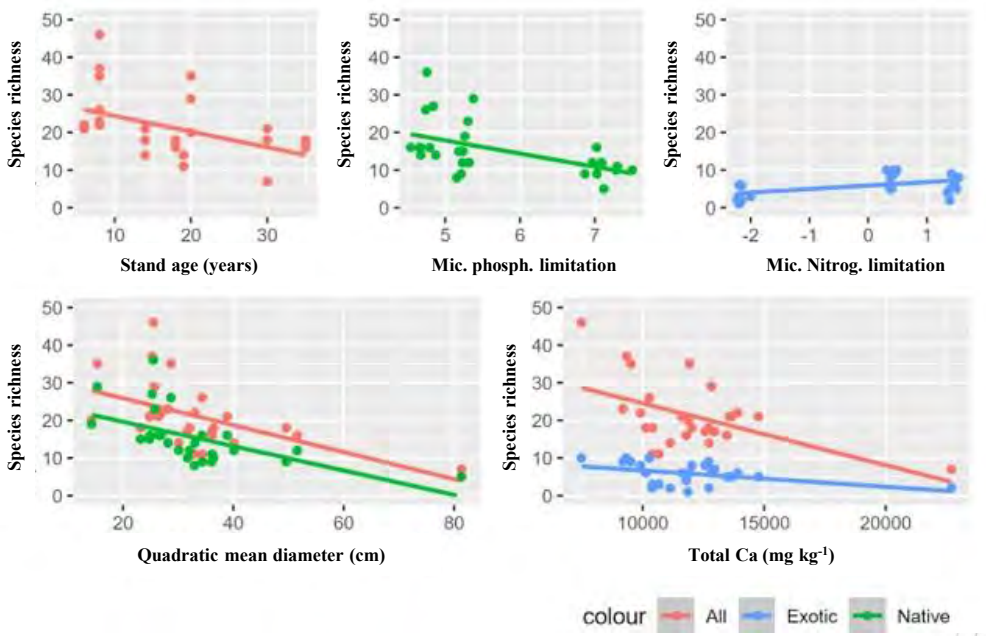


Woodland stand structure characterization





Determinants of vascular flora diversity



Improving the functionality of the river environment through new plantations is a powerful NBS. Our work tested the effectiveness of a novel and replicable methodological approach that allows the assessment of the ecology and functionality of riverine poplar stands with different gradients of naturalness. Results will allow the selection of river ecosystem management strategies that meets the requirements of Nature Restoration Law (Regulation EU 2024/1991).

NATIONAL BIODIVERSITY FUTURE CENTER

Finanziato dall'Unione europea NextGenerationEU

Genetic diversity and structure of *Alnus cordata* and *Quercus trojana* populations in the native range of southern Italy: an essential step towards the definition of management and conservation strategies

C. Mattioni, A. Marchesini, M. Gaudet, F. Chiocchini, L. Leonardi , M. Cherubini, P. Pollegioni P.

Microsatellite genotyping for:

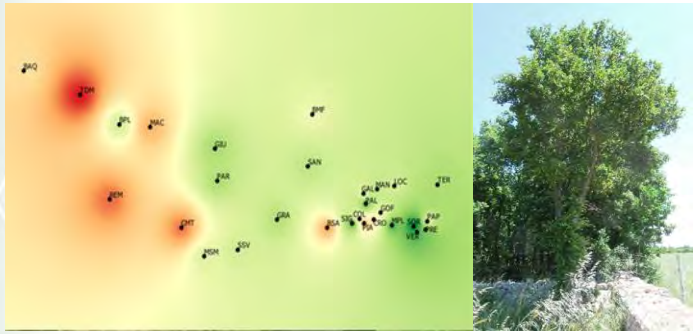
-Understanding demography and genetic structure of natural populations
-Identify hot spots of neutral diversity and conservation units
-Reconstruct evolutionary history
- integrate the genetic/genomic data with climatic and topographic data

→

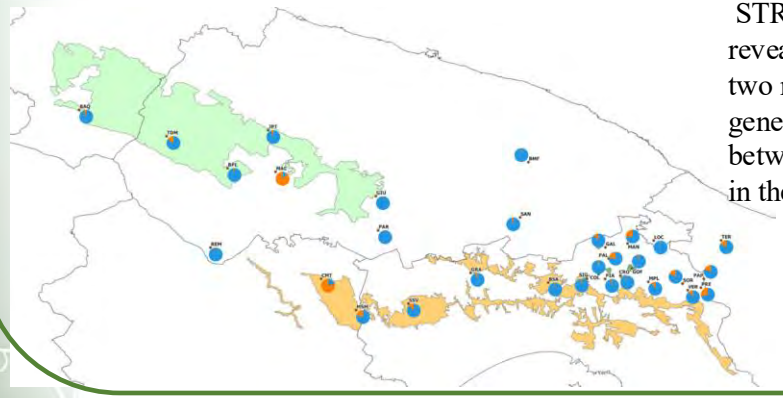
Priority conservation areas

Management strategies

Quercus trojana



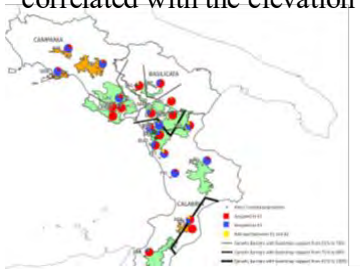
30 populations,
552 samples,
12 SSRs markers

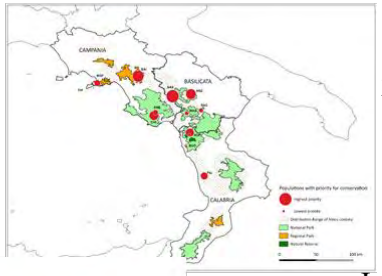


STRUCTURE analysis revealed the presence of two main gene pools, genetic divergence between two populations in the core of distribution

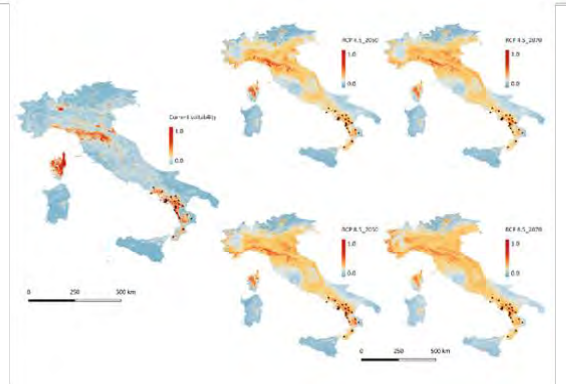
Alnus cordata

STRUCTURE identified two genetic clusters weakly correlated with the elevation





23 populations,
517 samples,
10 SSRs markers



Indication of priority conservation areas

Predicted current (A) and future potential geographic distribution of *Alnus cordata* by 2050 (range 2041-2060)and 2070 (range-2061-2080) according to the climate CMIP6 model under RCP4.5 and RCP 8.5 scenarios

Claudia Mattioni

Jackal-howling in urban and rural areas: status of a protected species in Tuscany

Emiliano Mori[1,2], Andrea Viviano[1], Olivia Dondina[2,3], Stefano Pecorella[4] & Leonardo Ancillotto[1,2]

1. Istituto di Ricerca sugli Ecosistemi Terrestri IRET, Consiglio Nazionale delle Ricerche, Via Madonna del Piano 10, 50019 Sesto Fiorentino (Firenze), Italy.
2. National Biodiversity Future Center, 90133 Palermo, Italy.
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4. Therion Research Group, Castel San Mauro, 34170, Gorizia, Italy

INTRODUCTION

The golden jackal *Canis aureus* is a wild canid species of Asian origin, which is naturally fast-expanding its range in Europe (Figure 1). First occurrences on North-Eastern Italy date back to late 1980s.

The first record in Tuscany dates back to 2021 at the north-western outskirts of Firenze metropolitan area, with a pair of individuals [1].

In 2022, a juvenile individual was road-killed in central Tuscany (Empoli, province of Firenze).

Then, a further individual has been camera-trapped in the Maremma Regional Park, in southern Tuscany (province of Grosseto) [2].

Aims

Assessing the distribution of the golden jackal in Tuscany by combining different approaches: bioacoustics, molecular analysis and literature/newspaper review

Figure 1. Worldwide and Italian distribution of the golden jackal *Canis aureus*.

MATERIALS AND METHODS

1. **Literature/online newspaper review** on golden jackal in Tuscany
2. **Molecular analyses on road kills** by means of mitochondrial markers (480 bp fragment of cyt-*b*).
3. **Bioacoustic survey (jackal howling)** through standard methods in seven sites to assess the occurrence of reproductive groups [3].

RESULTS

Literature review confirmed three sites of occurrence of golden jackal in Tuscany (Figure 2).
Molecular analyses on the road-kill from Empoli confirmed it as belonging to the *C. a. moreoticus* clade, with a new haplotype (Figure 3).

DISCUSSION

The limited but expanding presence of golden jackals in Tuscany highlights the need for further research to understand their ecological role and potential impact on the existing ecosystem, particularly in relation to the established grey wolf population. Conservation efforts should focus on mitigating potential human-wildlife conflicts, as the golden jackal has been mostly recorded within urban and suburban areas, as well as on ensuring the long-term viability of this newly arrived species.

REFERENCES
[1] Bacci, F., & Lunghi, E. (2022). Natural History Sciences, 9(2), 59-62.
[2] Pacini, G., Lazzeri, L., & Ferretti, F. (2022). Habitat Online. https://www.habitatonline.eu/2022/05/prima-documentazione-di-sciacallo-dorato-canis-aureus-nel-parco-regionale-della-maremma/
[3] Giannatos, G., Marinos, Y., Maragou, P., & Catsadorakis, G. (2005). Belgian Journal of Zoology, 135, 145–149.

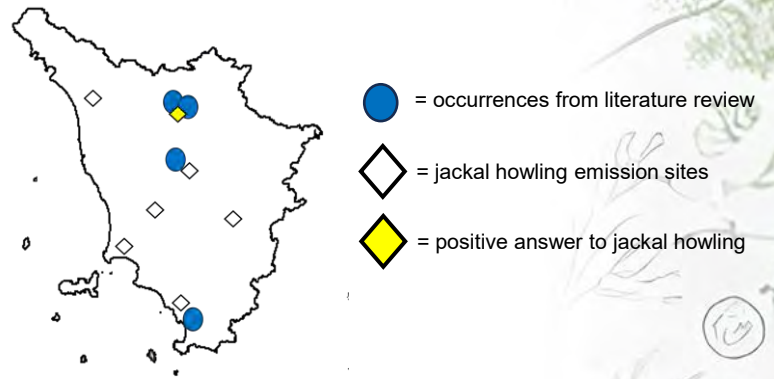


Figure 2. Distribution of the golden jackal in Tuscany combining literature data, jackal howling and molecular data.

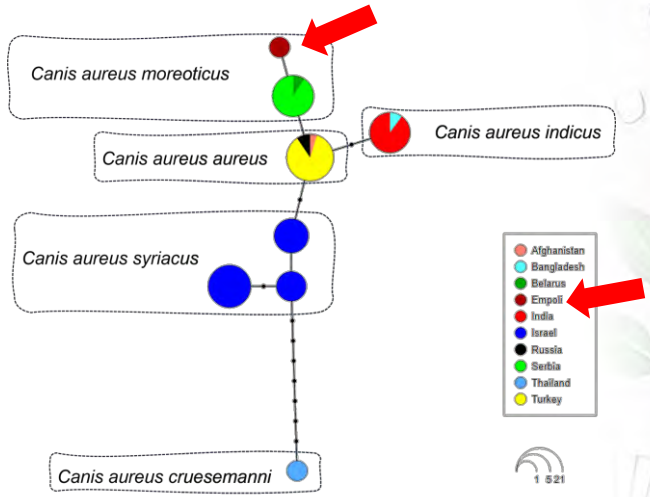


Figure 3. Haplotype network of mitochondrial cytochrome-*b* sequences (480 bp) of golden jackal from throughout its range. Italian samples were confirmed to belong to *C. a. moreoticus* clade. Circles represent different haplotypes. Circle sizes are proportional to the number of specimens examined for each haplotype, whereas dots indicate mutational steps.

EMILIANO MORI

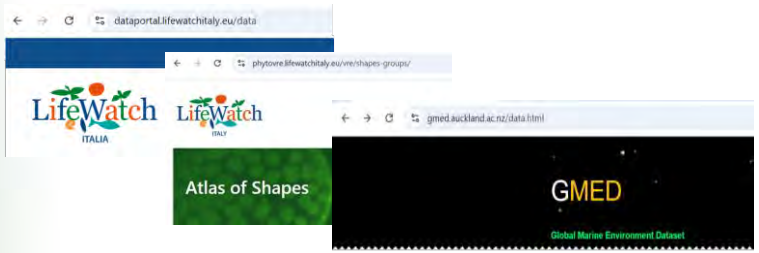
CNR IRET Conference Rome, February 18th-19th 2025

Modelling transitional water phytoplankton communities by functional traits in climate change scenario: an ecological niche-based approach

Introduction and aim:

Phytoplankton guilds are a critical component of aquatic ecosystems that are likely to be strongly affected by climate change. Here, we present an approach to phytoplankton ecological responses to climate change that links species functional traits and ecological niche analysis. The study focuses on transitional water ecosystems, which, due to their physiographic and geomorphological characteristics, as sedimentary and energy rich functional ecotones, are among the aquatic ecosystems most affected by global warming.

Methods:



- 127.311 organisms (35 body shape categories)
- 6 lagoon areas in 5 biogeographical zones

- 14 parameters in actual scenario (Depth, Land Distance, Wind speed, Diffuse attenuation coefficient, Mean Temperature, Salinity, PAR, Chl-a, PPN, pH, Nitrate, Phosphate, Silicate, DO)
- 5 environmental parameters in future scenario (Depth, Land Distance, Temperature, Salinity, PPN)

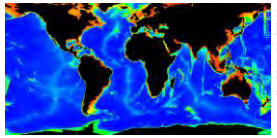
- SDMs (Maximum Entropy algorithm)
- Ecological Niche Models

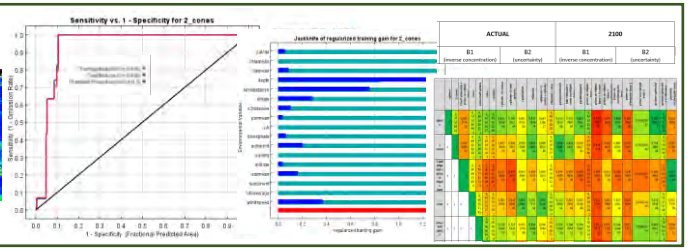
Actual scenario vs. future scenario (year 2100) distributions of suitable areas (4 classes)
Ecological niche parameters (B1 and B2 for breadth; I, D, RR indexes for overlap)

Main Results and Discussion:

- 24 actual + 25 future distribution models of body shapes (ROC + AUC>0,5 training/test data)
- *Depth* is main parameter (71%) that influences models by *Jacknife test*;
- Rounded shapes ↑ (+37%) *vs.* Elongated shapes ↓ (-48%) in 2100 highest suitable categories areas
- Niche breadths ↑ (+13%) and Overlaps ↑ (+89%) among species (shapes) in future scenario

CHANGE IN BIODIVERSITY DISTRIBUTION AND MORE SPECIES COMPETITION





Conclusion:

By modelling morpho-functional traits, we can understand **how organisms can adapt to future environmental changes**, and so we can **take specific actions to prevent the loss of biodiversity and ecosystem functionality** (the predicted increase in sea temperature and related increase in nutrients will lead to a loss of "elongated" organisms in some areas and a substitution in biodiversity and an increase in competition between "globular" organisms in other zones), so this approach can **contribute to planning conservation strategies**, also in relation to the *Agenda 2030 Standard Development Goals*.

Lorenzo Liberatore

Liberatore L., Titocci J., Semeraro T., Monti F., Basset A. (2025). Modelling transitional water phytoplankton communities by functional traits in climate change scenario: an ecological niche-based approach.

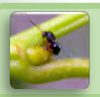
Consiglio Nazionale delle Ricerche

CNR IRET

CNR IRET Conference — Rome, February 18th-19th 2025

Ex-situ collections of *Castanea sativa* provenances as genetic sources of resistance to abiotic and biotic stress

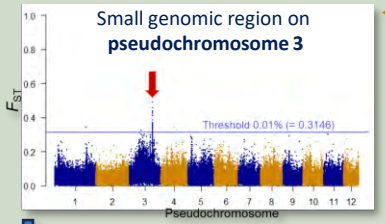
Resistance to Asian Chestnut Gall Wasp

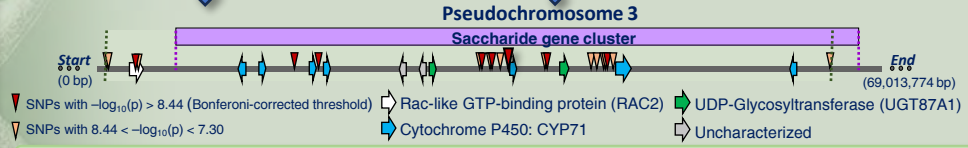


Castanea sativa
Provenance Hortiatis (Greece)
High number of plants **resistant**

- **DNA Pool sequencing (Pool-GWAS)**
- Alignment with ***C. mollissima* reference genome**
- **Pool comparison** with POPOOLATION2
- **F_{ST} analysis** on 1 kpb windows
- **Fisher exact test** on individual SNPs

21 significant SNPs associated to resistance

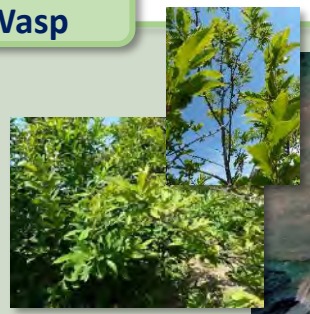


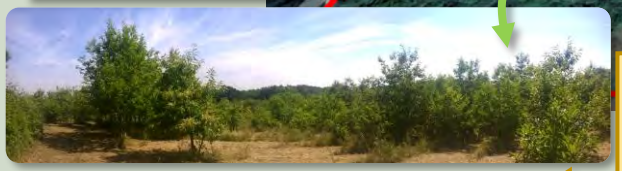


➢ **Unique genomic region associated to Asian Chestnut Gall Wasp resistance**

Identification of a Unique Genomic Region in Sweet Chestnut (*Castanea sativa* Mill.) That Controls Resistance to Asian Chestnut Gall Wasp *Dryocosmus kuriphilus* Yasumatsu.
Muriel Gaudet; Paola Pollegioni; Marco Ciolfi; Claudia Mattioni; Marcello Cherubini; Isacco Beritognolo
Plants 2024, Volume 13, Issue 10, 1355

Castanea sativa ex-situ common garden field CNR IRET





Provenance field trial
Plantation in 2002
EU Project CASCADE)
Today ≈ 1000 plants
6 provenances:
- **Spain,**
- **Italy,**
- **Greece**

→ 2 contrasting sites per country (mesic vs xeric)

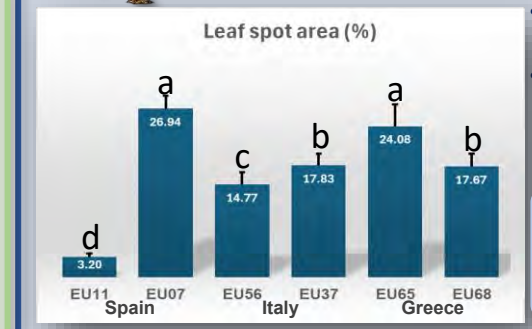
Cross of **contrasting** genotypes from **Bursa** and **Hopa (Turkey)**
Bursa X Hopa (1998)
↓
Full-sib F1 familly

Half-sib families from Bursa, Hopa and Golcuk (Turkey), 2-year-old trees planted in **2022**

Experimental design to test differences between provenances:

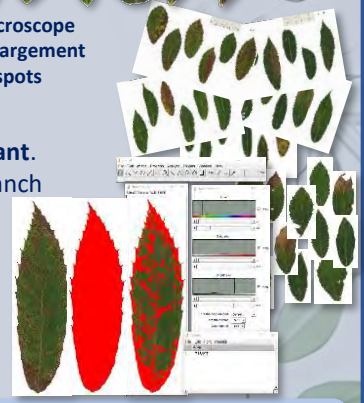
10 random plants / provenance = 60 plants
12 leaves / plant = 720 leaves.

