UNIVERSITÀ DI TRENTO

PhD in AGRIFOOD AND ENVIRONMENTAL SCIENCES

CALL 2021 – CYCLE 37

Title: AGRI 01 - Exploitation of mating interference for biological control of *Bagrada hilaris* - BIOBAG

Funding Body: University of Trento (C3A); Foundation BBCA Onlus

PhD Program Supervisor/s: Gianfranco Anfora (C3A), Massimo Cristofaro (Foundation BBCA Onlus), Valerio Mazzoni (FEM**)**

Context / Synthetic description of the project and research outcome

Invasive alien species adversely impact biodiversity and related ecosystem services, causing a multitude of negative effects on natural and agricultural ecosystems, thus resulting in heavy economic losses worldwide. The painted bug Bagrada hilaris is an invasive pest on several Brassicaceae, originally from Africa and Asia. It was recorded for the first time in the US in 2008 since then it is rapidly spreading in other territories. Its presence has also been reported in southern Europe (Pantelleria Island, Italy), where it is seriously damaging valuable caper crops. The risk of invasion of other areas, including the rest of Italy and Europe, is very high, with potentially devastating effects on the host crops of this phytophagous pest.
The aim of BIOBAG is therefore to characterise the still poorly understood biology of B. hilaris (intraspecific and interspecific communication) under quarantine laboratory conditions and consequently verify the potential application of developmental disruption methods for eradication and biological control.

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PhD in AGRIFOOD AND ENVIRONMENTAL SCIENCES

CALL 2021 – CYCLE 37

Title: AGRI02 - Insect rearing: welfare and sustainability - BEFWelSust

Funding Body: University of Trento (C3A), BEF Biosystems

PhD Program Supervisor/s:
Sihem Dabbou (C3A), Marco Meneguz (BEF Biosystems)

Context / Synthetic description of the project and research outcome

The global production of feeds has reached 1.07 billion metric tons, and the trend is expected to continue to increase in developing countries (FAO, 2020). As proteins are the most important component of animal feeds, new alternative sources which should not compete with land associated with soy or other crop production, are needed. Thanks to their nutritional composition and their low environmental impact, insects have become a promising alternative protein source for animal feeding (Gasco et al., 2019). One of the insect species with the highest potential to be used in animal feeds is the black soldier fly (*Hermetia illucens* L.; BSF). The larvae of this fly can be reared on low value organic waste, with low water demand and generating low greenhouse gas emissions (Meneguz et al., 2018). Generally, the meals obtained from BSF show a protein content ranging from 37% to 63%, and a fat content from 7% to 39% on a dry matter (DM) basis (Gasco et al., 2018). A limited number of international companies are developing insect rearing without considering insect welfare, transport and slaughtering, and substrates used or processing methodologies are not disclosed as they are considered confidential. The PhD doctoral project aimed to evaluate the effects of organic wastes (vegetables and fruits) and agro-industrial by-products generated by the Italian food sector as rearing substrates for BSFL, to study the Brambell's Report (five freedoms) on BSFL and finally to investigate the effect of BSFL in poultry diets.

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PhD in AGRIFOOD AND ENVIRONMENTAL SCIENCES

CALL 2021 – CYCLE 37

Title: AGRI03 - Identification of grapevine Pectato Lyase genes altering Berry Texture during ripening – BerTex

Funding Body: Fondazione Edmund Mach

PhD Program Supervisor/s: L. Dalla Costa; G. Malacarne

Context / Synthetic description of the project and research outcome

Berry crispiness is one of the most important qualitative traits for consumers in table grapes. It also impacts on the quality of the fruit during post-harvest and is therefore of considerable interest in breeding programs. The texture of the ripe berry is genetically determined and is the product of a complex organization of the cell wall polysaccharides (cellulose, hemicellulose and pectins) of the cells of the pulp and the skin. In particular, previous studies in grapevine have indicated that the loss of turgidity during the ripening of the berry is mainly caused by a solubilization of the pectin matrix by degradative enzymes, the expression of which is significantly modulated during the final stages of ripening. Furthermore, various works in tomato and strawberry have shown how the silencing of members of the Pectate Lyase (PL) gene family prolongs the turgidity of the fruit, reducing its susceptibility to the necrotrophic fungus Botrytis cinerea.

