PhD in AGRIFOOD AND ENVIRONMENTAL SCIENCES

CALL 2026 – CYCLE 42

A - SEdiment Regime in Regulated Alpine Rivers and its restoration
Acronym: SERRAR

Co-funding body: University of Trento – C3A

Supervisor 1: Walter Bertoldi
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Supervisor 2: Guido Zolezzi
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Overview:
Many river reaches in Alpine settings are heavily regulated by dams, water abstractions, sediment mining, grade control structures and other hydro-morphological alterations. As a consequence, their sediment regime is often altered, with relevant morphological effects occurring at different time and spatial scales (e.g Grant, 2012, Grams et al., 2007) Such effects may consist of channel incision, riverbed aggradation, and/or depletion of ecologically-relevant sediment size classes, increased armoring, riverbed clogging and compaction. These alterations are often associated with relevant environmental effects, such as reduced habitat availability and turnover, changes in the composition and dynamics of riparian vegetation, increased flood risk in nreaby agricultural and urban areas, increased risk of alien species invasion. To reduce the loss of such important ecosystem functions, several restoration measures have been proposed, like dynamic e-flows, including e-floods (Robinson et al., 2023, Soto Parra et al., 2024), sediment replenishmentfor morphological and habitat improvement. However, the complexity of processes triggered by their implementation still prevents a clear understanding of the underlying sediment dynamics in the channel, of the ecosystem response and, therefore, the development of tested and effective restoration procedures.

Project goals:
The project aims at investigating the eco-morphodynamic response of regulated rivers to measures aimed at partially restoring their natural sediment regime. More in detail, it will mainly focus on the downstream effect of dams and will aim at:

- Quantifying the reach-scale sediment dynamics in dam-regulated rivers
- Developing predictive approaches to support the design and monitoring of sediment regime restoration measures
- Assessing the effect of these measures on fish habitat and riparian vegetation dynamics

Two main types of sediment transport processes will be targeted:

1) 1D processes that control the dynamics of riverbed aggradation / degradation waves resulting from an altered equilibrium between sediment supply and transport capacity
2) Selective transport processes for those size classes that are relevant for specific fish life stage, like spawning, and that show recurring depletion in multiple dam-regulated reaches

Methodologies:
The investigation foresees the integration of different methods:

- Field measurements of sediment properties and dynamics, related habitat suitability, and of landforms resulting from sediment – vegetation interactions

- Hydraulic modelling (fixed and mobile bed) to develop predictive approaches able to support the design of
- Analysis of remotely and proximally sensed imagery for reconstruction of short and medium term morphological changes

Keywords:
Sediment regime; regulated rivers; gravel reinjection; habitat modelling

Grams, P. E., et al. (2007). *Geological Society of America Bulletin*, *119*(5-6), 556-575.
Grant, G. E. (2012). The geomorphic response of gravel-bed rivers to dams: perspectives and prospects. *Gravel-bed Rivers: Processes, tools, environments*, 165-181.
Robinson, C. T., et al. (2023). Science of The Total Environment, 882, 163569.
Soto Parra T., et al. (2024). Earth Surf Proc and Landf. 49(15), 5167-5185.

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B- Valorization of organic by-products and waste from the agro-industrial sector

Co-funding body: University of Trento – C3A/DICAM

Supervisor 1: Luca Fiori
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Overview: The research intends to implement process schemes for the valorization of by-products and organic waste from the agro-industrial sector (such as grape marc, apple pomace, trout processing waste) to recover materials and energy following the principles of the circular bioeconomy. The research includes both laboratory activities and process simulation activities aimed at optimizing/making processes more efficient. Different processes will be investigated: physical and thermal pre-treatments of biomass, thermochemical processes (hydrothermal carbonization, pyrolysis, activation), physical separation (extraction with supercritical CO_2, mechanical extraction such as centrifugation), possibly also anaerobic digestion.
The holistic vision of the research will allow for maximizing the recovery of materials (carbon materials in particular, but also oils and proteins from fish waste) and energy in integrated process schemes typical of the biorefinery approach.

Project goals:
Transforming organic agro-industrial waste into products: products for use in the food sector (fish flour and oil), for environmental remediation (e.g. activated carbon-like adsorbent material), and possibly others.