- **Leaves** sampled on **October 10, 2024** on **2 opposite sides each plant**:
- **3 branches randomly** sampled at the **top, middle and bottom of the plant**.
- The **2nd** and the **7th leave** of **the year's shoot** were collected on each branch



- Leaf digital images analysed **with *Image J*** to determine the **ratio of infected leaf area.**
- **Kruskal-Wallis test and Wilcoxon Post-hoc test for multiple comparison**

Kruskal-Wallis; Factor Provenance, $p < 2.2e\text{-}16$
Wilcoxon tests; $p < 0.05$, Benjamini-Hochkberg adjust..



- **Significant variation in leaf spot susceptibility among provenances**
- **Spain provenance EU11** showed a markedly lowest level of **leaf spot susceptibility.**

➢ **Suitable plant material to study mechanisms of leaf spot resistance at genetic/genomic level**

Resistance to leaf spot disease (Fersa)

Fersa: Parasitic **fungi,** *Mycosphaerella maculiformis*, that **cause leaf spot**. **Emerging diseases of European chestnut.**

➢ **Differences** in **extent of leaf spot necrosis** was observed **among provenances.**

Typical spots on chestnut leaves

Microscope enlargement of spots

Relevance of experimental fields

Isacco Beritognolo, Marcello Cherubini, Luca Leonardi

Muriel Gaudet

Improving productivity in *Tanacetum balsamita* L. and vineyards through sustainable soil cropping management strategies

M. Grattacaso[1], A. Bonetti[1], S. Di Lonardo[1,3], E. L. Tassi[2], F. Bretzel[2,3], I. Rosellini[2], M. Scatena[2], R. Pini[2], L. P. D'Acqui[1,3]

[1]Research Institute on Terrestrial Ecosystems (IRET), National Research Council (CNR), Via Madonna del Piano 10, 50019, Sesto Fiorentino, Italy, [2] Research Institute on Terrestrial Ecosystems (IRET), National Research Council (CNR), Via Moruzzi 1, Pisa, 56124, Italy, [3] National Biodiversity Future Center (NBFC), Palermo, 90133, Italy.

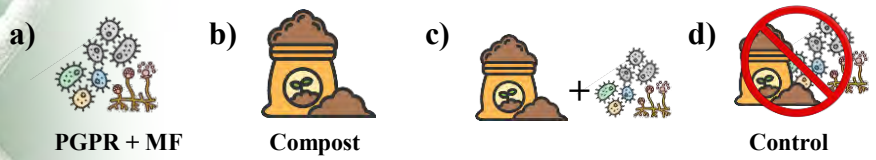
Introduction

This study focuses on enhancing soil health and crop resilience in Mediterranean agroecosystems through the combined use of microbial inoculants, biofertilizers, and sustainable farming practices, reducing the dependence on chemical fertilizers and improving soil fertility and water use efficiency.

Material and Methods

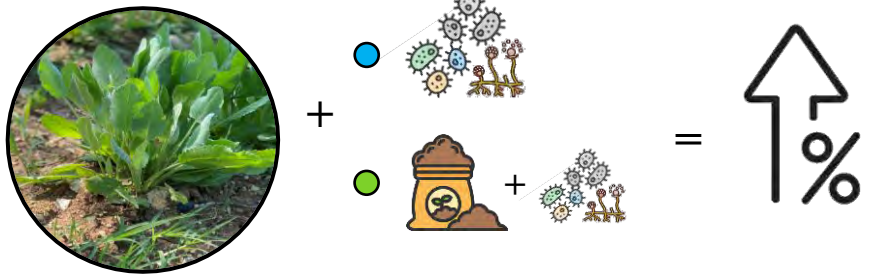
Experimental fields of a medicinal plant in **Florence** and vineyard in **Calci** (Pisa) were established.

The experimental design consisted of 12 plots each with 3 replicates. Treatments included:

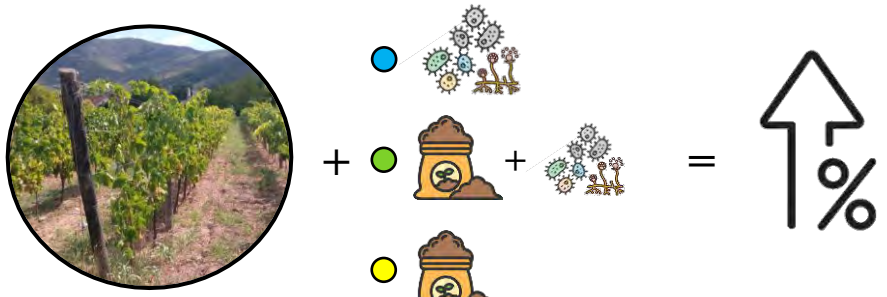


Soil and plants were collected after one year (2023) to compare various treatments and control in terms of the main soil properties and plant performances.

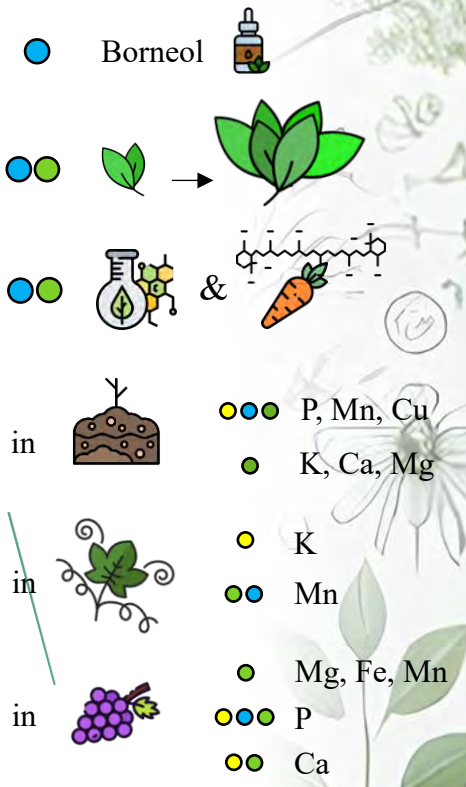
Results and Discussions



Tanacetum balsamita L.



Vitis vinifera L.



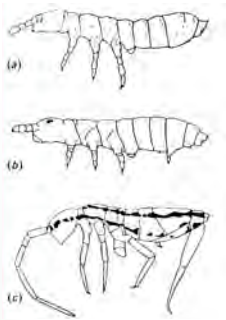
Conclusions

Results show that the inoculum had the greatest impact on Balsamita yield, while the combined treatment mainly influenced grape nutrition. Further studies are underway to clarify the mode of action and identify the most effective treatment for each species.

Martina Grattacaso

Application of the QBS-ar index as a new indicator for the NEC network in Italy

The soil microarthropods are particularly sensitive to alterations in the chemical-physical balances of edaphic environment



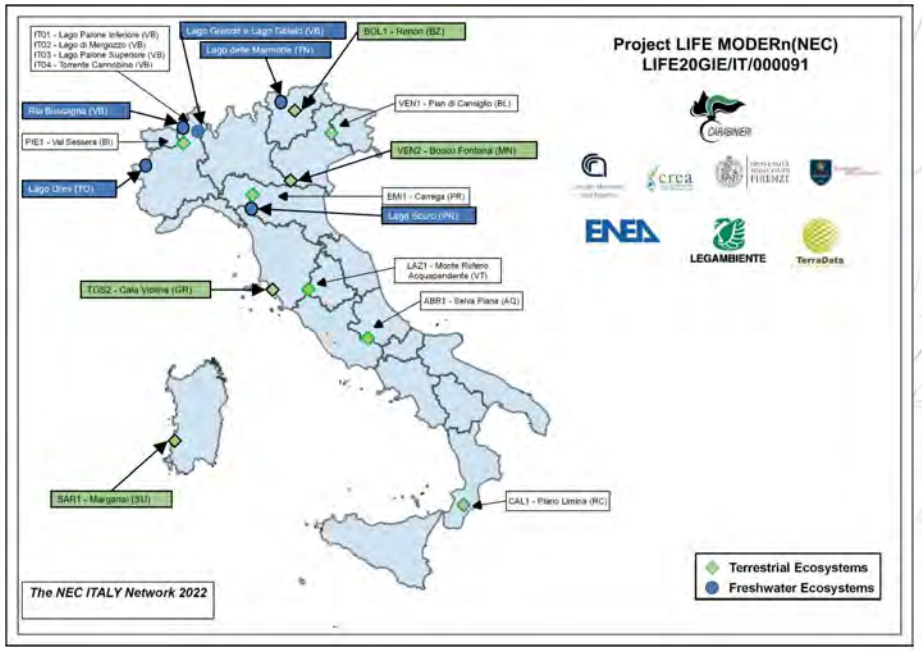
ADAPTATION

VULNERABILITY

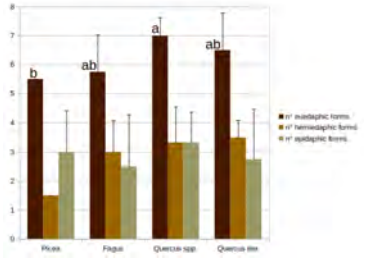
Direct human activities (agricultural or forestry activities)

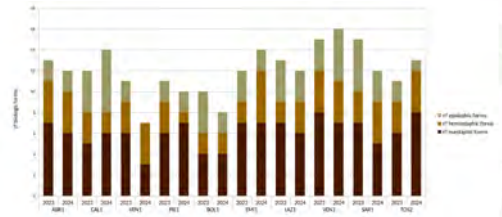
Long-term processes (changes in thermal and precipitation regime due to climate change)

The QBS-ar (Parisi et al. 2005) allows for the assessment of soil biological quality through a synthetic index that describes the characteristics of the edaphic microarthropod population in terms of biodiversity and vulnerability.



Early results: ANOVA shows significantly different numbers of euedaphic forms with respect to forest type; the lowest value for spruce forest and the highest for mixed oak forest and intermediate value for beech and holm oak forests





F. Sicuriello, L. Latilla, S. Carloni

MOSTRA D'OLTREMARE URBAN PARK AND ITS BOTANICAL HERITAGE

Barbara Bertoli, Marina Russo
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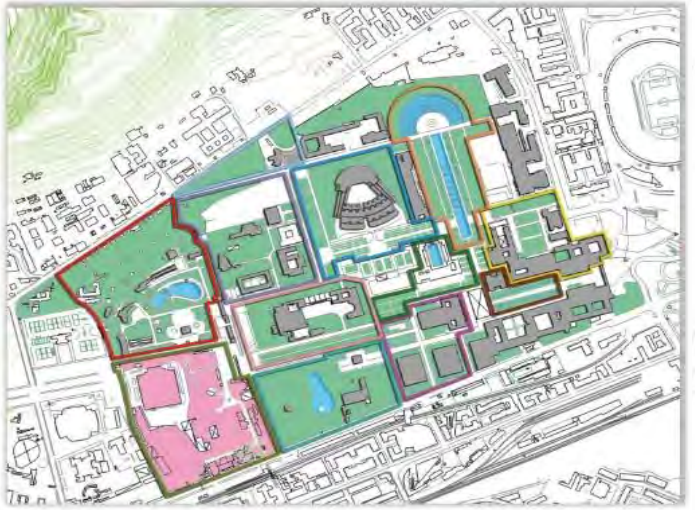
Fountain of the Esedra - frontal view

Analysis of the state of sites, urban planning and vegetation of the northern sector of Mostra d'Oltremare. (Gis application by Prof. Luigi Scarpa)

The aim of this study is to investigate and retrace the stages of the significant and progressive transformations of the botanical heritage in Naples' Mostra d'Oltremare. In 1940 the "I Mostra Triennale delle Terre Italiane d'Oltremare" was inaugurated, for the will of the fascist government. The exhibition grounds, an urbanism and architectural pride, represents today an excellent union of architecture, urbanism and biodiversity protection, and it was built according to the city plan written by architect Marcello Canino (1895 - 1970). With the Exposition, one of the most significant green interventions of the twentieth century in Naples was made. The executive design of the green spaces was entrusted to the architects L. Piccinato (1899 - 1983) and C. Cocchia (1903 - 1993). In the 600000 sq.mt. ground, which were originally allocated for the exhibition complex, more than 30000 tall trees were planted and about one million shrubs and herbaceous plants.

The main green mass was made of a varied and massive collection of palm trees which gave to the environment the mediterran tropical appearance, with several specimens of eucaliptus, acacia, pine and magnolia. The executive design of the green areas, developed by L. Piccinato and C. Cocchia, was made in order to assure that the green area could have a major connecting role for the whole architectural and urban complex. The numerous exposition pavilions resulted to be immersed in suggestive green areas filled with exotic plants and that were often imported by their original lands, and which reproposed habitat and flor of the whole overseas colonies. The conspicuous green heritage, in spite of its modifications and decay over the years, is still one of the few green resources on the urban scale of Naples' wester area. It is fundamental today to work on the knowledge, valorization and preservatio this important environmental and cultural heritage.



Mostra d'Oltremare area- 620.000mq total extension -400.000 mq green areas.

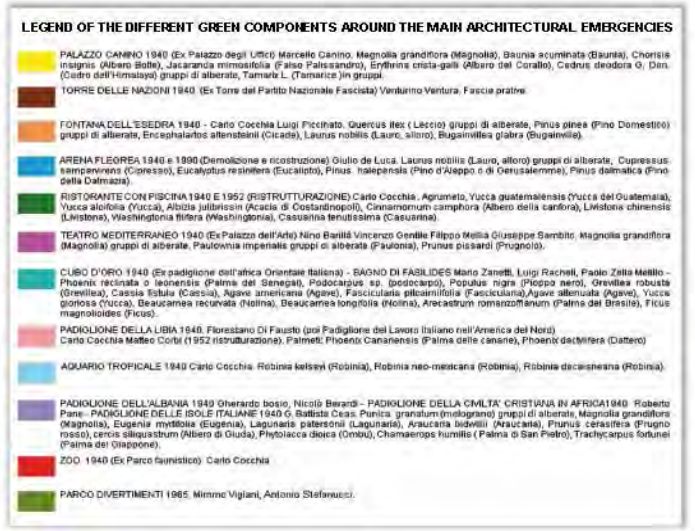


Fig. 1 - Zoo park, artificial pond.

Fig. 2 - Tree-lined avenue of Palms (1939). In "rassegna fotografica a cura di Lino Mellino."

Fig. 3 - Area of the 28 fountains. Turf in Lilium perenne punctuated by circular fountains.

Fig. 4 - Decorative detail of the Esedra fountain, ceramic mosaics by G. Macedonio, 1952.

Fig. 5 - Entrance Viale, Piazza Impero.

Fig. 6 - Fasilides' Bath.

Fig. 7 - Palm grove, in the background the Libyan Pavilion (photo 1940).

Fig. 8 - Particular ceramic mosaic, Esedra fountain.

Fig. 9 - "Mostra d'Oltremare" area, from Google Earth.

Fig. 10 - Area of "Cubo d'Oro, aerial photo.

Poster Presenter Name: Barbara Bertoli

CNR IRET Conference

Rome, February 18th-19th 2025

Meta-Genomics: Exploring Every Surface

P. Pollegioni[1,2], C. Mattioni[1,2], S. Cardoni[3], Federica d'Alò[1], Marco Ciolfi[1], Chiara Anselmi[1], Marco Lauteri[1], Olga Gavrichkova[1,2]

[1]Research Institute on Terrestrial Ecosystems, National Research Council, Porano (TR), [2]National Biodiversity Future Center, Palermo [3], Istituto di Ricerca Sulle Acque, National Research Council, Taranto

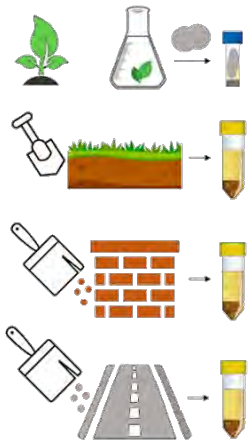
Over the last four years, the CNR-Research Institute on Terrestrial Ecosystems (IRET, Porano, Terni) has focused its attention on **biodiversity of microbial communities.**

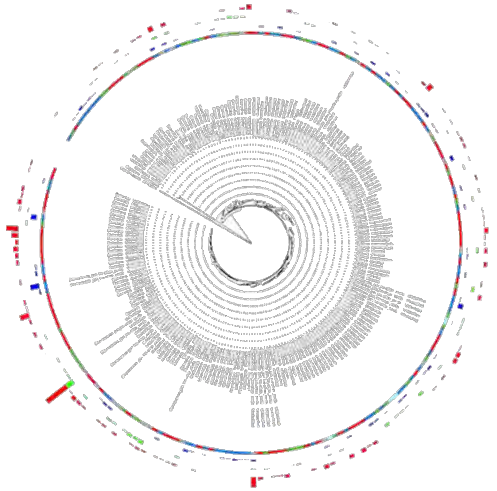
>> Assessing the biodiversity of microbial communities in relation to pollution levels in urban environments.