The general objective of this project is to investigate the mechanisms that regulate the texture of the grape berry during ripening. In particular, specific objectives are: 1) to identify the isoforms of the PL family potentially involved in texture regulation and 2) to demonstrate their function in planta. To this end, the rheological properties of the berry, the chemical composition and the structure of the skin and pulp cell wall in table grapes characterized by different texture properties, from extremely soft to extremely compact, will be analyzed. At the same time, an in-depth analysis of gene expression will be carried out on members of the PL and on other genes encoding enzymes known to be involved in the degradation of the wall. PL candidate genes will be then knocked out in 'Microvine', via gene editing based on CRISPR / Cas9 technology. 'Microvine' is a suitable model genotype that allows fast regeneration and flowering of transformed lines. The grapes of the edited lines will provide the material for the functional evaluation of these genes in grapevine.

The identification of genes controlling the texture of the berry can be of great interest not only for the table grape industry, but also for the wine sector, in particular for the defense against the fungus B. cinerea.

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PhD in AGRIFOOD AND ENVIRONMENTAL SCIENCES

CALL 2021 – CYCLE 37

Title: AGRI04 - Use of systems biology and NBT approaches to develop biotic and abiotic stress resistant grapevine plants - GrapeSystress

Funding Body: Fondazione Edmund Mach

PhD Program Supervisor/s: Mickael Malnoy

Context / Synthetic description of the project and research outcome

Climate change is projected to have negative impacts on the socioeconomic system. Despite the discrepancy between projected scenarios, even the most optimistic models predict an increase in the occurrence and duration of abnormal droughts and heat, especially in Mediterranean climate regions where water sources will become increasingly scarce. Climate change will also affect pest pressure and increase crop loss due to pathogen infection. These threats are of great concern for agriculture and in particular for viticulture, as it is one of the most profitable crops in these regions. In 2016, less than 10% of vineyards in the European Union were irrigated, even though they accounted for about 60% of global grape production. Thanks to the recent moderation of legal restrictions, irrigation use has increased in many states (for example, in 2018, the irrigated area of vineyards in Spain exceeded 30%). The deleterious effects of climate change will negatively affect the extent and quality of water sources, and irrigation alone is not a sustainable and sufficient strategy to counteract the expected impacts on grape production. To address these constraints, a general improvement in viticulture techniques is needed, and achieving this goal requires a better understanding of vine physiology under stress conditions. The drought/heat (abiotic stress) and fungal (biotic stress) tolerance strategy of the grapevine consists of a set of interactions between morphological/structural traits and a pronounced control of water loss through stomatal regulation. The latter is mainly mediated by hormonal regulation, and a central role in this process is played by abscisic acid (ABA).

The main objective of the project is to provide a comprehensive overview of the role of ABA in V. vinifera as a key hormone involved in the regulation of mechanisms to cope with major threats caused by climate change and genetically modify ABA biosynthesis or signaling to ameliorate biotic (pathogenic) and abiotic (drought, heat, metals) stresses. To this end, the use of public transcriptomic data to generate tissue-specific gene co-expression networks related to different biotic and abiotic stresses will be used to identify hub nodes (genes) as potential regulators. These genes will be used 1) to develop markers associated with drought/heat stress susceptibility or resistance, 2) to engineer grapevine genotypes to be overexpressed or deleted using a CRISPR/Cas9-based genome editing approach. The modified plants will be characterized for the level of resistance to biotic and abiotic stresses. In parallel, the generation of a microvine overexpressing ABACUS sensor for ABA will allow us to map on a spatio-temporal scale the levels of ABA in grapevine seedlings and fruits in response to different biotic and abiotic stresses and also during plant and fruit development. The project also aims to evaluate some of the edited and cisgenic grapevine lines obtained during the GRAPESYSTRESS project under field conditions.

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PhD in AGRIFOOD AND ENVIRONMENTAL SCIENCES

CALL 2021 – CYCLE 37

Title: AGRI05 - Efficacy and ecological impact of classic biocontrol programms against the spotted-wing drosophila, Drosophila suzukii -SWD-CBC