Methodologies:
The research project is highly ambitious because it is based on research already underway in the laboratories of the supervising professors. The candidate will be required to perform both laboratory work and process simulation and optimization activities typical of chemical and process engineering.

Keywords: Circular Bioeconomy, agro-waste, hydrothermal processes, hydrothermal carbonization

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CALL 2026 – CYCLE 42

C - From copper dependence to ecological resilience by redesigning organic viticulture with the integration of sustainable alternatives and agroecological leverage points

Acronym: SCALE-VINE

Co-funding body: University of Trento - European project SCALE-it

GA Project 101181496 - CUP E43C25000210006

https://scale-it-organic.eu/scale-it-in-a-nutshell/

Supervisor 1:

Ilaria Pertot https://webapps.unitn.it/du/it/Persona/PER0003369/Pubblicazioni

Overview:

Modern viticulture is characterized by strong genetic and structural uniformity, which has increased grapevine susceptibility to epidemic diseases, particularly downy mildew (*Plasmopara viticola*). In organic viticulture, copper-based products remain the only consistently effective control method. However, due to their environmental toxicity and accumulation in soils, copper use is subject to increasing regulatory restrictions. This situation threatens the sustainability and economic viability of organic grapevine production. Agroecological practices and crop diversification strategies have the potential to enhance crop resilience and reduce disease pressure, yet their adoption by growers remains limited and their effectiveness in reducing copper dependency is insufficiently quantified. In parallel, alternative products to replace copper are emerging, but lack comparable efficacy.

This PhD project addresses these challenges by evaluating and modelling the integration of agroecological practices, crop diversification strategies and alternative plant protection tools to design resilient organic grapevine production systems.

Project goals / Specific aims are:

- To identify ecological tipping points at which diversification, agronomic practices and system complexity suppress epidemic development of downy mildew by assessing the grower behavior in terms of application of these solutions.
- To unravel multi-scale mechanisms (canopy, field, landscape) through which agroecological practices regulate pathogen pressure in the multi-year trials on copper replacement over the EU.
- To assess whether copper alternatives can act as leverage points rather than substitutes when embedded in resilient system designs.
- To co-construct and validate transformative, low-copper viticulture prototypes capable of maintaining yield stability under epidemic risk.
- To train and co-supervise a fully interdisciplinary PhD student in plant pathology, plant physiology, and socio-economics.
- To disseminate project results through at least three scientific publications and at least three presentations at international conferences.

Methodologies:

WP1. Development of a resilience-based conceptual model linking farmers' practices, vineyard structure, microclimate, host diversity, and epidemic dynamics.

WP2. Experimental redesign of vineyard systems along diversification and complexity gradients to detect non-linear responses and epidemic thresholds.

WP3. System-embedded evaluation of copper alternatives (natural molecules, plant extracts, biocontrol, resistance inducers) as modulators of disease trajectories.

WP4. The PhD student will be supervised through weekly meetings, and his/her training will be optimized in multidisciplinary topics.

WP5. Expected publications: 3-4 peer-reviewed articles addressing resilience theory, plant disease ecology and alternatives, farmers practices and agroecological system design.

Keywords:

Agronomic practices, copper replacement, sustainable agriculture, plant health

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D - Genetic analysis of fruit quality in apple

Acronym: GAIN-APPLE

Co-funding body: University of Trento - Centro di Sperimentazione Laimburg

Supervisor 1: Fabrizio Costa_UniTN
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Supervisor 2: Walter Guerra_Laimburg Research Centre

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Supervisor 3: Matteo Scampicchio_UniBZ
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Overview:

Fruit quality represents a key determinant of economic value and consumer acceptance. Beyond sensory attributes, fruits are increasingly valued for its exceptional fruit texture and functional properties, frequently associated with the presence of redox-active secondary metabolites, particularly polyphenols. These compounds may contribute to oxidative stress modulation through radical-inhibition mechanisms; however, the relationship between polyphenolic composition and antioxidant performance remains insufficiently resolved. Antioxidant capacity is commonly described using empirical indices that inadequately capture reaction kinetics and thermodynamic driving forces.