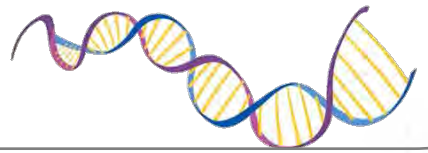
>> Shedding light on the role of soil-associated microbial communities in the plant invasion process (*Ailanthus altissima,* Mill.)

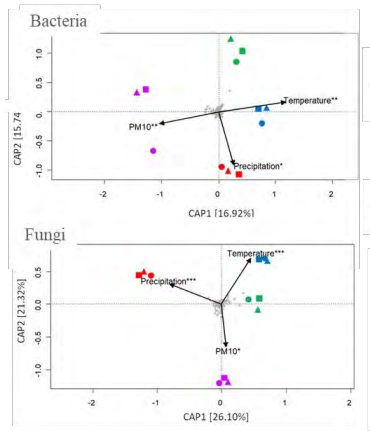
High-throughput amplicon sequencing of the bacterial 16S rRNA gene and the fungal internal transcribed spacer (ITS) regions. This approach has been applied to environmental DNA extracted from various substrates:

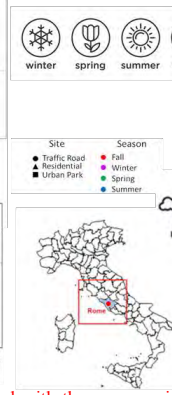
- PM10 filters (Project MicroAir, PRIN2022-BIOMASTER)
- Leaf surfaces (Project MicroAir, 3D ozone FACE)
- Soil samples (Project CNR@ UseIt)
- Wall surfaces of ancient palaces (Collaboration with Accademia Nazionale dei Lincei)
- Paved road surfaces (Project MicroAir)

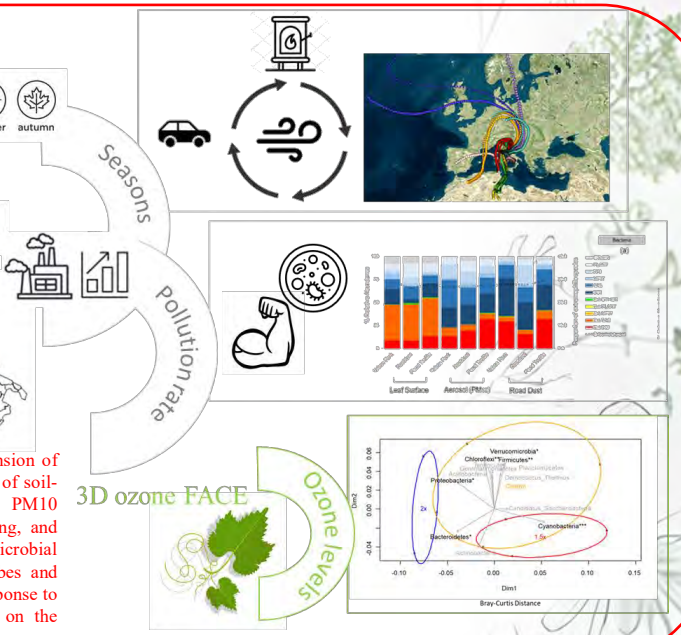






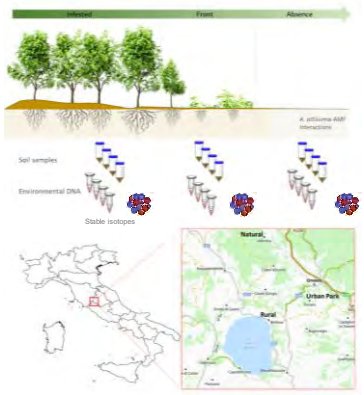


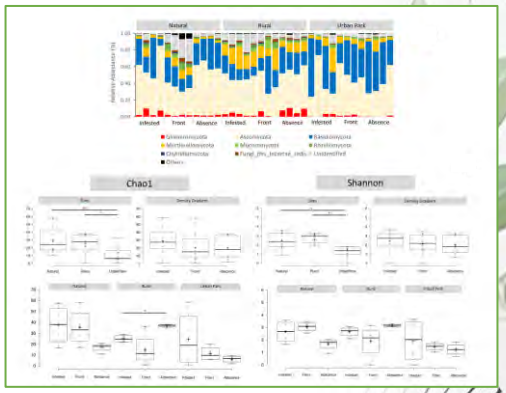




In Rome, the absence of precipitation, combined with the resuspension of dust caused by vehicular traffic, contributes to the peak abundance of soil-associated microbes during winter and summer. Elevated PM10 concentrations, influenced by climatic conditions, domestic heating, and dust advection events from the African desert, further shaped microbial communities in winter. Over the seasons, extremotolerant microbes and opportunistic pathogenic fungi showed a progressive increase in response to rising pollution levels similarly to the ozone-associated effects on the phyllosphere communities of common grape vine.

In the framework of UseIt, we combined a high-throughput amplicon sequencing of ITS regions, with stable isotopes analysis of soil samples to investigate the community compositions and structures of soil-associated fungi across *Ailanthus altissima* density gradient (Absence, Front and Infested) in three pilot experimental sites (Urban Park, Rural and Natural) of central Italy. The tree of heaven is in fact one of the worst invasive plant species in Europe and North America. We are currently investigating the putative role of symbiotic relationships between *A. altissima* and associated Arbuscular Mycorrhizae Fungi (AMF) in its Evolution of Increased Competitive Capacity (EICA).





Paola Pollegioni

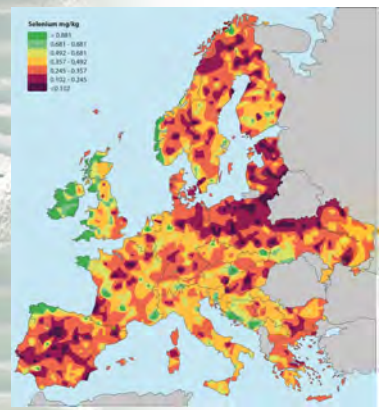
Consiglio Nazionale delle Ricerche

CNR IRET

CNR IRET Conference

Rome, February 18th-19th 2025

Selenium Nanoparticles: Improving Tomato Quality and Protecting Ecosystems



Background

- Selenium (Se) deficiency affects **one billion people**.
- Se uptake **depends on soil Se content**, with plant-based food being the main source.
- Italy and the EU have predominantly **Se-deficient** soils.
- Biofortification of fruit crops with Se is a strategy to enhance human dietary intake.
- Se intake **less than 50 µg/day** causes health problems. Se intake **above 400 µg/day** can be toxic.
- In plants, Se enhances antioxidant capacity, delays senescence, and slows fruit ripening.
- The poster summarise research from IRET on **sustainable Se biofortification** of tomato fruit.

Figure 1. Soil selenium content in Europe (Huag et. al., 2007)

Materials and Methods

Tomato cultivar	[Se] supplemented mg L^{-1}	Se chemical form	Se supplementation method	Se in enriched edible part (mg/kg DW)	% of Recommended Dietary Allowance provided by 100 g serving size	Reference
Red bunch	0 and 1	sodium selenate	added to nutrient solution	11.46	105	Pezzarossa et al [4]
Red bunch	0, 1 and 1.5	sodium selenate	added to nutrient solution	0.94 – 3.54	43	Puccinelli et al [3]
Micro tom	0, 5 and 10	chemical SeNPs	sprayed on plants	0.68	11	Shiriaev et al [2]
Micro tom	0, 5 and 10	sodium selenate	sprayed on plants	1.22	24	Shiriaev et al [2]

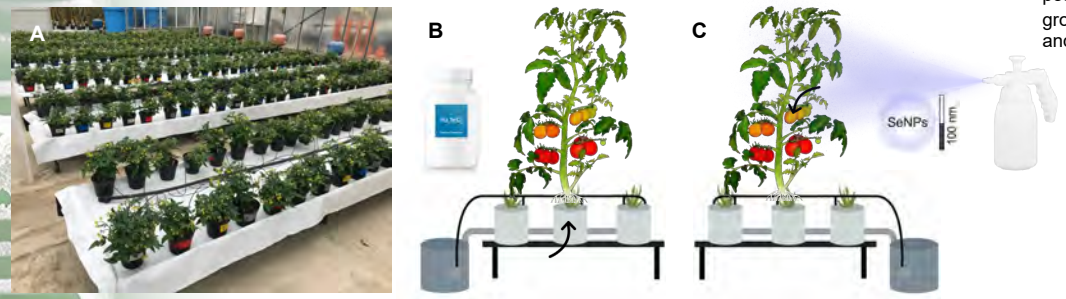


Figure 2. Experimental set-up (A), Se biofortification strategies scheme: foliar spraying (B) and substrate supplementation (C).

Results

Se accumulation [2]

- Se was accumulated primarily by vegetative parts (Fig. 3), over the time it has been transported to fruit.

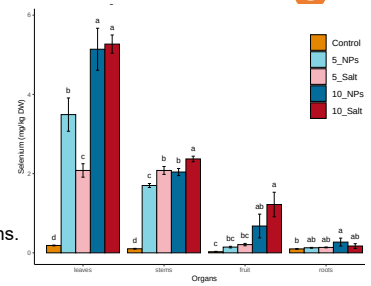


Figure 3. Se distribution in tomato organs.

CV Red bunch [3, 4]

- Se **postponed the ethylene climacteric peak** for 2 days (Fig. 4), reduced respiration rate and weight loss.
- Se delayed color change due to **postponed lycopene and b-carotene** synthesis and chlorophylls degradation.
- Se reduced color change rate and **ethylene rate** in red ripe fruit throughout the postharvest (Fig. 5).

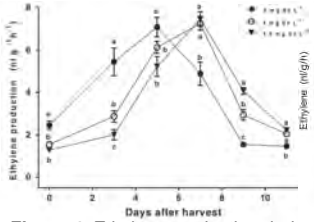


Figure 4. Ethylene production during post-harvest ripening in tomato fruit grown in nutrient solution with 0, 1 and 1.5 mg Se L^{-1}.

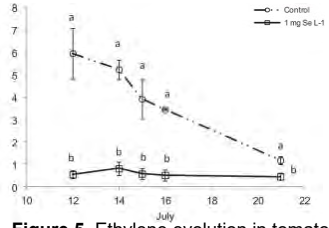


Figure 5. Ethylene evolution in tomato fruit treated with 1 mg Se L^{-1} detached at red stage and kept at 22 °C for 9 days.

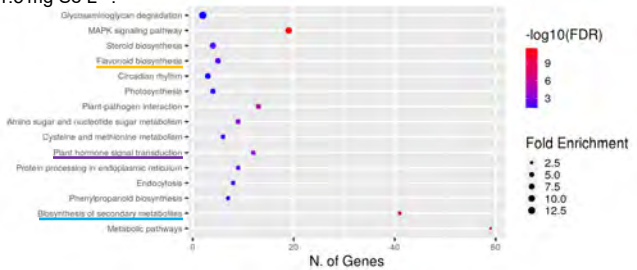


Figure 6. KEGG pathway enrichment analysis of DEGs in Se-enriched tomato fruit. Increasing the bubble size indicates an increasing enrichment score. Bubble colors from blue to red indicate an increasing false discovery rate (FDR).

CV Micro tom [2]

- RNA-seq showed that Se impacted expression of genes involved in **hormonal signaling**, **secondary metabolism**, **flavonoid biosynthesis**, glycosaminoglycan degradation (Fig. 6).
- Se **alternated biosynthesis** of **carotenoids and VOCs**, and **increased antioxidant polyphenols** (Fig. 7).

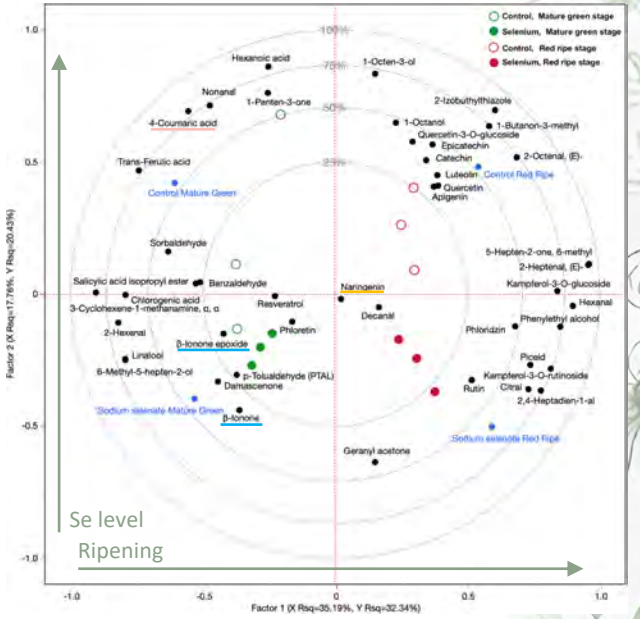


Figure 7. Partial least square discriminant analysis (PLS-DA). The model has been created using the identified VOCs and polyphenols as predictor variables, a factor combining ripening stage and Se concentration in tomato fruit as a response variable.

Conclusions

- Se biofortification allowed to **improve the nutritional value** of tomato.
- Application of NPs allowed to produce tomato fruit capable to safely fulfil or supplement RDA.
- Se **suppressed ethylene** biosynthesis or postponed appearance of the climacteric peak, positively **changed metabolome**, which indicate an improvement of the **shelf-life**, consumer-liking and **post-harvest** quality.

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1. Haug A, Graham R, Christophersen O, Lyons. 2008. How to use the world's scarce selenium resources efficiently to increase the selenium concentration in food. Microb. Ecol. Health Dis. 19. 209-228.
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4. Pezzarossa B, Rosellini I, Borghesi E, Tonutti P, Malorgio F. 2014. Effects of Se-enrichment on yield, fruit composition and ripening of tomato (*Solanum lycopersicum*) plants grown in hydroponics. Sci. Hortic. 165, 106–110.

Dr. Anton Shiriaev, PhD

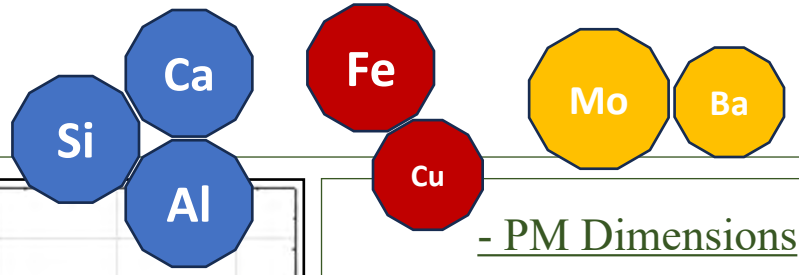
Co-Authors: Irene Rosellini, Beatrice Pezzarossa

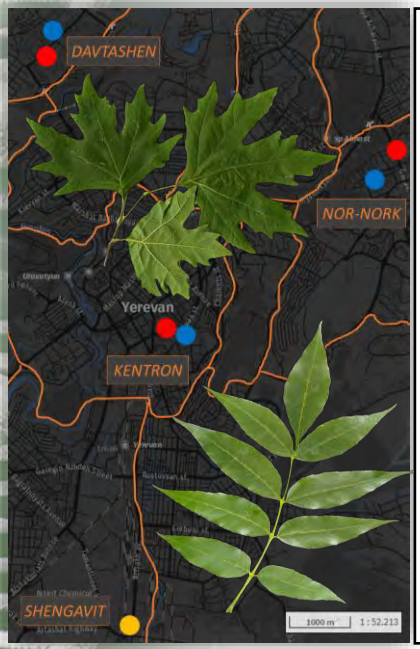
Elemental profiling of **PM10** in **Yerevan**: *F. excelsior* and *P. orientalis* leaves as bioindicators

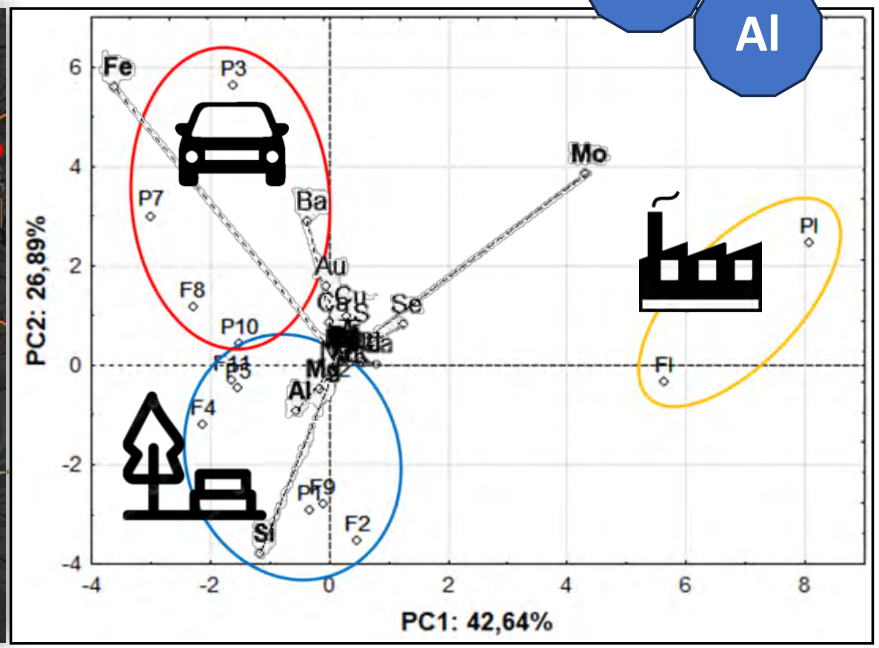
- *Fraxinus* and *Platanus* leaves sampling
- 4 districts, 3 micro-environments
- **Park** / **Street** / **Industrial**
- PM characterization→SEM/EDX
- PM Density, Composition, Dimensions

RESULTS and EVIDENCES

- PM Density: not significant differences
- PM Composition: **Significant differences**