Funding Body: Fondazione Edmund Mach

PhD Program Supervisor/s:
Marco Valerio Rossi Stacconi

Context / Synthetic description of the project and research outcome

Non-native invasive insects threaten global biodiversity and food security resulting in substantial economic losses, which have been reported to exceed US$100 billion annually. The threat posed by these species is increasing due to various factors, such as globalization of trade and climate change. After invasion, a larger use of insecticides is required for their control, thus specific environmentally friend sustainable strategies are highly needed. The main aim of SWD-CBC is to develop classical biological control (CBC) programs against a main invasive pest in Trentino, the spotted-wing drosophila (SWD), Drosophila suzukii (Matsumura). For such pest, which is present throughout Italy, a risk assessment study has been recently submitted to get the authorization for the first field release of the Asian larval parasitoid Ganaspis brasiliensis, which has been already imported in FEM's quarantine facilities. Moreover, an adventive population of another exotic parasitoid, Leptopilina japonica, is currently spreading in North Italy.
Three interrelated and multidisciplinary work packages will allow a proper characterization of the biology, behavior and ecology of the two exotic parasitoids in the Trentino-Alto Adige's ecosystems. The acquired knowledge will be used to optimize the biocontrol services of the involved BCAs in the context of socio-economically sound Integrated Pest Management (IPM). Strong scientific impact is expected: SWD is an interesting model capable of shading new lights in the field of biocontrol. Such knowledge will accelerate the development and implementation of innovative pest management strategies. The final scope of this project is indeed to significantly impact on the applied research, the environmental health and the local society and economy of Trentino-Alto Adige.

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PhD in AGRIFOOD AND ENVIRONMENTAL SCIENCES

CALL 2021 – CYCLE 37

Title: AGRI06 - Genome editing for engineering resilience to climate changes in grapevine - STOMALTER
Funding Body: Fondazione Edmund Mach
PhD Program Supervisor/s: Lorenza Dalla Costa
Context / Synthetic description of the project and research outcome Numerous studies carried out on model plants and cereals have shown that the hormonal peptides of the "Epidermal Patterning Factors" family (EPF or EPFLike) play a key role in determining the behaviour of the plant in conditions of water stress. It is in fact known that some of these factors control the formation and distribution of stomata, microscopic pores located on the leaf surface responsible for the gaseous exchanges between the plant and the environment (water vapour output and incoming CO2). The aim of this project is to investigate the function of EPF peptides in grapevine by means of the genome editing technology to evaluate the applicative potential of their manipulation in the context of unfavourable environmental conditions.

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PhD in AGRIFOOD AND ENVIRONMENTAL SCIENCES

CALL 2021 – CYCLE 37

Title: AGRI07 - Research into the role of potential new vectors of apple proliferation phytoplasma – ORISHI

Funding Body: Fondazione Edmund Mach

PhD Program Supervisor/s:
Mario Baldessari

Context / Synthetic description of the project and research outcome

The mosaic leafhopper, Orientus ishidae (Matsumura) (Hempitera: Cicadellidae) is an Asian alien species widespread in Europe, where it is studied for its ability to transmit 16SrV phytoplasmas, associated to the grapevine disease, flavescence dorèe.
Following an outbreak of this species that was reported in 2019 in an apple orchard and due to its ability to transmit phytoplasmas we want to deeper investigate the possible role of O. ishidae in the epidemiology of Candidatus Phytoplasma mali, the causal agent of Apple Proliferation (AP) .
Moreover, we aim to deeply investigate the various aspects of the biology, ecology and agroecosystem relationships that O. ishidae is able to establish in Trentino-Alto Adige.
The final objective of this project is to increase knowledge about this species, since it can be used to contain this potential new pest.

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PhD in AGRIFOOD AND ENVIRONMENTAL SCIENCES

CALL 2021 – CYCLE 37

Title: FOOD08 - Rapid VOLAtilome profiling of raw and roasted HAZelnuts by direct injection mass spectrometric tools and correlation with their sensory quality through sensory and chromatographic assessment - VolHaz

Funding Body: Fondazione Edmund Mach

PhD Program Supervisor/s:
Dr. Franco Biasioli

Context / Synthetic description of the project and research outcome

The constant increase of the hazelnut market lead to the widening and fragmentation of the offer and, consequently, to the need for rapid tools to evaluate hazelnut quality. The VolHaz project combines the unique skills of Soremartec Italia srl, the Technical Research and Development and Marketing Company of the Ferrero Group, with those of the Sensory Quality unit at Fondazione Edmund Mach (FEM) for the rapid and non-invasive phenotyping of hazelnut volatile compounds in relation to sensory analysis, consumer preference
and genomic aspects.
In particular, the research project provides for the characterization of large hazelnut samplings with the reference gas-chromatographic analytical methods used by Soremartec Italia srl and with more rapid or less invasive innovative methodologies such as PTR-MS (Proton Transfer Reaction mass Spectrometry) and GC-IMS (Gas chromatography Ion Mobility Spectrometry). The analytical datasets will be analysed and correlated with sensory characterization and genomic information by advanced data mining techniques.
The selected PhD student will conduct the activity in a stimulating academic and applicative contest and will master some of the most interesting analytical methods for the phenotyping of food volatilome.