The proposed project aims to address two important fruit quality features in a reference apple collection. The first trait to be investigated will be represented by texture and storability. The properties of the cell wall and middle lamella complex and its dismantling during storage play a relevant role in the determination of the texture properties and storability, two aspects highly considered by producer and representing central targets in breeding programs world-wide. Fruit texture will be assessed through the employment of a sophisticated texture analyser and the assessment carried out at harvest and after storage will enable the definition of a storage index parameter, essential for the definition of the storability properties.

The second trait that will be considered in the project will be represented by the antioxidant activity, essential for the definition of the functional type of quality. Antioxidants will be ranked using parameters such as inhibition rate constants, standard redox potentials, and Gibbs free energy changes associated with electron- and hydrogen-transfer reactions,

thereby moving beyond concentration-based and single-endpoint assays. These mechanistically grounded descriptors will be used to define robust antioxidant phenotypes.

The resulting phenotypes will be coupled with genomic analyses to identify loci associated with both fruit texture and kinetically efficient and thermodynamically favourable antioxidant profiles. This approach may enable a more precise linkage between genotype and functional quality traits, supporting DNA-informed breeding strategies and advancing the selection of fruit varieties with improved functional quality.

Project goals:

- Characterization of the texture performance and antioxidant activity in a large apple collection.
- Correlation between polyphenolic compounds and antioxidant properties.
- Mapping of the QTLs controlling storability and antioxidant properties of apple fruit and defining the set of genes deputed to the control of these quality features.
- Identification of the genes included in these QTL intervals.
- Genomic selection for fruit texture and storability.

Methodologies:

- Texture profiling
- SNP markers
- Genome Wide Association Studies
- Genomic prediction
- Electrochemistry, calorimetry, spectrometry

Keywords: apple, genetics, GWAS, texture, antioxidant

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E - Functional and metabolomic characterization of cold-tolerant alpine bacteria to mitigate freezing stress on apple and grapevine

Acronym: MITIFROST

Co-funding body: University of Trento - Laimburg Research Centre

Supervisor 1:
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Supervisor 2:
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Overview:
Climate change is responsible for mild winter and spring seasons, with anticipated plant development (e.g., budding and flowering) and increased risk of late frost damage to flowers and young shoots. Late frost has increased in frequency and severity in recent years, and physical methods commonly applied to protect crops (e.g., overhead irrigation, wind machines, and heaters) are based on the large use of natural resources (e.g., water and fuels). Thus, sustainable strategies are required to mitigate freezing stress on crops.
Beneficial plant-associated microorganisms are a viable approach to support plant growth and production under abiotic stresses. Cold-tolerant endophytic bacteria exert beneficial effects by producing antifreeze molecules (bacterial compounds) and/or triggering physiological processes (induced tolerance) to mitigate cold stress in the host plant.
Although some studies have shown that cold-tolerant bacteria mitigate cold stress in horticultural crops, no information is available on their efficacy and mechanisms of action in perennial crops, such as apple and grapevine.

Project goals:
This project aims to understand the mode of action of cold-tolerant bacteria in mitigating cold stress in apple and grapevine plants using physiological and metabolomic approaches.
O1. To select cold-tolerant bacteria for the mitigation of freezing damage in apple and grapevine.
O2. To identify metabolic compounds induced by bacterial inoculation in apple and grapevine under freezing stress.
O3. To identify metabolic compounds produced by cold-tolerant bacteria under freezing stress.
O4. To train and co-supervise the PhD student in plant physiology, metabolomics, and microbiology.
O5. To disseminate project results through three scientific publications and at least three presentations at international conferences.

Methodologies:
A collection of cold-tolerant bacteria was previously obtained from wild cold-adapted alpine plants, and some of them mitigated freezing damage in apple and grapevine plantlets (unpublished data).