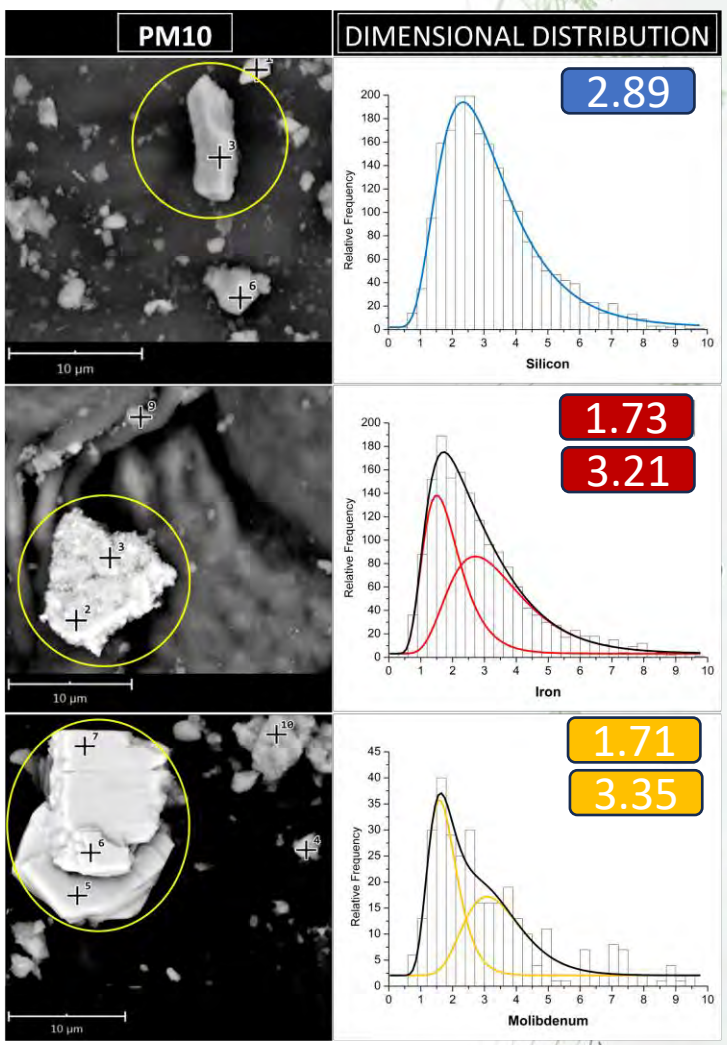






- PM Dimensions:

Significant relationship Composition/Dimension, Dimensional distribution and source: **Mode Peaks** for **Background**, **Street** and **Industrial**



G. Sgrigna, C. Calfapietra, L.Khachatryan

Predicting Ecosystem Functional Properties at ICOS sites with hyperspectral PRISMA data using machine learning: a comparison between random forest and extreme gradient boosting

L. Nardella [1], A. Sebastiani [2], A. Montaghi [3], D. Papale [2], G. Vaglio Laurin [2]

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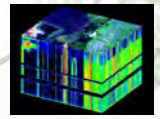
Background

Ecosystem Functional Properties (EFPs) characterize key ecosystem processes (e.g. photosynthesis, respiration, nutrient or water cycles), and help monitor ecosystem response to biotic and abiotic factors, including climate change. EFPs are derived from Eddy Covariance (EC) fluxes of carbon, water and energy, collected in EU by the **ICOS network** at footprint (local) scale.

Innovative hyperspectral satellite remote sensing data (**PRISMA**) and derived **Vegetation Indices** (VIs), collect vegetation spectral response/health status in hundreds of fine bands, and can support the upscaling of EFPs over large regions.



Objectives

1. Test the capacity of PRISMA VIs to predict EFPs in different ecosystems/plant functional types (PFT);
2. Compare the results obtained from two different Machine Learning modelling approaches: **Random Forest** (RF) and **eXtreme Gradient Boosting** (XGB).

Methods

ICOS: 15 sites in 5 EU countries, 5 PFTs

EFPs elaborated by ICOS:

- **GPP** = Gross Primary Productivity
- **NEE** = Net Ecosystem Exchange

EFPs computed here:

- **LUE** = Light Use Efficiency: **GPP / SW_{IN}** (ShW. in. rad.)
- **WUE** = Water Use Efficiency: **GPP / LE** (latent heat)
- **BW** = Bowen Ratio: **H** (sensible heat)**/ LE**

Extraction of 29 PRISMA VIs over homogeneous areas

- Min **70%** for pixel inclusion
- **Area-based statistics** (NDVI-based homogeneity)

Modelling

1. **Default parameters:**
   > **RF** (*randomForest* R)
   > **XGB** (*XGB* Python)
2. **Hyperparameter tuning:**
   > **RF** (*caret* R)
   > **XGB** (*optuna* Python)
3. **Feature Selection (VSURF R)**
   - Hyperp. tuning and Cross Validation **RF** (*caret* R)
   - Hyperp. tuning and Cross Validation **XGB** (*optuna* + *DART* Python)

Results

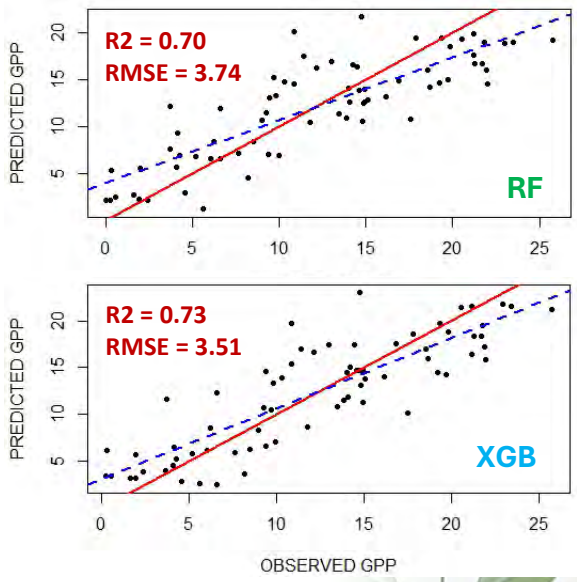
TUNING (post Feature Selection)

Model	HyperPar.	GPP	NEE	LUE	WUE	BW
RF	ntree	500	500	500	500	500
	nodesize	8	10	10	3	4
	mtry	2	3	2	1	2
XGB	eta	0.767	0.998	0.591	0.998	0.357
	lambda	1.87E-05	4.91E-08	0.334	6.37E-04	0.153
	alpha	0.0232	7.28E-07	2.13E-08	4.46E-05	2.34E-05
	gamma	2.11E-06	2.50E-03	1.57E-05	1.84E-08	3.20E-03
	max_depth	7	7	11	7	8
	max_leaves	320	60	870	990	210
	max_bin	448	448	576	512	704
	grow_policy	depthwise	depthwise	depthwise	lossguide	depthwise
	min_child_weight	14	13	7	15	8
	max_delta_step	6	6	7	6	5
	subsample	1	0.9	0.5	0.5	1
	colsample_bylevel	1	0.7	0.7	0.7	0
	colsample_bytree	0.9	0.5	0.9	0.8	0.9
	rate_drop	0.070	0.357	0.191	0.909	0.023
	n. estimators	1040	1420	1340	900	970

EFP	Selected VIs
GPP	VOG, RENDVI, IRECI, OSAVI, Simple_Ratio, NIRv, CAI **(7)**
NEE	VOG, IRECI, OSAVI, CAI **(4)**
LUE	VOG, IRECI, CAI **(3)**
WUE	VIgreen_Index, VARI **(2)**
BW	EVI, NIRv, NDLI, MCARI, SATVI, CRI, ARVI **(7)**

EFP	Metric	RF	XGB
GPP	R2	0.70	**0.73**
	RMSE	3.74	**3.51**
NEE	R2	0.58	**0.58**
	RMSE	3.54	**3.49**
LUE	R2	0.58	**0.61**
	RMSE	0.01	**0.01**
WUE	R2	-0.33	**-0.02**
	RMSE	0.06	**0.05**
BW	R2	**0.34**	0.32
	RMSE	**1.66**	1.69

MODEL PERFORMANCE: GPP



Conclusion

Results show that PRISMA VIs can predict with good accuracy GPP, NEE and LUE in EU independently on the natural ecosystems considered (wetlands, grasslands, or forests). Further studies exploiting other VIs are ongoing, to assess the lower accuracy obtained by WUE. VOG, IRECI, NIRv resulted frequently selected, highlighting which spectral regions mostly contributed to accurate models. Hyperparameter tuning improved performances for both RF and XGB models in all cases. Extreme gradient boosting provides a more sofisticated tuning framework which improves model perfomances in most cases.

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FlorTree model: optimal tree species selection considering air pollution removal capacity in urban ecosystems

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CNR IRET Conference
Rome, February 18th-19th 2025

FlorTree model

Tree selection is a crucial step for proper urban planning:

Development of a species-specific model for the removal of the main air pollutants

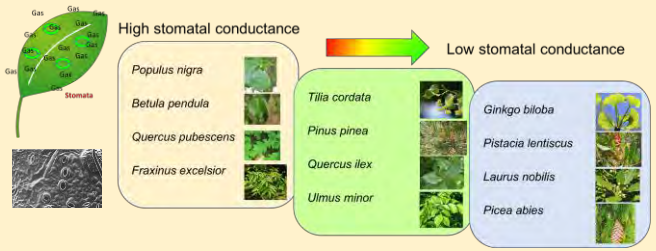
New empirical model for tree species selection for urban greening considering air quality

Species	gmax	First author	Year	Journal
Abies_alba	0.230	Giucherd	1994	Ann_For_Sci
Acacia_xanthophloea	0.350	Otieno	2005	J_Arid_Environ
Acer_campestre	0.150	Elias	1979	Biol_Plant
Acer_japonicum	0.230	Nabeshima	2008	Ecol_Res
Acer_pseudoplatanus	0.340	Morecroft	2002	Funct_Ecol
Acer_rubrum	0.100	Jurik	1986	Am_J_Bot
Acer_rubrum	0.160	Wilson	2000	Tree_Physiol
Acer_saccharum	0.288	Dawson	2007	Tree_Physiol
Acer_saccharum	0.145	Federer	1976	Ecology
Acer_saccharum	0.160	Tjoelker	1995	PCE
Arbutus_unedo	0.185	Castell	1994	Oecologia

For 220 species (trees and shrubs) commonly used in Tuscany region

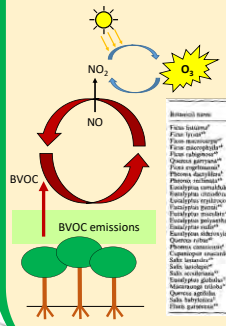
Parameters were obtained by **the survey with more than 300 literatures**

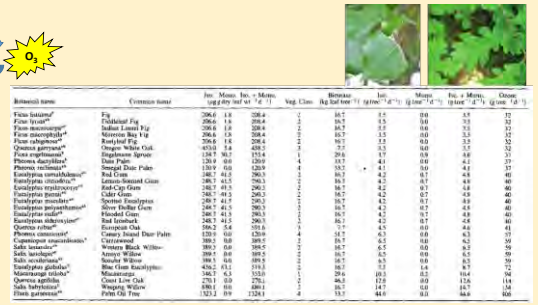
- Gas pollutant removal



Stomatal conductance (index for stomatal aperture) is an essential parameter to calculate gas pollution uptake to tree leaves.

- BVOC emissions for O_3 formation



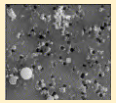


Benjamin & Winer (1998, Atmos Environ)

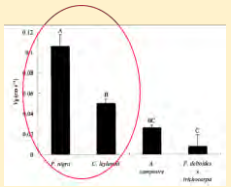
BVOC emission (isoprene & Monoterpene) may contribute to the formation of O_3.

Species-specific parameter POF (potential ozone formation) was used to assess the negative impacts on air quality.

- Particulate matter (PM10)



Cedrus libani *Cupressus sempervirens*



Beckett et al. (2000, GCB)

Conifers are more efficient to catch PM compared to broadleaf trees thanks to the **greater leaf surface and crown structural complexity**.

According to the literature data, we developed an emipirical equation using STAR (Shoot silhouette to total leaf area ratio) and PT (Phyllotaxis) to estimate the species-specific PM removal capacity.

- Best species for air quality for Florence

Species	Net O_3	NO_2	PM_{10}	CO_2	Score
Tilia platyphyllos	3	3	3	3	12
Tilia x europaea	3	3	3	3	12
Tilia cordata	3	3	3	3	12
Acer negundo*	3	3	3	3	12
Acer platanoides	3	3	3	3	12
Acer pseudoplatanus	3	3	3	3	12
Quercus cerris	3	3	3	3	12
Quercus palustris	3	3	3	3	12
Fraxinus excelsior	3	3	2	3	11
Fraxinus angustifolia	3	3	2	3	11
Fraxinus uhdei	3	3	2	3	11

Tilia platyphyllos

Net O_3	NO_2	CO_2
23.4	17.6	0.069

g/tree/day

Fraxinus excelsior

Net O_3	NO_2	CO_2
26.1	19.5	0.049

g/tree/day

Cedrus libani

PM_{10}
9.6

g/tree/day

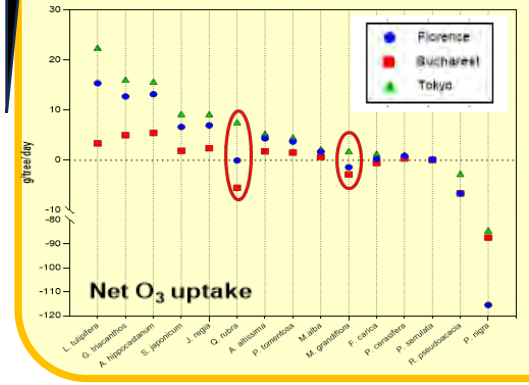
Species with high g_s and low VOC emission are recommended for gas pollution removal. Large conifers have shown a good performance for PM removal.

On the other hand…

Genus	Species	O_3 removal	OFP	Net O_3 (g/tree/day)
Liquidambar	styraciflua	8.08	63.58	-55.50
Quercus	petraea	18.41	85.89	-67.49
Quercus	suber	11.11	79.14	-68.03
Quercus	ilex	19.02	103.53	-84.51
Populus	nigra	10.27	125.73	-115.46
Eucalyptus	glaucescens	3.89	128.51	-124.62
Quercus	robur	13.79	138.58	-124.79
Quercus	frainetto	5.13	184.37	-179.24
Quercus	coccinea	9.31	243.10	-233.79
Eucalyptus	globulus	17.43	428.93	-411.49

BVOC emitted plants (*Quercus*, *Populus* sp.) are not suitable due to the potential formation of O_3.

- Is species-specific removal performance affected by different climate and air pollution conditions?



· Different climate and pollution conditions led to a partial change in the air pollutants removal by trees.

· *Quercus rubra* and *Magnolia grandiflora* showed **negative net O_3 uptake in the European cities but the O_3 balance was positive in Tokyo**.

Yasutomo Hoshika (IRET-CNR Firenze)

The BRISMIC project: Interactions among landform, soil, vegetation, and microbiome during initial colonization stages in High Arctic patterned grounds

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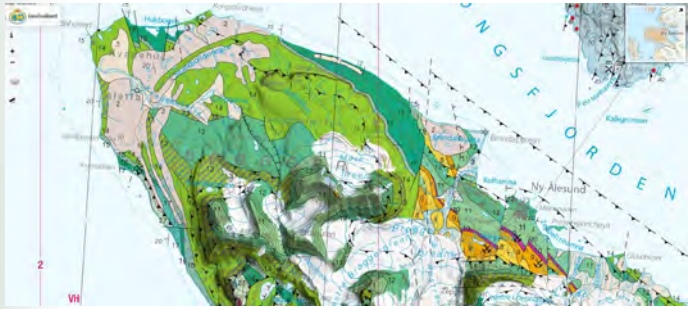
[1]IRET-CNR, Research Institute on Terrestrial Ecosystems, National Research Council, via Madonna del Piano 10, 50019 Sesto Fiorentino, [2]NBFC, National Biodiversity Future Center, Palermo

Brøggerhalvøya



Patterned grounds like sorted circles, frost boils and polygons are widely diffused in the High Arctic, where they are connected to the presence of permafrost. Their structure, development, and pedology have been thoroughly studied, while associated colonizing plants and microbiota are far less characterized, and their distribution in relationship to the developmental stages of the landforms not well known.

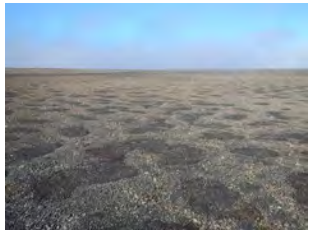
The BRISMIC project addresses these research needs by evaluating how plants and soil microbiota affect the properties of patterned ground soil and the development of permafrost-driven morphologies in two High Arctic ecosystems along a N-S gradient using latitude and exposure to the North-Atlantic Current as a proxy for climate/temperature change.

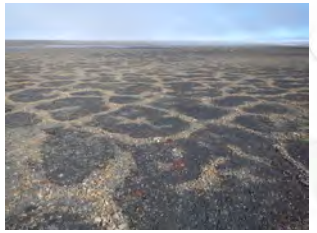
To reach this goal, the sites at Brøggerhalvøya in Svalbard (78° 58' N, 11° 30 E) and Villum in Greenland (81º 36' N, 16º 39' W), have been selected.

Villum

At Brøggerhalvøya, on the southern coast of Kongsfjorden, we characterized patterned ground systems with different degrees of plant and biocrust colonization: slightly, moderately and highly colonized. We went along the coastal plan of the Brøggerhalvøya and up to the Kongsfjordneset and to the westernmost point of the peninsula, the Kvadehuken to target 1) plant species; 2) soil morphology; 3) soil physical properties (bulk density and structure); 4) soil organic matter content and its pools; 5) microbial community structure and activity in bulk and rhizosphere soil.

We will replicate the study at Villum, where the patterned system is less diverse. Then, we will complete the large surveying and sampling at Brøggerhalvøya.





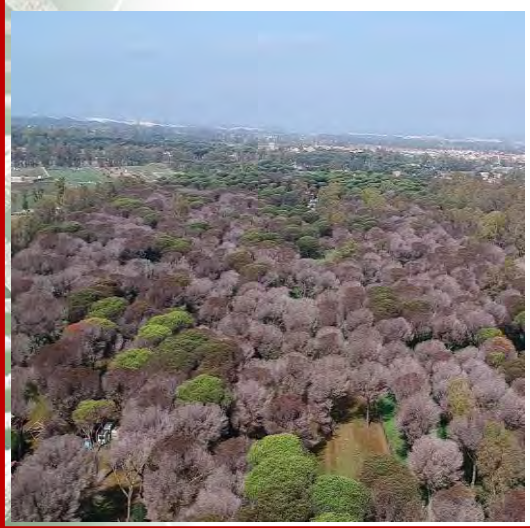
After completing field activities, linking soil physical, chemical and biochemical properties and functioning to the presence and activities of microbiota and plants in the two targeted sites will allow to identify the potential drivers of the early stages of colonization and soil development of patterned grounds in the High Arctic, where cyclic burial and exhumation of material is believed to play an important role in the soil carbon cycle.