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PhD in AGRIFOOD AND ENVIRONMENTAL SCIENCES

CALL 2021 – CYCLE 37

Title: ENVI09 - A new game to play: emerging ecological functions of large herbivores in rapidly changing Alpine ecosystems - UNGULALPS

Funding Body: Fondazione Edmund Mach

PhD Program Supervisor/s:
Francesca Cagnacci

Context / Synthetic description of the project and research outcome

Anthropogenic modifications and climate change have profoundly reshaped Alpine landscape over the last decades, consequently affecting the density and distribution of key ecosystemic large herbivore species and, in turn, their impact on the vegetation community. In particular, red deer (Cervus elaphus) populations have substantially expanded, potentially influencing the vegetation structure due to intense browsing activity, and the functional relationships with other ungulates such as roe deer (Capreolus capreolus), chamois (Rupicapra rupicapra), and ibex (Capra ibex) through competition mechanisms. In this dynamic context, the interactions between Alpine large mammal species, in terms of spatial overlap and resource use, and between mammals and other trophic levels, e.g. plants or microbiota, as well as large carnivores that are recolonizing the Alps, are still largely unexplored.

Objective

Through a highly inter-disciplinary and innovative methodological approach, where Movement Ecology, Conservation Genetics, and Community Ecology will be integrated, the project UngulAlps aims to assess the horizontal and vertical functional relationships of large herbivores and disentangle their drivers under contrasting climatic, biotic, and management contexts. In particular, the competition between red deer and other ungulates will be assessed via analysis of their movement and spatio-temporal occurrence patterns, as well as by measuring the trophic niche overlap. The impact of red deer on the vegetation structure and composition in presence of changes in the mammal community and climate change shifts will also be assessed. The observed patterns will be compared across three close-by study areas subject to different land and wildlife management regimes, and mammals community at large.

Expected Results

UngulAlps will allow to evaluate, for the first time in an integrated and multi-disciplinary way, whether key mountain ungulate species are in direct (niche-based) or indirect (behavioural) competition. By analyzing movement, space use, behavioural cycles, diet and trophic functional interactions all at the same time, UngulAlps has the potential to disentangle drivers and confounding effects for the co-occurrence of multiple ungulate species. The ambition is to reconstruct the energetic flow in the main and allegedly competing ungulate species and understand how it is mediated by internal (physiology, behaviour) and external (presence of predators, anthropogenic disturbance, management practices) factors.

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PhD in AGRIFOOD AND ENVIRONMENTAL SCIENCES

CALL 2021 – CYCLE 37

Title: ENVI10 - SUPER (Snow rUnoff production in Po rivER basin)

Funding Body:
Department of Civil, Environmental and Mechanical Engineering (DICAM, University of Trento) - Autorità di Bacino Distrettuale del fiume Po

PhD Program Supervisor/s:
Riccardo Rigon, Silvano Pecora

Context / Synthetic description of the project and research outcome

The project aims to simulate the snow height and snow water equivalent over the Po Basin using the tools provided in the GEOframe system and the data provided by the Po Basin Authority. The project will also evolve existing codes of GEOtop (http://www.geotop.org)and Admunsen (https://github.com/openamundsen/openamundsen) and brought them to the GEOframe platform. Besides the project is intended to make leverage on the remote sensing data deriving from platform Sentinel to improve the snow forecasting which will include both snow water equivalent and snow height. The project is in collaboration with the Basin Authority of River Po. The final goal of the project is not the snow simulation by itself, but estimating the runoff production from snow, because of its importance for the Spring and Summer water resource management. Climatic forecast will also be pursued by using of stochastic weather generators.