WP1. Apple seedlings, grapevine cuttings, and detached apple flowers will be treated with cold-tolerant bacteria, stress markers (electrolyte leakage, H_2O_2, malondialdehyde, and proline), and freezing damage (tissue discoloration, wilting, chlorophyll content, and photosynthetic activity) will be assessed after freezing stress.
WP2. Metabolites will be extracted from control and bacterium-inoculated leaf and flower samples and analyzed by ultra-high pressure liquid chromatography-electrospray ionization-high-resolution mass spectrometry (UHPLC-ESI-ORBITRAP-MS) to identify plant compounds associated with freezing stress mitigation.
WP3. Metabolites will be extracted from cold-tolerant bacteria under freezing stress and analyzed by UHPLC-ESI-ORBITRAP-MS to identify bacterial compounds that contribute to cold tolerance.
WP4. The PhD student will be co-supervised through weekly meetings, and his/her training will be optimized in multidisciplinary topics.
WP5. Expected publications: i) identification of apple compounds induced by bacterial inoculation; ii) identification of grapevine compounds induced by bacterial inoculation; iii) identification of compounds produced by cold-tolerant bacteria.

Keywords:
Climate change, apple, grapevine, frost, cold stress

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G1 - Functional diversity and evolution of fungal-rich microbiomes from natural and agrarian ecosystems

Acronym: Fun-Fung

Co-funding body: Fondazione Edmund Mach

Supervisor 1: Claudio Donati
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Supervisor 2: Omar Rota Stabelli
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Overview:
Shotgun metagenomics allows exploring the fine scale biodiversity of microbial communities by inferring their taxonomic profiles and functional properties and providing strain-level genomic data of selected microorganisms. While robust analysis frameworks have been established for bacterial-dominated communities, the efficacy of this approach in the presence of communities where the fungal component is important has not been well explored. This is especially relevant in the case of agro-environmental matrices, where fungi play a major role both as fermentation agents and as pathogens. This is due to a range of reasons, including the lack of specialized computational framework and incomplete genomic databases of fungal biodiversity. This project aims at establishing a robust pipeline for the functional analyses of fungal-rich microbial communities. By linking this pipeline with genome-scaled phylogenetic evidence, the project shall unveil the evolutionary trajectories of less studied environmental microbial communities. The student will focus on the evolution of grape and wine microbiomes with the goal of shading light on the co-evolutionary history of human-yeast domestication. The project builds upon recently obtained 60 wine and 44 grape metagenomes and is facilitated by multiple computational facilities and the two established host labs with strong experience of computational metagenomics and molecular phylogenetics.

Project goals:
-Development of pipelines for the functional analysis of fungal-enriched microbiome
-Application of this pipeline to two complementary agro-environmental microbiomes

Methodologies:
-Unix and python scripting
-Multivariate statistics using R
-Shotgun data management and Metagenomic profiling
-MAG reconstruction and Functional analysis
-Strain level phylogenetics from metagenomic data

Keywords: ***Fungi, metagenomics, phylogenetics***

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G2 - Research and Experimentation Data Management in Agriculture

Acronym: REDMA

Funding body: Fondazione E. Mach

Supervisor 1: Arturo Pironti

https://fmach.it/La-Fondazione/Personale/Pironti-Arturo

Supervisor 2: Matteo Ferrari,
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Overview:
the project addresses the increasing complexity of data management within the agricultural research and experimentation sector from a legal perspective. As data emerges as the primary asset of modern agri-tech innovation, the absence of clear regulatory frameworks poses a significant challenge to researchers, public institutions, and private stakeholders.
To bridge this gap, the project provides a comprehensive legal analysis of the regulations governing the management of research and experimental data, with particular focus on: 1) data ownership and intellectual property rights; 2) legal frameworks governing data access and data sharing; 3) the role of intermediaries (e.g.: platforms, cooperatives, consortia).

Project goals:

- defining the notion of data generated during agricultural research and experimentation activities
- exploring the presence and impact of institutional actors (platforms, cooperatives, consortia, etc.) in data generation and access
- investigating the regulatory tools and contractual arrangements which govern the ownership, access and circulation of such data
- developing guidelines/procedures for managing data produced in carrying out research and experimentation activities

Methodologies:

- review of primary legal sources (legislation and regulations)
- analysis of scholarly doctrine and academic debate within the agri-tech sector
- evaluation of case law
- access to academic/professional legal databases

Keywords: research and experimentation data regulation, data ownership, data access and data sharing, institutional and contractual arrangements