Finanziato dall'Unione europea NextGenerationEU
Ministero dell'Università e della Ricerca
Italiadomani PIANO NAZIONALE DI RIPRESA E RESILIENZA
NATIONAL BIODIVERSITY FUTURE CENTER

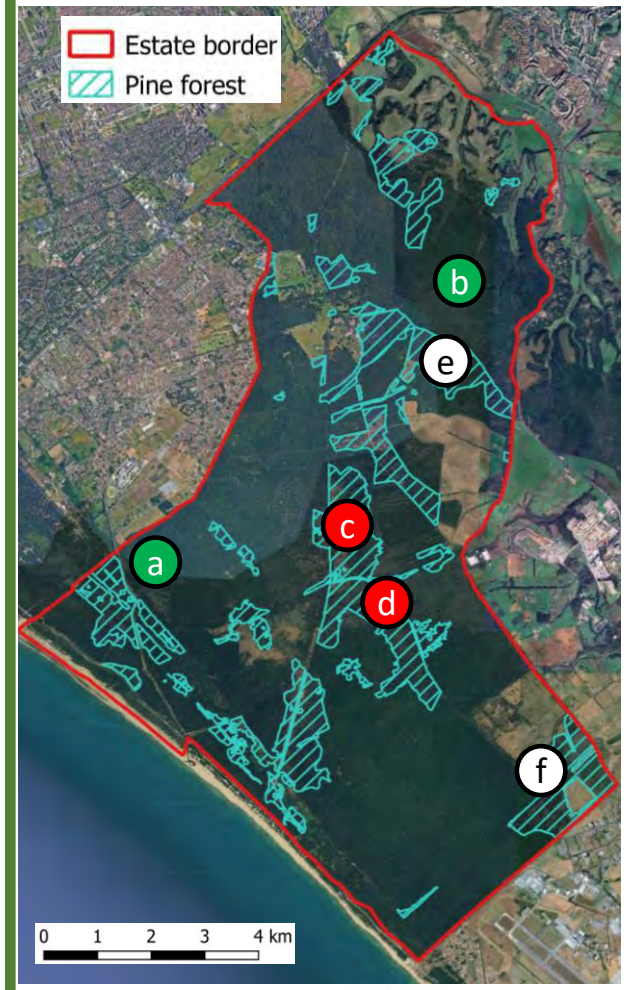
Holistic assessment of ecosystem restoration strategies after a natural disaster

The Disaster

The *Pinus pinea L.* dieback



The Restauration



a Reference ICOS
evergreen oak forest

b Reference
deciduous oak forest

c Reforestation
Biodiversity island

d Natural evolution
No grazing

f Reforestation
20 yrs-old oak under pine

e Dead Pine forest
Just harvested

The Assestment

Fluxes: *Carbon, Water, Energy*
Biodiversity: *plants,lepidotera, reptiles, mammals*

Gabriele Guidolotti

Revitalizing urban landscapes by desealing: the REUSES project for soil restoration and sustainable community development

S. Di Lonardo[1,2], N. Pampuro[3], G. Giacomello[1,3], A. Salvucci[4], D. Serrani[4], L.P. D'Acqui[1], S. Cocco[4], V. Cardelli[4]

[1]Research Institute on Terrestrial Ecosystems (IRET), National Research Council of Italy (CNR), Via Madonna del Piano 10, 50019 Sesto Fiorentino, Italy; [2]National Biodiversity Future Center (NBFC), Piazza Marina 61, 90133 Palermo, Italy; [3]Institute of Sciences and Technologies for Sustainable Energy and Mobility (STEMS), National Research Council of Italy (CNR),Strada delle Cacce 73, 10135 Torino, Italy; [4]Department of Agricultural, Food and Environmental Sciences, Polytechnic University of Marche (UNIVPM), Via Brecce Bianche 10, 60131 Ancona, Italy

Manipulation experiments in Alpine ecosystems: Exploring climate change impacts and carbon dynamics

F. D'Alò, O. Gavrichkova, C. Volterrani, L. Latilla, M. Sarti, A. Milcu, S. Devidal, E. Brugnoli, L.M. Borruso, L. Montagnani, A. Augusti

MICROPLANTALP

MICROorganism-**PLANT** Interactions in the Forefield of Glaciers: a Hotspot for Studying the Impact of Climate Change in **ALP**ine Habitats

Site: Courmayeur, Val Veny-Italy

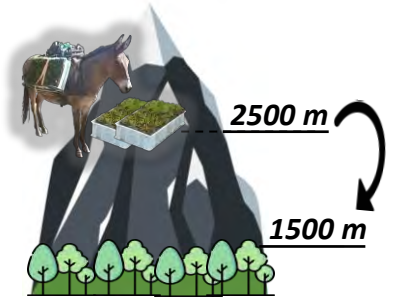
BACKGROUND

Alpine areas are warming faster than the global average, making them highly sensitive to climate change and potentially significant CO_2 sources. Climate change is expected to disrupt the balance between carbon assimilation, storage in vegetation and soils, and release through respiration.

OBJECTIVES

Analyze the state of alpine ecosystem under future climate conditions, by integrating the study of carbon fluxes, plants, and soil microorganisms with climate manipulation experiments.

TRANSPLANTATION EXPERIMENT

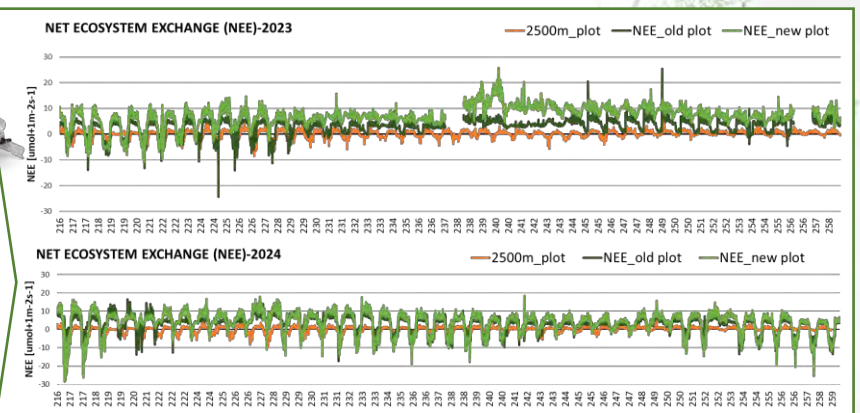


1° transplantation OLD PLOT — *2° transplantation* NEW PLOT

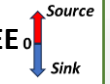
2022 — 2023 — 2024

Installation continuous C-fluxes chambers LI 8100

- Unraveling changes in the carbon balance (NEE) and its components (R_{eco}, GPP) in an alpine grassland subjected to climate manipulation.
- Assessment of the responses of carbon fluxes under different acclimation stages.



In 2023 both transplanted plots acted as carbon sources, with the new plots emitting more C. By 2024, the differences diminished, and the emissions declined, likely due to increased photosynthetic rates and reduced carbon loss through respiration, characteristic of the recovery phase following disturbance.



Warming reduced carbon uptake immediately after disturbance, with partial recovery after one year, but not to pre-disturbance levels

MICROCOSM EXPERIMENT

Montpellier European Ecotron (CNRS, France)

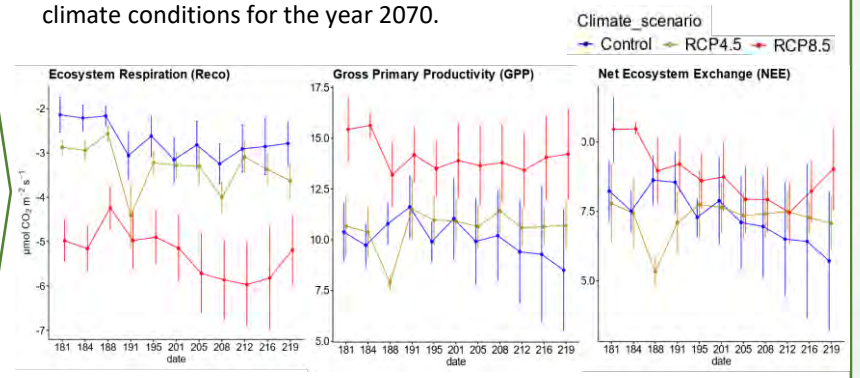
Three climate scenarios projected for 2070 in the IPCC 2022:

- **Control** (420 ppm CO_2)
- **RCP 4.5** (550 ppm CO_2)
- **RCP 8.5** (800 ppm CO_2)

- Temperature
- Precipitation
- Relative Humidity
- Radiation
- [CO_2]

- ✓ CO_2 flux measurement (IRGA - EGM5, PP-System)
- ✓ Vegetation cover assessment
- ✓ Microbiological sampling
- ✓ ^{13}C pulse labeling-chasing experiment

- Analyze the projected dynamics of soil-plant carbon fluxes under future climate conditions for the year 2070.



Under RCP 8.5, elevated CO_2, and temperatures stimulated canopy growth, preserving carbon sink functions despite higher respiration

Alpine ecosystems demonstrate short-term adaptability to warming conditions, but their long-term ability to sequester carbon is uncertain, highlighting the need for both field and experimental studies to understand future climate impacts.

Federica D'Alò

The KasTrack project: chestnut biodiversity and distribution in Campania

M.M. Calandrelli[1], L. De Masi[2]

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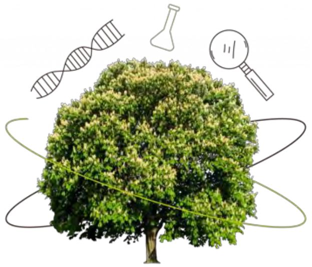
[2]CNR - Institute of Biosciences and Bioresources, Via Università, 133 - 80055 Portici (NA), Italy

Email: marinamaura.calandrelli@cnr.it

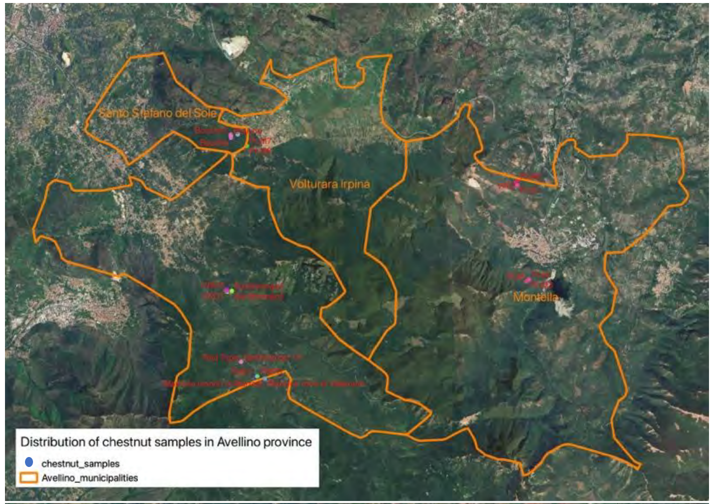
BACKGROUND AND AIMS

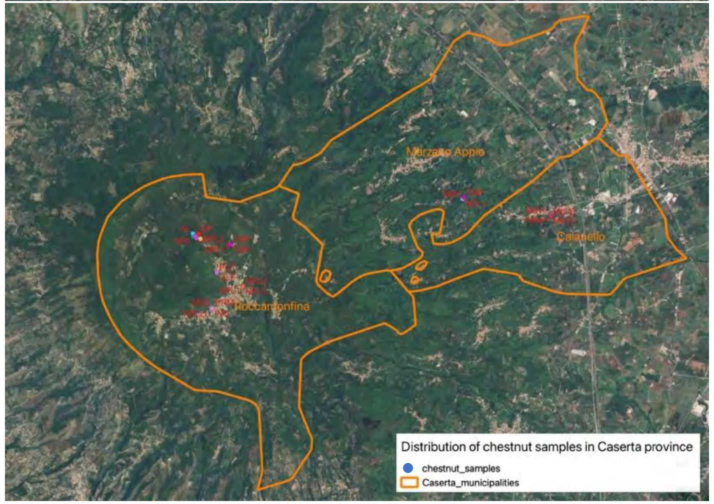
Varietal recognition is a key factor for rational management of sweet chestnut horchards (*Castanea sativa* Mill.). Since the morphological characteristics have some limitations and can be misleading, the main goal of technology transfer project KasTrack is to provide chestnut growers with an innovative system for genetic identification. After creating a genetic-spatial mapping, suitable protocols and bioinformatics tools will be released to the control laboratories interested in providing the service of varietal identification.



ACTIVITY AND EXPECTED RESULTS

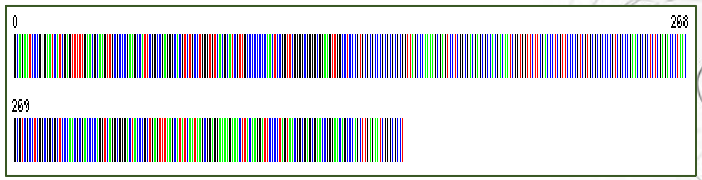
- Genetic-spatial mapping
- Fingerprints database
- Control laboratories with implemented service
- Ex situ collection of genetic standards
- Dissemination to stakeholders





PROJECT IMPACT

- Nursery Sector Development
- Varietal Heritage Conservation
- Product Traceability
- Varietal Diversification



CONCLUSIONS AND PERSPECTIVES

The KasTrack project will make the genotyping service accessible to potential users and will create a portal where information on the most widespread chestnut cultivars can be quickly found.

https://kastrack.crea.gov.it

Marina Maura Calandrelli

FOSTERING THE KNOWLEDGE UPTAKE ON NBS: a review of digital tools and platforms

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[1]National Research Council, Research Institute on Terrestrial Ecosystems, Viale Guglielmo Marconi 2, 05010 Porano,
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INTRODUCTION:

Nature-based Solutions (NbS) address environmental challenges while providing co-benefits for society and biodiversity. However, their successful adoption and implementation require accessible, digital, and interactive resources to guide stakeholders through the planning, implementation, and monitoring phases. Over the last decade, the European Community's effort in funding NbS research and implementation projects has been very significant. Nevertheless, information on NbS remains fragmented, dispersed across multiple platforms, and the lack of standardization and consistent monitoring protocols for measuring NbS effectiveness, continues to impede the interaction among disciplines and the widespread adoption of NbS across diverse ecosystems.

OBJECTIVES:

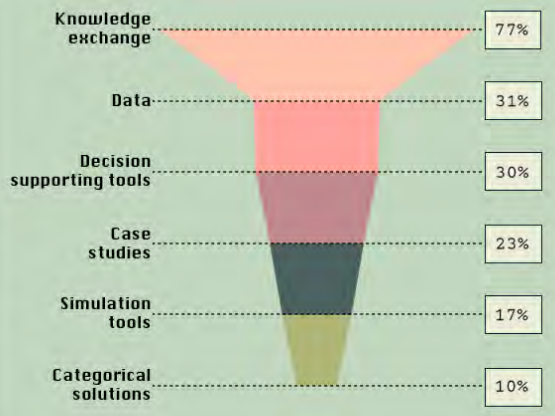
1) providing an overview of NbS platforms, tools and repositories, showing their crucial role,
2) identifying the barriers and gaps that hinder their effective use for NbS uptake, for example the lack of monitoring- and business-oriented platforms;
3) guidance and suggestions to upload and update NbS case studies into relevant repositories, according to the project outputs and the societal challenges addressed.

RESOURCES from this study

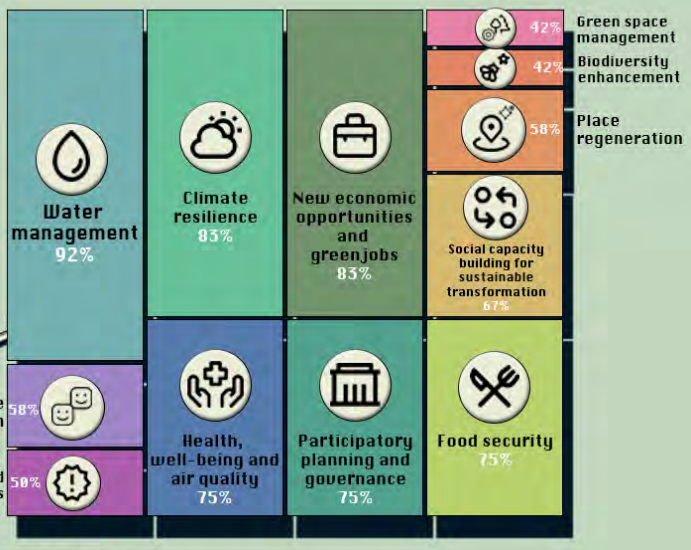
Guiding Flowchart

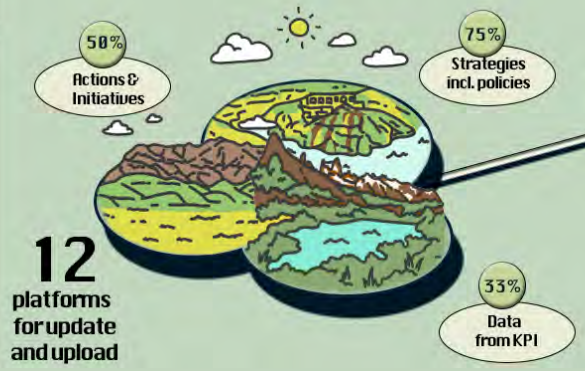
115 platforms and tools

77% KNOWLEDGE EXCHANGE
30% DECISION SUPPORTING TOOLS
17% SIMULATION TOOLS
31% DATA
23% CASE STUDIES
10% CATEGORICAL SOLUTIONS



27 case study platforms





12 platforms for update and upload

CONCLUSIONS

The platforms screening highlighted a vast range of available and accessible resources. Nevertheless, the information conveyed in such platforms is still unbalanced. This highlights the need for platforms to store monitoring data, and to standardise the indicators used to evaluate the NbS performances (12 societal challenges).

On the one hand, there is a wide range of technical and governance tools available for planning effective NbS; on the other hand, we recognise the clear necessity for tangible actions and implementations to obtain available, reliable, and ready-to-use empirical data. Data availability is a prerequisite for upscaling and mainstreaming NbS. Nonetheless, there is the need to create synergies among the different repositories (e.g., developing a common database across different platforms), so to reduce the knowledge fragmentation.