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PhD in AGRIFOOD AND ENVIRONMENTAL SCIENCES

CALL 2021 – CYCLE 37

Title: ENVI11 - Development and testing of new parameterisation schemes and downscaling procedures for high-resolution numerical weather prediction and reanalysis

Funding Body:
Department of Civil, Environmental and Mechanical Engineering (DICAM, University of Trento) – Hypermeteo

PhD Program Supervisor/s:
Dino Zardi (C3A/DICAM), Gianluca Ferrari (Hypermeteo)

Context / Synthetic description of the project and research outcome

Numerical weather prediction (NWP) models are the main tools for the analysis and forecasting of weather and climate processes, at different space and time scales, providing a basis to decision-makers for a variety of applications in many different sectors.

Recent progress in available systems and instruments for earth observations, along with increasingly available computational resources, are offering unprecedented opportunities for improving the initialisation of model runs and the performance of modelling schemes. Indeed, to reproduce as accurately as possible the above processes, in view of precisely determine the resulting values of the atmospheric variables (e. g. air temperature, wind speed and direction, precipitation, atmospheric radiation, etc.), suitable parameterisations need to be implemented.

The research project goals include implementing a set of modelling and data analysis algorithms aimed at producing datasets representative of past and future state of the atmosphere, from local to global scale, especially for those meteorological variables that have the most significant impact on the economic activities and society.
In particular, the project aims at improving the performance of simulations from existing numerical weather prediction models through a three-fold approach:
(1) development and testing of innovative parameterizations of physical processes within the adopted numerical weather prediction models;
(2) improvement of initial and boundary conditions of model runs through the assimilation of data from a variety of observations (e. g. surface temperature, surface wind strength and direction, soil moisture content, vertical profiles of temperature and winds, etc.);
(3) development and testing of suitable ex-post downscaling techniques for refined estimate of model output or evaluation of subgrid-scale processes.

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PhD in AGRIFOOD AND ENVIRONMENTAL SCIENCES

CALL 2021 – CYCLE 37

ENVI12-13 – MUR – Departments of Excellence scholarships

Candidates interested in this scholarship can develop their research project on one of the following sub-topics:

Title sub-topic 1:

Understanding sediment transport processes for improving river management

Funding Body:
Borse finanziate dal MIUR – Dipartimenti di Eccellenza / MUR – Departments of Excellence scholarships

PhD Program Supervisor/s:
Walter Bertoldi, Marco Tubino

Context / Synthetic description of the project and research outcome

Knowledge and quantification of sediment transport processes is crucial for understanding the functioning of fluvial systems and for predicting their evolution in the next decades. Alteration of sediment flux has been widespread in many rivers during the last century, causing severe issues in terms of flood protection as well as extensive ecosystem degradation (Wohl, 2020).
The unprecedented availability of distributed spatial data, along with the continuous improvements of remote sensing techniques and modelling capabilities, are offering new opportunities to effectively characterize and quantify the morphological evolution associated with bed load transport processes in gravel bed rivers, opening new perspectives to river management, under different climate, flow regulation, and river restoration scenarios (Vericat et al., 2017, Bizzi et al., 2019, Brenna and Surian, 2019).
In this context, the goal of the project is to understand (i) the relevant spatial and temporal scales of bed load transport in rivers with different planform morphology; and (ii) the associated morphological patterns and their dynamics. Moreover, the research aims at assessing the most effective way to implement indirect measurements techniques (e.g. the morphological method, the virtual velocity method) to quantify bed load flux in gravel bed rivers.
The project is mainly based on physical modelling, taking advantage of new survey techniques to map bed load transport processes through photographic monitoring and using fluorescent tracers (Redolfi et al., 2017).
The successful candidate will have a strong engineering/geomorphological background, skills in coding (e.g. Python, MATLAB), experience (or strong interest) in performing laboratory experiments, and good organisation, collaborative and project management skills. Fluent spoken and written English, as well as good communication skills are required. The candidate is expected to present the results at international conferences and to publish scientific papers in top class journals.

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Wohl E. 2020. Rivers in the Anthropocene: The U.S. perspective. Geomorphology, 366, 106600.