Valentina Verduchi

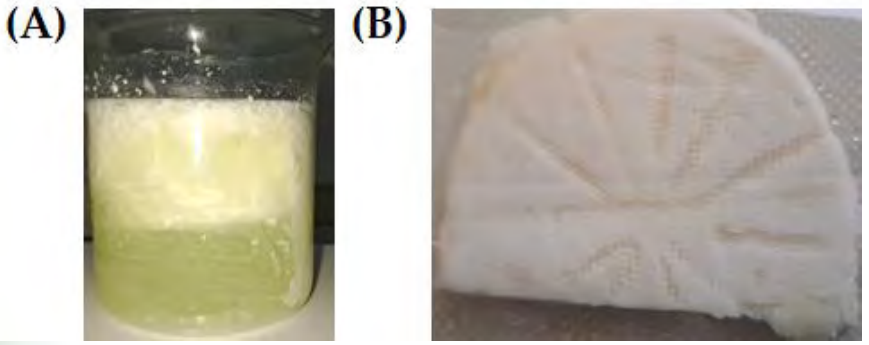
New vegetables rennet development for vegetarian cheeses production

Emilia Caputo[1], Luigi Mandrich[2]

[1]Institute of Genetics and Biophysics, (IGB)-CNR, Via Pietro Castellino 111, 80131 Naples, Italy; [2]IRET-CNR, Via Pietro Castellino 111, 80131 Naples, Italy;

Cheese making is an ancient practice to preserve perishable food such as milk for a long time. The first phase of cheese making involves the addition of animal-derived rennet, containing the enzymes necessary for the hydrolysis and coagulation of milk caseins, and for cheese ripening (mainly lipase/esterase).

The proposed technology concerns the production of cheeses, by using rennet from vegetables sources, i.e. replacing the enzymes involved in milk caseins coagulation and cheeses ripening, with enzymes of vegetable origin. In this way, vegetarian cheeses are obtained. Various vegetables have been selected and tested for this purpose, in particular: cardoon (*Cynara cardunculus*), artichoke (*Cynara cardunculus* var. *scolymus*), papaya (*Carica papaya* L.), pineapple (*Ananas comosus* (L.) Merr.), mushrooms (*Pleurotus ostreatus* (Jacq. ex Fr.) P. Kumm.) and fig milky sap (*Ficus carica* L.).



Mini-curd making. A) Milk clotting; B) Final product.

	calf rennet	internal bracts artichoke	cardoon	pineapple	papaya	fig milky sap	oyster mushroom
pH	5.5	5.8	5.5	6.2	5.3	5.0	5.5
esterase activity (U/mL)	0.017±0.001	0.010±0.001	0.008±0.001	0.013±0.002	0.004±0.001	0.012±0.001	0.016±0.002
protease activity§ (% BSA digested)	46±4	>99	>99	28±5	18±4	51±4	98±2
MCA (SU◊)	8000	800	667	1067	593	8000	640
c.p.* yield from 500 mL milk (g)	72±5	68±3	70±4	57±3	67±4	69±3	51±4

Mini-curd analysis. Main characteristics of the vegetable and fruit rennet.
MCA=Milk Clotting Activity; *c.p.= cheese curd; § the incubation time was 10 min; ◊SU=Standard Unit

In all cases, cheeses were obtained, and as observed by the analysis of some profiles of volatile substances released, they exhibited interesting features. The artichoke, cardoon, and thistle mushroom extracts showed high proteolytic activity compared to calf rennet, while the level of esterase activity appeared to be similar for all the extracts. The papaya extract showed the lowest proteolytic and esterase activity. Although the pH, moisture, fat, and protein contents were very similar to those of cheese made with calf rennet, the medium- and long-chain FFAs broadly differed among produced cheeses, with variations in the lipid quality indices.

This technology has been selected for future promotions by the CNR PROMO-TT Instrument Office, Record Card:294 (https://promott.cnr.it/en/technology/294/new-vegetables-rennet-development-for-vegetarian-and-vegan-cheeses-production).

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Dipartimento di Biologia Ambientale
Sapienza Università di Roma

CNR IRET Conference

Rome, February 18th-19th 2025

Urban vegetation and air pollution: dealing with particulate matter deposition, physiological and molecular responses in plants grown in a green wall in Rome. The study case of Villa Leopardi

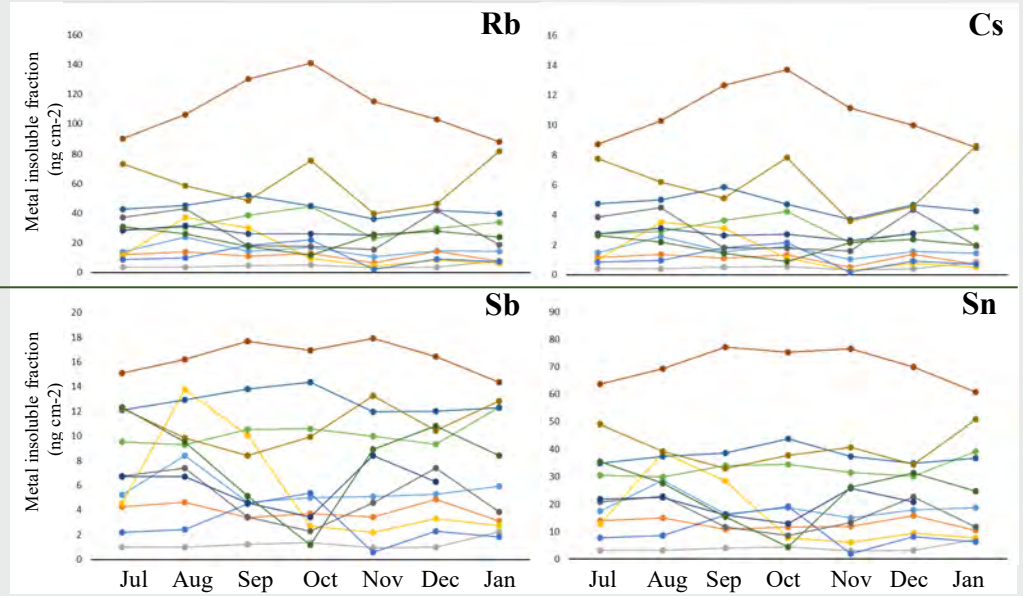
M. L. Antenozio[1], D. Marzi[1], L. Massimi[2], A. Zara[2], F. Porcu[2], L. Varone[2], S. Canepari[2], C. Perrino[3], M. Cerasa[3], C. Balducci[3], S. Mosca[3], A. Pietrodangelo[3], P. Brunetti[1]

[1]Research Institute on Terrestrial Ecosystems, National Research Council of Italy (CNR IRET), Via Salaria km 29.300, 00015 Monterotondo, Rome, Italy;
[2]Department of Environmental Biology (DBA), Sapienza University of Rome, P.le A. Moro 5, 00185 Rome, Italy;
[3]Institute of Atmospheric Pollution Research, National Research Council of Italy (CNR IIA), Via Salaria km 29.300, 00015 Monterotondo, Rome, Italy

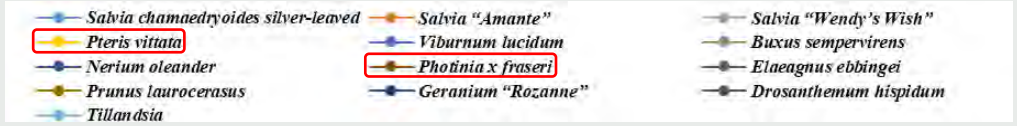
Particulate Matter (PM) and Trace Element Deposition

Soil resuspension

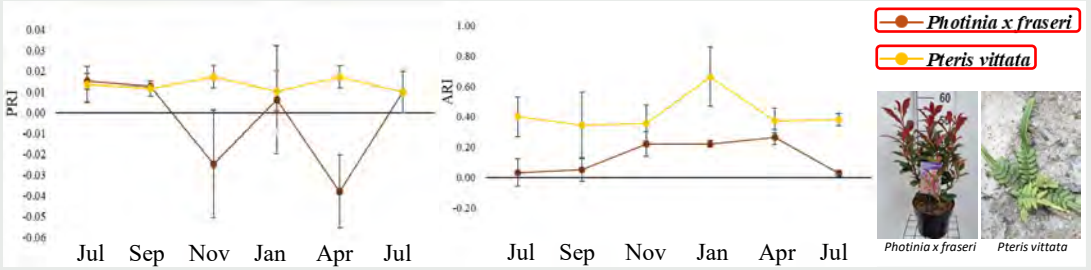
Vehicle brake abrasion



Plants

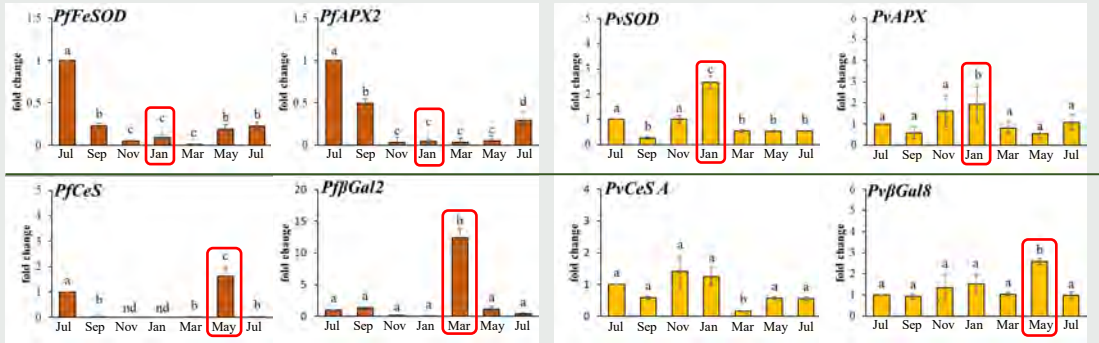


Physiological responses



Photinia x fraseri exhibited the lowest values for **the photochemical reflectance index (PRI)**, while ***Pteris vittata*** revealed the highest **anthocyanin** production rate.

Expression of Abiotic stress-marker genes



Antioxidant defense

Changes in the cell wall

Conclusions:

- ***Photinia x fraseri*** **and** ***Pteris vittata*** **can be used to monitor PM generated by urban pollution;**
- ***Photinia x fraseri*** **showed resilience to seasonal stresses and constant ability to retain metals on its leaf surface without showing signs of suffering.**

Funding: *The project was funded under the NRRP, Mission 4, Component 2, Investment 1.4-Call for tender No. 3138 of 16.12.2021, rectified by Decree n.3175 of 18.12.2021 of MUR funded by the EU-NextGenerationEU; Award Number: Project code CN_00000033, Concession Decree No. 1034 of 17 June 2022, adopted by the Italian Ministry of University and Research, CUP B83C22002930006, Project title "National Biodiversity Future Center-NBFC".*

Maria Luisa Antenozio

Consiglio Nazionale delle Ricerche
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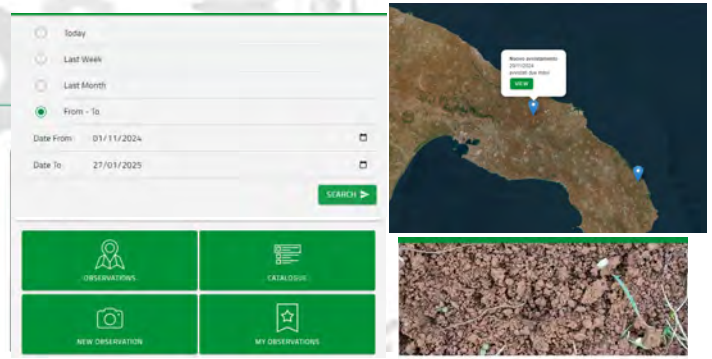
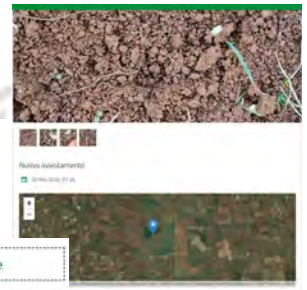
CNR IRET Conference
Rome, February 18th-19th 2025

Training Platform

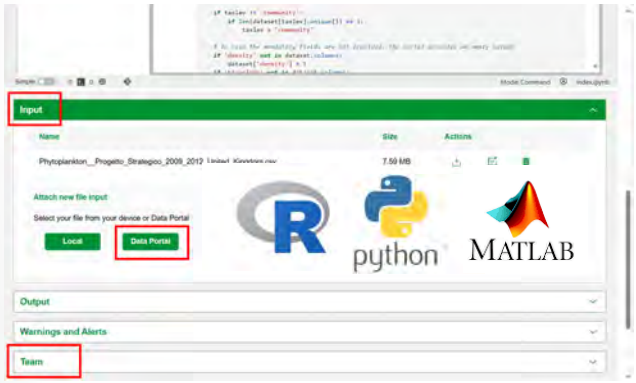
Education and Schools
Biodiversity eCampus
User Manuals and Tutorials
Webinars and Conferences

Citizen Science Platform



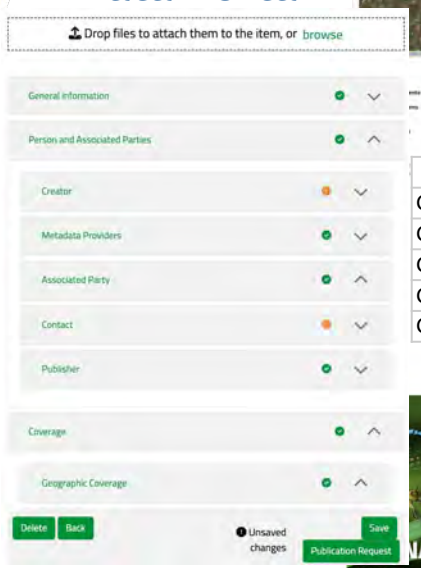


DataLabs



Services
Scripts

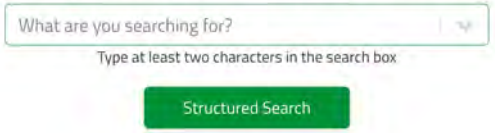
Data Portal

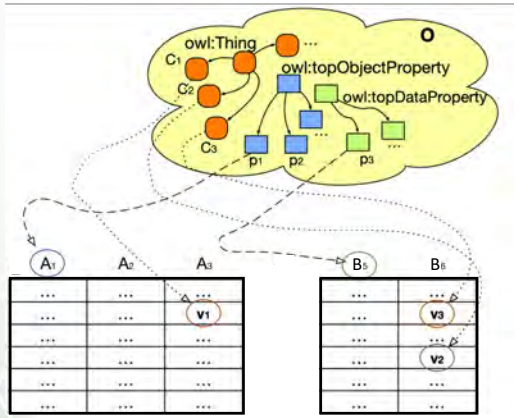


Taxonomic backbone

locality	scientificName	feces
Grotta delle Grazie	Chiroptera	N
Grotte di Castellana	Myotis blithyii	N
Grotte di Castellana	Myotis capaccinii	N
Grotte di Castellana	Myotis blithyii	N
Grotte di Castellana	Rhinolophus euryale	N

Semantic Platform



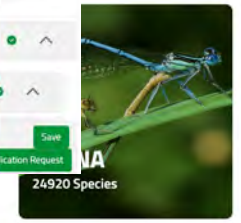


Modified from Chang et al., 2020

EcoPortal

Metadata Catalogue

Research Sites
Scripts
VREs
Workflows
Services
Audio



WoRMS World Register of Marine Species
Catalogue of Life

Andrea Tarallo[1], Alberto Basset[2], Ilaria Rosati[1]
1. CNR-IRET, 2. UniSalento

Infrastructure improvement at CNR-IRET Institute of Montelibretti financed by ITINERIS project

W. Stefanoni, E. Pallozzi, C. Calfapietra

The PNRR funding opportunities have enabled IRET to make significant investments in local infrastructure, enhancing both the quality and impact of ongoing scientific research. The acquisition of state-of-the-art instruments will facilitate deeper investigations into plant responses to biogenic and anthropogenic disturbances, critical factors in our current era of climate change.

The LiCOR LI-6800 replaces the older LI-6400XT model, offering faster data acquisition, improved portability, and extended configuration options. Its accessories enable monitoring of soil respiration, respiration rates of small organisms (e.g., insects), and photosynthetic rates of both evergreen and broadleaf species, as well as algae and mosses in aqueous solutions.

Agilent Gas Chromatography/Mass Spectrometry (GC/MS) system equipped with a H_2 gas generator for in-situ carrier gas production to analyze Volatile Organic Compounds (VOCs) emissions. The instrument features a Markes autosampler that handles up to 100 tubes for continuous analysis. This setup enables the analysis of numerous samples within hours, with overnight programming capability, significantly accelerating the process. Unlike the previous GC/MS system, it eliminates the need for helium, offering both cost and environmental benefits. The system also supports liquid-phase injections for analyzing laboratory-derived extracts.

High-Res Spectroradiometer

ASD FieldSpec 4

covers the full solar irradiance spectrum (350–2500 nm), enabling the measurement of vegetation indices including NDVI, PRI, WI, NDWI, ARI, and CRI. These indices provide insights into plant functional traits related to photosynthetic pigments (chlorophyll, carotenoids, and anthocyanins), leaf structure, and water content.

The LI-7810 (CO_2, CH_4, and H_2O analyzer) enables high-precision, long-term monitoring of greenhouse gas emissions and can be mounted on a backpack for real-time field data acquisition in both static and dynamic configurations. The instrument supports soil experiment measurements, and up to 16 units can be interconnected to continuously monitor CO_2, CH_4, and H_2O emission rates across larger areas.

Projects in which the instruments have worked in the last year:

M.i.T.e.: P. Brunetti, D. Marzi, M.L. Antenozio, C. Caisutti
PRIN 2022 – Assisted Phytoremediation: P. Brunetti, D. Marzi, M.L. Antenozio, C. Caisutti
MCIN_Spanish Ministry of Universities: NEOCOMP - M. I. Nogues Gonzalez, C.A. Alonso
STUDY VISIT ABROAD of Polish Academy of Sciences: M. I. Nogues Gonzalez, Z. Miszalski, M. Gieniec
MiPAAF - Sviluppo del vivaismo e della piattaforma varietale corilicola: VI.VA.CO“ S. Portarena e Prof.ssa D. Fanelli (UniPG)
NBFC –Spoke4.5.2-Monitoring functional characterization and traceability of resilient basic propagation material for ecosystem restoration and nature-based solutions, E D’Andrea, N. Rezaei Sangsaraki, P. De Angelis, D. Liberati, G. D’Onofrio, S. Pagliarani
ARSIAL - identificazione di specie arboree idonee agli attuali scenari di cambiamenti climatici nella Regione Lazio: L. Fusaro (CNR_IBE), L. Passatore, G. Giorgetti

Dr. Walter Stefanoni

CNR IRET Conference Rome, February 18th-19th 2025

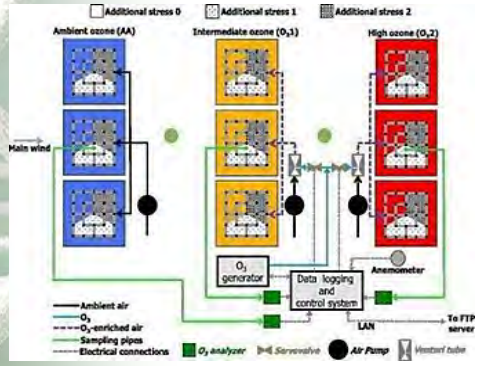
TECHNOLOGIES FOR ECOSYSTEM RESEARCH: FO$_3$X – FREE – AIR O$_3$ EXPOSURE

Lazzara L.[1]*, Marra E.[1], Hoshika Y.[1], Moura B.B.[1], Manzini J.[1], Garosi C.[1], Viviano A.[1], Materassi A.[2], Fasano G.[2], Paoletti E.[1]

[1]Research Institute on Terrestrial Ecosystems, National Research Council, Sesto Fiorentino, Italy
[2]Bioeconomy Research Institute, National Research Council, Sesto Fiorentino, Italy
* Corresponding author

FO$_3$X Free-air O$_3$ eXposure

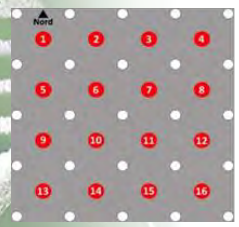
FACILITY SPECIFICATIONS



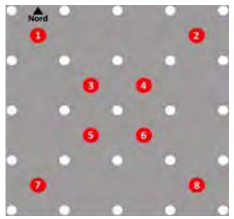
- **9 plots 5x5x2 m** (L x W x H)
- **Split-plot experiment design**: Each O$_3$ treatment is replicated three times.
- **Teflon-made vertical pipes network**.

Climatic variables: meteorological station (3 m height) with multisensory instruments.

DIFFUSIVE SAMPLERS



Up: 1.5 m



Botton: 0.5 m

The sensors are used for long-term measurements of O_3 concentration within the plots

O_3 dispersion was below 20%.

Up: 1.5 m Botton: 0.5 m

FACE FACILITY

FO3X is an advanced FACE system designed to study the **effects of ozone pollution on vegetation under ambient conditions**. It is crucial for the study of plant O$_3$ uptake.

HEAT FACE

Temperature Free Air Controlled Enhancement technology to assess the combined effects of (**O_3 + high Temperature**)

CNR IRET Conference Rome, February 18th-19th 2025

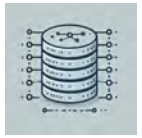
A FAIR and User-Friendly Web Application for Democratizing Research on Zoosporic Parasites in Aquatic Systems

Raho D.[1]*, Tarallo A.[1], Rosati I.[1]

[1]Research Institute on Terrestrial Ecosystems, National Research Council, URT Lecce, Italy
* Corresponding author

Zoosporic parasites play a crucial, yet often overlooked, role as invisible regulators of ecosystems, posing significant challenges to microalgae production. A comprehensive understanding of parasite-host interactions is not merely an ecological concern but a fundamental requirement for ensuring the sustainability of algae-based resources and industrial-scale production.

The ParAqua database represents the first structured effort to centralize knowledge on zoosporic parasites, integrating *in situ* observations, genetic data (from NCBI), and literature data, to provide a comprehensive understanding of algae-parasite interactions.



PARAQUA

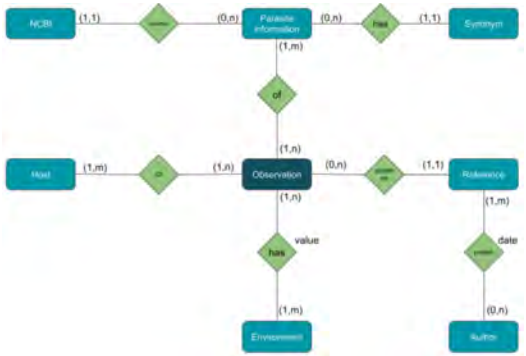
LifeWatch ITALIA

cost EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY

Analyzing Research Needs

- The taxonomy of the parasite and its fixed traits.
- The taxonomy of the host algae and its fixed traits.
- Observation variables collected on the sampling event.
- Genetic data collected from the NCBI database.
- Synonymous parasites names.
- Literature sources for the data gathered in the other categories.
- Information about the authors of the referenced literature.

Designing Conceptual Model



Harmonizing Data

Use of Controlled Vocabularies: Darwin Core, LifeWatch Traits Thesaurus, Dublin Core, NCBI

Democratizing

Developing a web-application for data access. User-friendly UI for structured queries to get a navigable data-table output and downloading files in CSV. Stateless Restful API for JSON files.

CSV API JSON

Davide RAHO

CNR IRET Conference Rome, February 18th-19th 2025

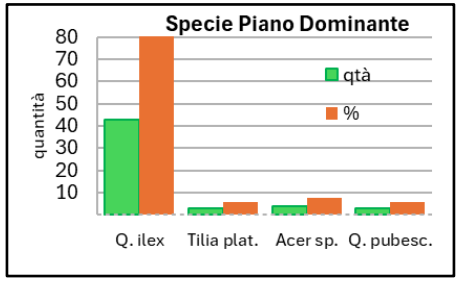
The ICOS ecosystem site of Real Bosco di Capodimonte

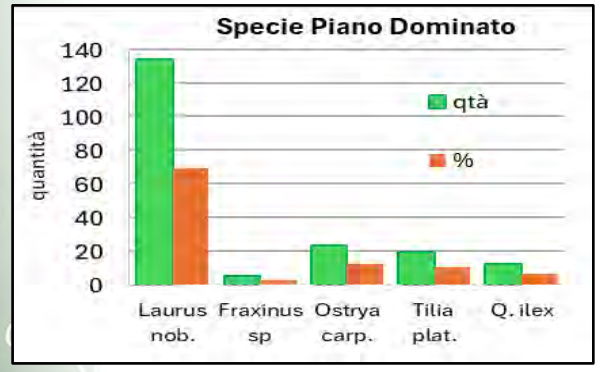
Teresa Bertolini. T. Zenone, C.Corradi, G. Guidolotti, M. Mattioni, M.Micali, L.Sessa, D. Piastrelloni, A.Di Palma, I.Tunno, A scartazza, E. Pallozzi, and C. Calfapietra

Aerial view of the park: commissioned by King Charles Borbone in 1734 to the architect Ferdinando Sanfelice as a hunting reserve around the Reggia Borbonica, now the Museum of Capodimonte. For its botanical (400 botanical species) and architectural heritage, is one of the most important park in Italy.

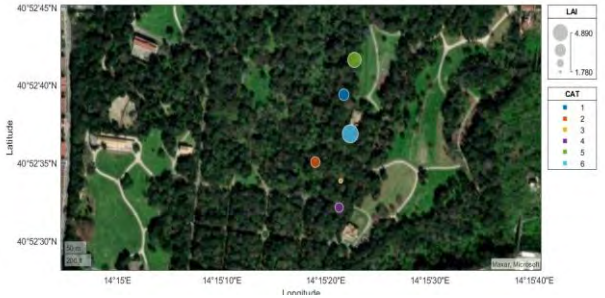
The CO_2 and H_20 exchange are monitored with an eddy covariance system.

Soil environmental conditions and CO_2 fluxes are monitored continuously





The site is located within the city of Naples and cover an area of about134; the main species that characterized the park are *Quercus ilex* L., which occupies about 80 % of upper canopy layer with a height average of 22 m. The underneath layer is characterized by the presence of *Laurus nobilis* and other Mediterranean species



The temporal dynamics of LAI is monitored throughout the year within the footprint of the eddy covariance tower

This research is made possible by the ICOS network and the National Biodiversity Future Center - NBFC. We would like to acknowledge the Soprintendenza of Real Bosco di Capodimonte in particular the former director Dr Sylvain Bellenger, and the new director Dr Eike Schmidt.

Teresa Bertolini

Consiglio Nazionale delle Ricerche
CNR IRET

CNR IRET Conference Rome, February 18th-19th 2025

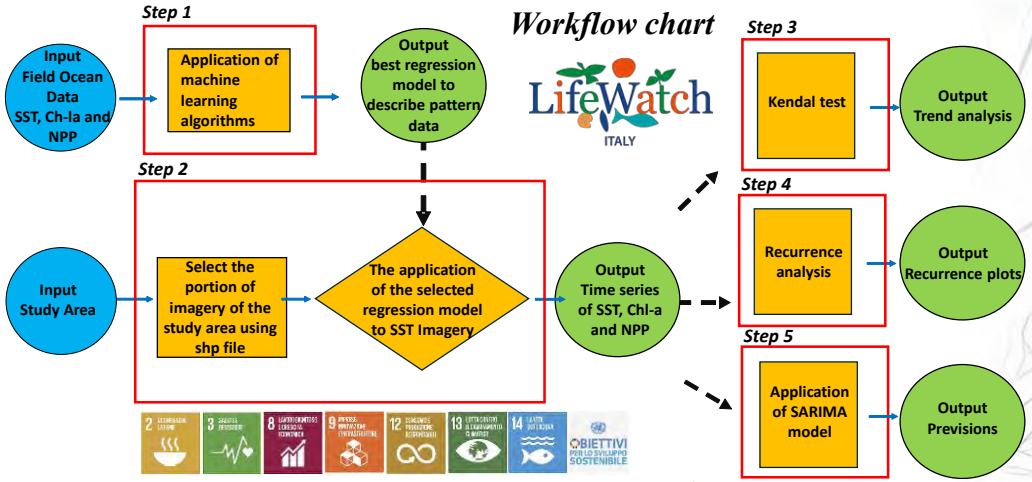
Analytical Workflow to Study Ocean Production Response to Global Warming

Context: Phytoplankton is highly sensitive to temperature, making it vulnerable to the effects of global warming with impact on biomass production and on the ability of the ocean to act as a sink for CO_2.

Aim of the workflow: Investigate the variation of chlorophyll-a (**Chl-a**) as a proxy for phytoplankton biomass and Net Primary Production (**NPP**) as an indicator of biomass production rate, in response to changes in Sea Surface Temperature (**SST**).

Method: The workflow integrates field measurements with remote sensing imagery.

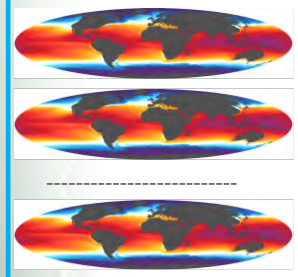
Case study: Equatorial zone, where ocean warming could have negative impact.



Data

- ***Input***
  - Chl
  - NPI
  - SST
  - …….
- ***Input 2:***
  - **Study area *(.shp)***

Global Ocean SST



Storage data

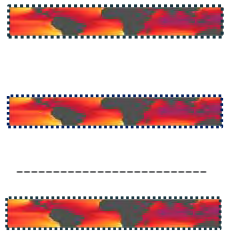
Result

Output Step 1

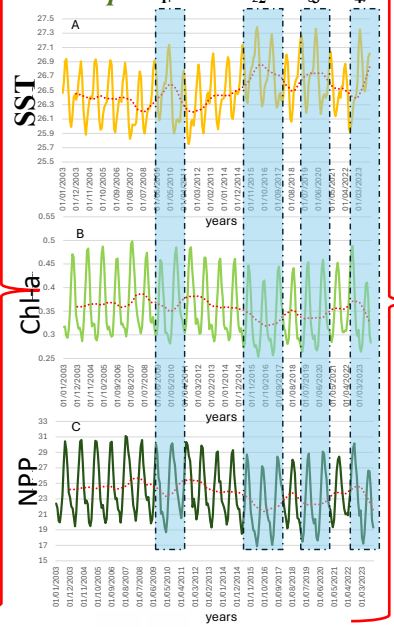
Model Chl-a ~SST	R2	MAE	RSME
Linear regression	0.602	0.775	0.954
Random Forest	0.753	0.567	0.762
Others	.....	.....	.....

Model NPP ~SST	R2	MAE	RSME
Linear regression	0.408	1.047	1.241
Random Forest	0.611	0.755	0.982
Others	.....	.....	.....

Clip



Output Step 2



Output Step 3

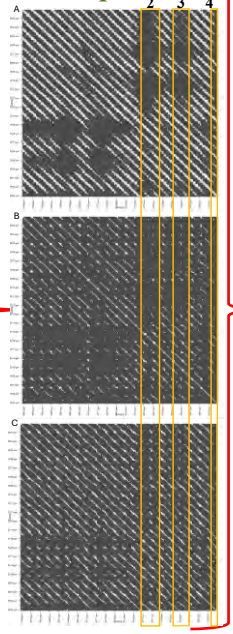
Trend:

SST - Up
p-value < 0.05

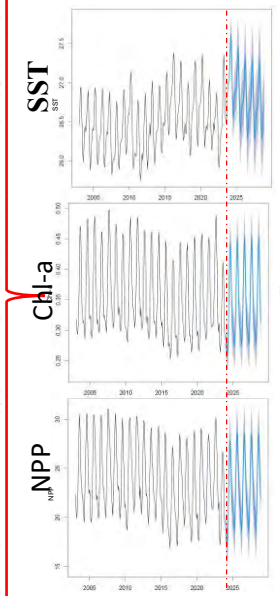
Chl-a - Down
p-value < 0.05

NPP - Down
p-value < 0.05

Output Step 4



Output Step 5



Discussion

The system showed:

1) Short-term dynamics, which may result from cycle perturbation events such as ENSO events (2-3-4-recurrence plots);

1) Long-term dynamics from 2003 to 2023, which may be driven by global warming (trend Analysis).

Teodoro Semeraro

Co-authors: Titocci J., Liberatore L., Monti F., De Leo F., Ingrosso G., Shokri M., Basset A.

Low $\delta^{13}C$ variability and high vessel density reveal anisohydric olive cultivar as most drought-resilient

Silvia Portarena[1,2], Matthias Saurer[3], Enrico Brugnoli[1], Daniela Farinelli[4], Paolo Cherubini[3]

[1] Institute of Research on Terrestrial Ecosystems, National Research Council, Porano, Italy; [2] National Biodiversity Future Center, Palermo, Italy, [3] WSL Swiss Federal Research Institute, Birmensdorf, Switzerland, [4] Department of Agricultural, Food and Environmental Sciences, University of Perugia, Perugia, Italy

Climate change

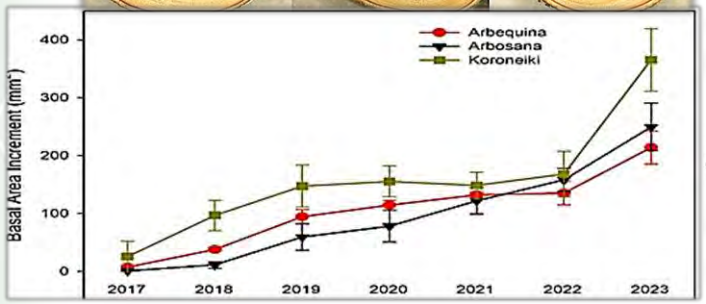
Challenges in agriculture: impacts and adaptation

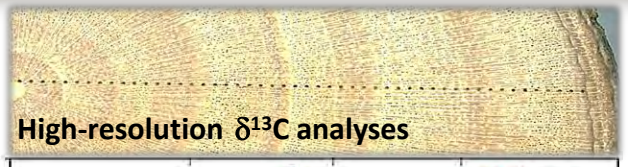
Olive orchard

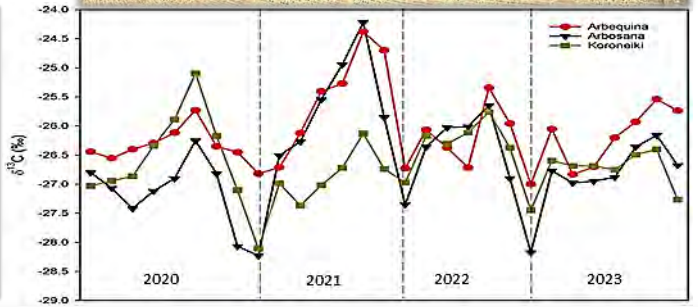
Spello (Umbria)
Rainfed
High density
Arbequina, Arbosana, Koroneiki cultivars

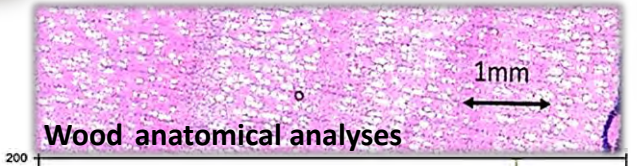
Research question

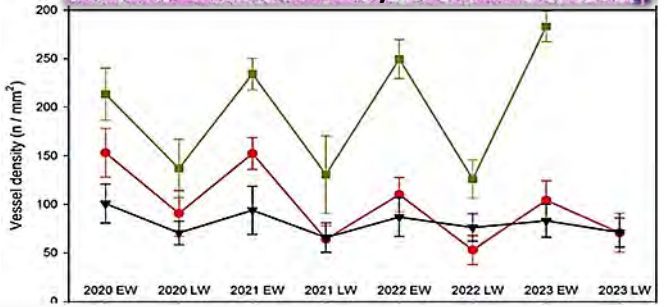
How do three distinct olive cultivars differ in their physiological and anatomical responses to environmental variation



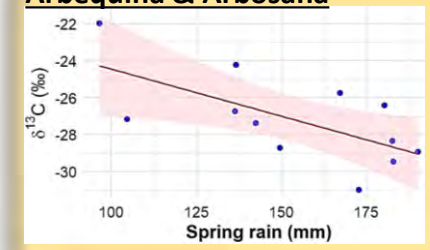




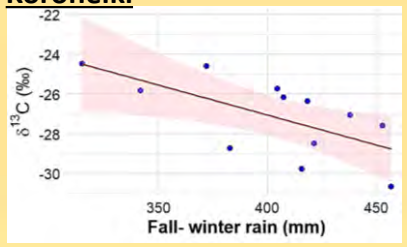




Arbequina & Arbosana



Koroneiki



Conclusion

Stomatal behavior: Arbequina & Arbosana: isohydric behavior, conserving water by closing stomata during summer stress; Koroneiki: more anisohydric behavior, using carbon reserves for xylem formation.

Hydraulic efficiency: Koroneiki: higher vessel densities, enhanced hydraulic capacity supporting efficient water transport and productivity.