Title of sub-topic 2: Response of meandering river dynamics to climate and anthropogenic stressors

Funding Body:
Borse finanziate dal MIUR – Dipartimenti di Eccellenza / MUR – Departments of Excellence scholarships

PhD Program Supervisor/s:
Guido Zolezzi, Marco Tubino

Context / Synthetic description of the project and research outcome

Meandering rivers are fundamental agents of the evolving landscape, especially in lowland – floodplain regions of the world, often characterized by intense anthropic activities such as agriculture, urbanization and infrastructural development. They display a multitude of forms and processes at a broad set of scales, connected to the river morphological dynamics, and their functioning is essential to sustain life on a variety of aquatic, riparian and terrestrial ecosystems.
The morphodynamic processes that control river meander dynamics have been mainly studied under equilibrium assumptions, though most of these rivers are far from such conditions, and follow morphodynamic evolutionary trajectories driven by human regulation and climate change.
These evolutionary trajectories are effective to understand river response to anthropogenic changes [Surian & Rinaldi, 2003, Fryirs & Brierley, 2016]. Predictive models are still limited by the assumption of equilibrium between sediment supply and transport capacity, which needs to be characterized at the proper time and space scales. Existing models for the planform evolution of river meanders are based on channel migration being locally driven by the differential excess of flow speed at the opposing banks [Bogoni et al., 2019], while globally governed by reference hydraulic conditions [Monegaglia & Tubino, 2019]. However, the reference state is specified with a constant discharge and a spatially invariant hydraulic geometry, while riverbed adaptation to anthropogenic and climate changes is still neglected.
The present PhD proposal aims at developing an integrated approach to predict the planform dynamics of river meanders under non-equilibrium conditions associated

with anthropogenic and climatic stressors. The research will combine mathematical modelling with the automated extraction and analysis of remotely sensed field data (Monegaglia et al., 2018) referring to both naturally evolving and human-regulated meandering rivers in different climatic, geological and environmental settings worldwide. The key foreseen outcomes are: (i) an integrated, non-equilibrim model of meander planform development; (ii) understanding how meandering evolutionary trajectories are controlled by relevant anthropogenic and climatic forcings.

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• Monegaglia, & al. (2018). Environ. Model. Softw., 105, 171-186.
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Title of sub-topic 3: Valorization of biowaste for material recovery: macro-nutrients and carbon for soil, and activated carbons for water remediation

Funding Body:
Borse finanziate dal MIUR – Dipartimenti di Eccellenza / MUR – Departments of Excellence scholarships

PhD Program Supervisor/s:
Luca Fiori

Context / Synthetic description of the project and research outcome

Biowaste treatment and management pose important environmental, social, and economical concerns. However, even if under-utilized, several technologies are nowadays at disposal for converting biowaste into useful materials to be used in several fields: e.g. agriculture, bioenergy sector, water treatment and remediation. With such a circular economy perspective, this research will address the upgrading of biowaste (in particular: agro, agro-industrial, and zootechnical waste) to products of great environmental interest: soil improver and fertilizer to be used in agriculture, and adsorbent media to be used for water remediation.
Some kind of biowaste are naturally rich in macronutrients (N, P, K): this project aims at recycling them to the land as substitute of synthetic chemical fertilizers, in the form of hydrochar, biochar, possibly after composting. All organic waste consists mainly of carbon atoms: a second goal of this project is to convert biowaste in materials having great adsorption capabilities, resembling the performances of activated carbons (a.c.), to be used for water remediation (typically a.c. find application in a water tertiary treatment in the framework of wastewater treatment plants).
Different technologies and their integration will allow to obtain the expected results: innovative technologies such as hydrothermal carbonization (HTC), and more traditional technologies such as anaerobic digestion and composting, will be coupled

in a symbiotic industrial process scheme, typical of the biorefinery approach, where all the streams will be valorized to achieve the zero-waste goal.
The approach to research will be primarily that typical of the chemical and process engineer, where experimentation in the lab will be performed in strict conjunction with process design, modeling, and optimization activities.
The PhD position is open primarily to chemical, environmental, energy, and industrial engineers.
The candidate is expected to have skills both in lab test execution and in software utilization (with commercial codes such as Aspen Plus and/or programming codes such as MATLAB), and should be effective in his/her working capability in a research group comprising researchers with different expertise profiles (experts in wastewater treatments and in the agronomy sector).
The candidate is expected to publish a substantial amount of paper (6-7 minimum during his/her 3-years PhD program) in high-impact factor journals.
Below, after the keywords, some references by the supervisor which could help the candidate to deliver an effective PhD research proposal taking into consideration what will be the research group in which he/she will operate and the experimental facilities that he/she will be able to use, either at the lab coordinated by the supervisor or at partner labs of this research.

Keywords: hydrothermal carbonization, water remediation, hydrochar, biochar, anaerobic digestion, composting, chemical and physical activation, process modeling, process simulation, circular economy, industrial symbiosis, process integration, activated carbons.

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