Silvia Portarena

Enhancing Ecosystem Recovery: The Role of Digital Plant Phenotyping (DPP) in supporting Nature-based (NbS) Solutions

M. Barbafieri , D. Di Baccio, A. Scartazza, E. Tassi, I. Guidoni, A. Vezzosi, I. Rosellini

DPP: advanced monitoring technology
Multispectal sensors - Non destructive - Real time

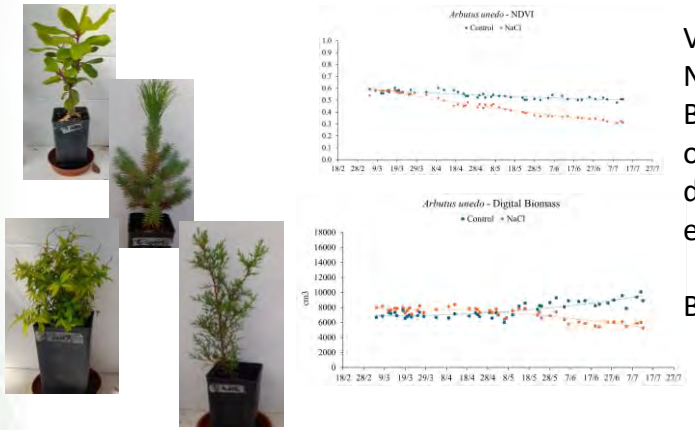
Analisys and selection of species for NbS
Adapted to degraded environments
Optimization of treatments for resilient growth

NbS application
Phytoremediation - Environmental Recovery - Biodiversity conservation

The Digital Plant Phenotyping Lab at IRET in Pisa

The STUDY within Spoke 4 - NBFC:

Evaluating salinity stress on Mediterranean maquis plants



Visualization of NDVI A) and Digital Biomass B) of *Arbutus unedo* during the experimental trial

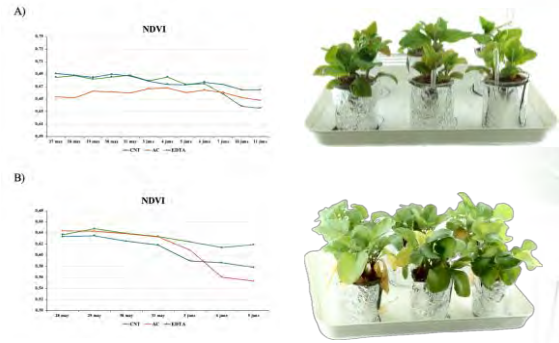
By TRAIT FINDER

The STUDY within PRIN - EUREECA:

Evaluating effects of treatments on plant growth and Rare Earth uptake

Visualization of NDVI of *Phytolacca americana* A) and of *Rafanus sativus* B) during the experimental trial

By MICROSCAN



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NATIONAL BIODIVERSITY FUTURE CENTER
CNR IRET

Meri Barbafieri
IRET - PISA

CNR IRET Conference Rome, February 18th-19th 2025

New indicators for the selection of plants adapted to saline environments: combining High-Throughput digital Plant Phenotyping with morpho-physiological and biochemical analyses in sustainable water management

D. Di Baccio, M. Barbafieri, I. Rosellini, M. Mascherpa, E. Tassi

Research Institute on Terrestrial Ecosystems – Pisa unit

daniela.dibaccio@cnr.it

Experimental set-up

- model plant: *Lactuga sativa* L.
- saline Irrigation Waters (IWs)

	Control	IW1	IW2	IW3
NaCl (g L^{-1})	0.04	12.0	12.0	12.0
$CaCl_2$ (mg L^{-1})	39.5	39.5	443.1	443.1
$ZnCl_2$ (mg L^{-1})	< ql	< ql	20.0	20.0
$CuSO_4$ (mg L^{-1})	< ql	< ql	< ql	51.6
EC (mS cm^{-1})	0.7	17.4	17.5	18.0
pH	8.2	7.9	7.4	7.5

Measurements

Phenotyping

Morphological parameters:

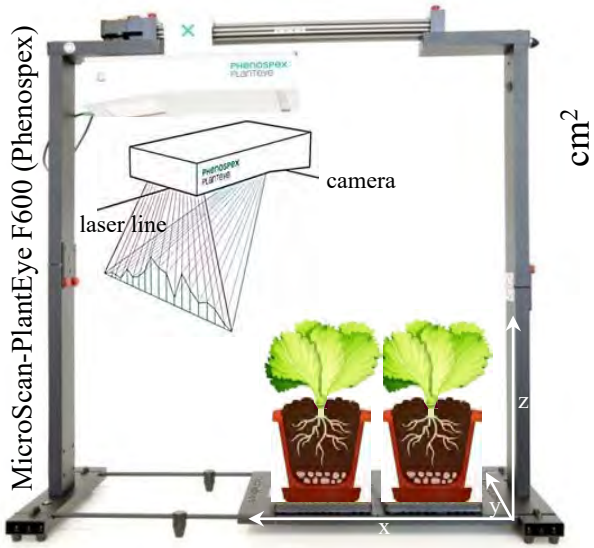
3D Leaf Area, Digital Biomass, Light Penetration Depth, Plant Height

Multispectral parameters:

NDVI, PSRI, NPCI, GLI

Technical parameters:

Hue, convex hull area, voxel volume, lightness



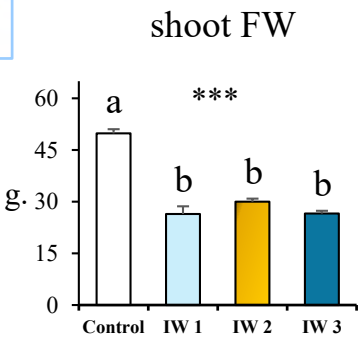
Plant trait measurements

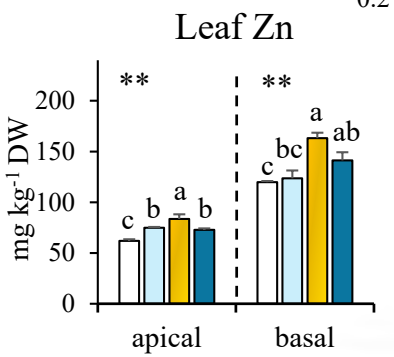
Physiological traits:

Growth analysis, chlorophyll fluorescence

Biochemical:

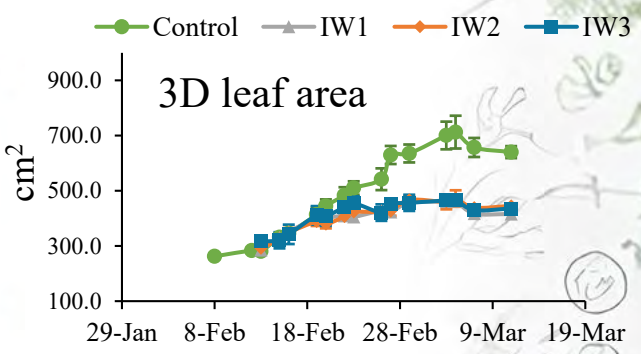
Pigments, minerals content



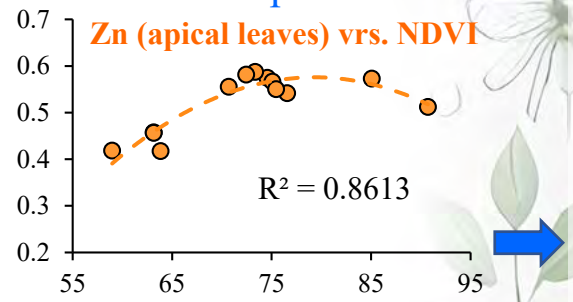


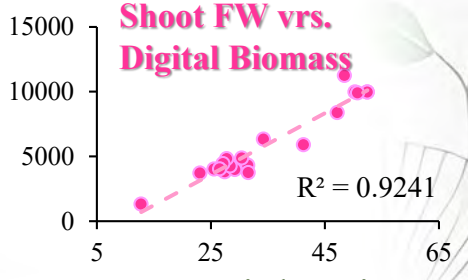
Results and Conclusions

- Real time monitoring



- Validation-prediction





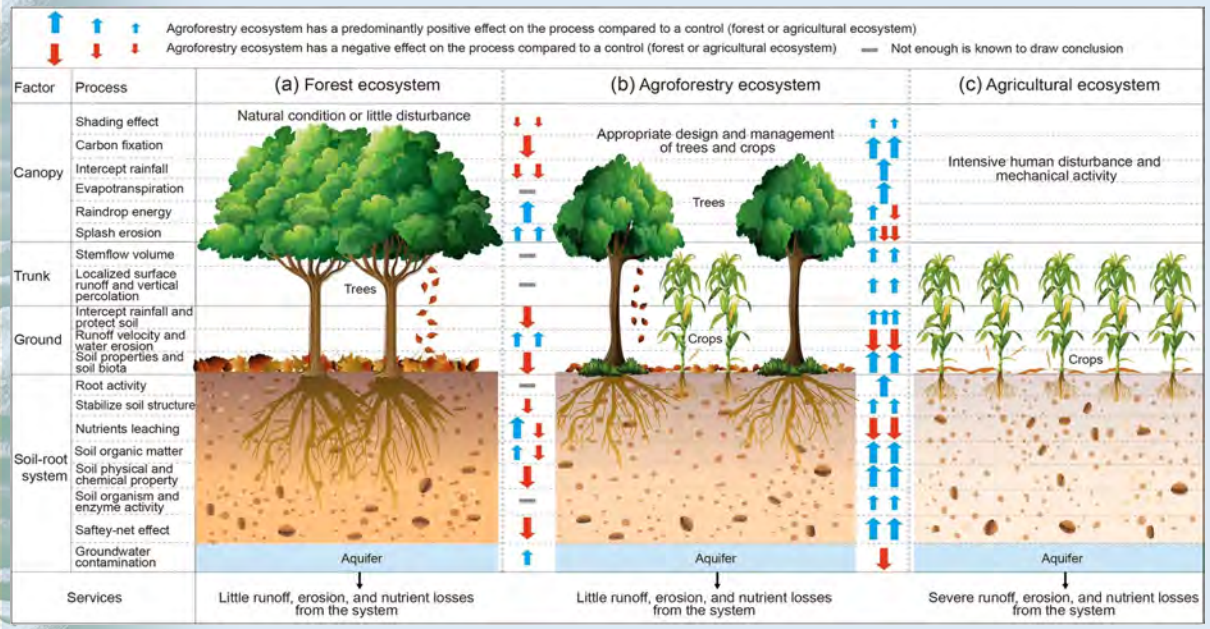
- Specific relationships- new combined indices

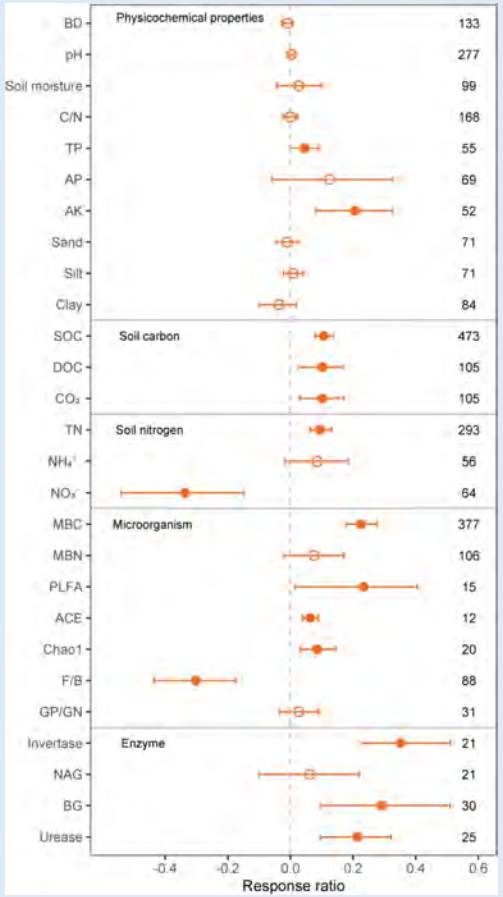
Daniela Di Baccio

Eco-physiological and growth characters of woody plant species in determining the potential of traditional agroforestry practices as nature-based carbon sinks in Mediterranean area

Garosi C., Marra E., Conti N., Della Rocca G., Paris P., Nigrone E., Palanti S., Hoshika Y., Paoletti E.

Agroforestry system as a nature-based carbon sink: how the **growth** and **eco-physiological characteristics** of forest species influence the potential of agroforestry systems as carbon sinks?





Study hypothesis

- The amount of C sequestered will depend on site biological, climatic, soil, management and specie-specific factors.
- Abiotic stress response represent a key factor in C-sequestration potential.

Living Hub – Case study

Agroforestry system consisting of ***Olea europaea* L.** (cv. *leccino* and *canino*) and ***Cupressus sempervirens* L.** (var. *stricta* and *horizontalis*), with ***Vicia faba* L.**, at the S. Paolina experimental farm - Follonica (GR). This agroforestry system, will be subjected to **water and salt stress**.

Cesare Garosi

Pan, J., Chen, S., He, D., Zhou, H., Ning, K., Ma, N., ... & Dong, Z. (2025). Agroforestry increases soil carbon sequestration, especially in arid areas: A global meta-analysis. *Catena*, *249*, 108667.

CNR IRET Conference

Rome, February 18th-19th 2025

Morpho-physiological and gene expression analyses in *Lepidium sativum* plants exposed to drought stress, heat stress and their combination

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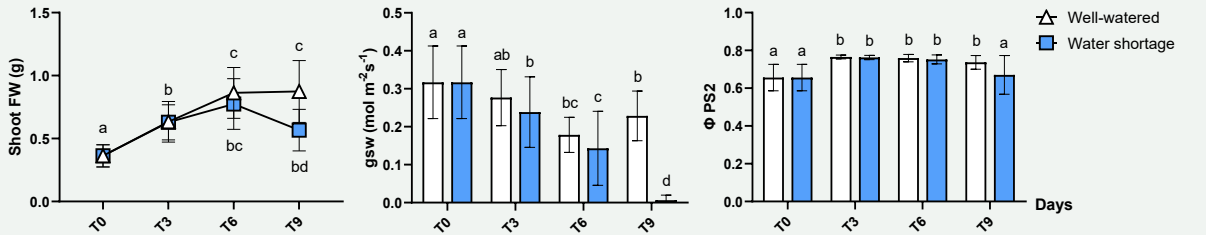
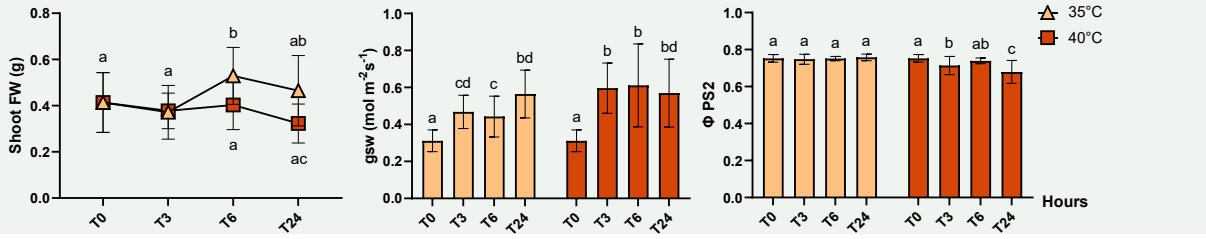
Morpho-physiological analysis

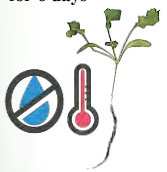
Drought stress — Water shortage for 9 days

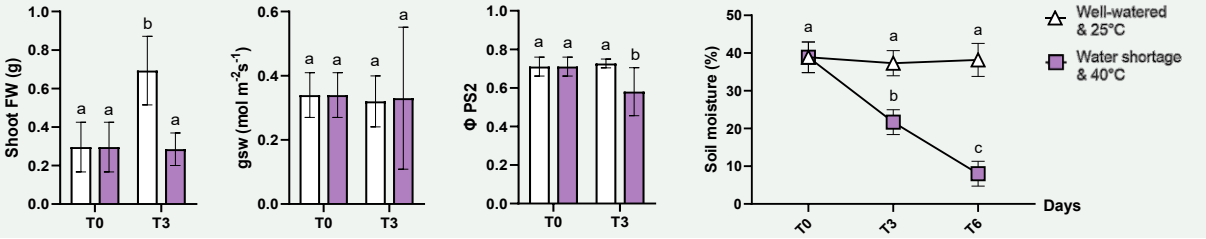


Heat stress — High temperatures for 24 hours



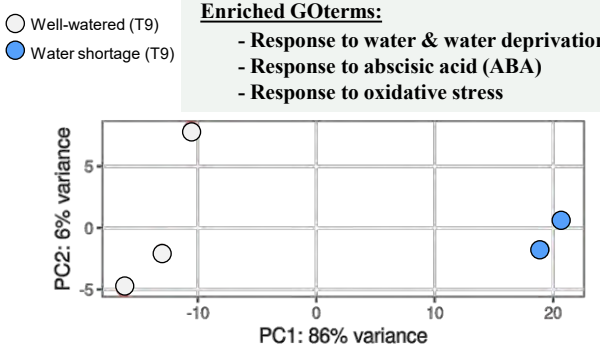
Combined stress — Water shortage and high temperature for 6 days





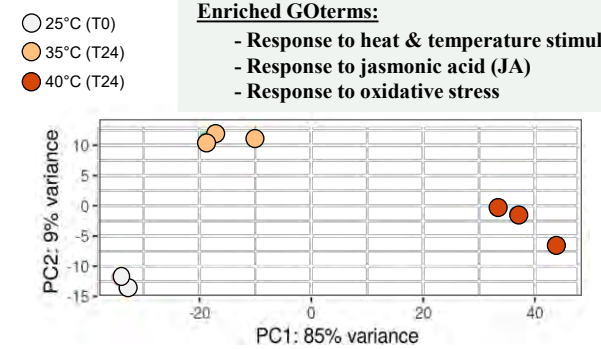
Transcriptomic analysis

Drought stress



Enriched GOterms:
- Response to water & water deprivation
- Response to abscisic acid (ABA)
- Response to oxidative stress

Heat stress



Enriched GOterms:
- Response to heat & temperature stimulus
- Response to jasmonic acid (JA)
- Response to oxidative stress

Conclusion

Morpho-physiological alterations induced by drought, heat and combined stresses correlate with transcriptomic data, mainly deregulating reactive oxygen species (ROS) and hormone signaling pathways.

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Cristina Caissutti

Thank you!