Freie Universität Bozen
Libera Università di Bolzano
Università Liedia de Bulsan

PhD programme in MOUNTAIN ENVIRONMENT AND AGRICULTURE

(Curriculum 2: Ecology, environment and protection of mountain areas)

Research projects and supervisors		
Curriculum 2: Ecology, environment and protection of mountain areas		
	Supervisor(s)	**Notes**
7. Evaluating the Impact of the Invasive Pathogen *Dothistroma septosporum* on Pine Forests in the Southern Alps under Global Change **Project description:** While shifts in tree species distribution are generally interpreted as direct responses of plant physiology to climate change, the role of biotic interactions, particularly with pathogens, remains underexplored and is often overlooked. Pathogens such as *Dothistroma septosporum* may act as key mediators of climate change impacts, potentially accelerating or reshaping vegetation dynamics beyond what would be expected from climate effects alone. Pine forests (Pinus cembra, Pinus mugo, Pinus sylvestris, and Pinus nigra) play a crucial ecological and economic role in the Southern Alps, contributing to soil protection, carbon sequestration, landscape value, and the provision of high-quality timber and non-timber forest products. However, these ecosystems are increasingly threatened by pests and diseases, whose impacts may be amplified under changing climatic conditions. The recent emergence of Dothistroma septosporum in the forests of Trentino–South Tyrol represents a potentially serious threat to pine species in the region. Initial field surveys have confirmed the widespread presence of the pathogen, with evidence of severe defoliation, tree decline, and mortality in affected stands. Dothistroma needle blight (DNB) has been detected across a wide altitudinal gradient, from valley bottoms to high mountain areas, highlighting the potential for extensive spread. This project aims to identify the main drivers of pathogen spread and to evaluate their impact on tree health and forest ecosystem dynamics. The study will investigate the ecology of the fungus, focusing on spore dispersal and infection conditions through spore monitoring, microclimatic measurements, and molecular identification techniques. The distribution and severity of the disease will be analysed in relation to environmental variables by	Prof. S. Baric	

integrating micro- and macro-climatic data, with particular attention to the role of climate change. The project will also explore the use of advanced monitoring tools, including remote sensing approaches based on satellite and drone data, to assess forest damage. These methods may be complemented by crown condition analysis and stand structure evaluation to provide a comprehensive assessment of the ecological impact of DNB. **Required qualifications:** The PhD student will conduct research on the interactions between fungal biology, plant physiological processes, and environmental drivers in mountain forest ecosystems, adopting an integrative and data-driven approach. Candidates should have a solid background in forest ecology, forest pathology, or related disciplines, along with quantitative and computational skills for the analysis of field and laboratory data. Experience with programming tools such as R or Python and basic knowledge of GIS and spatial data analysis are expected. **Preferred qualifications:** Experience in field surveys in forest ecosystems and familiarity with forest pathogens and their management are considered advantageous. Skills in laboratory analyses, including molecular techniques, are desirable. Experience with remote sensing data (e.g., satellite or drone imagery) is a plus. The ability to work in an international and interdisciplinary research environment, as well as the willingness to conduct fieldwork under mountain conditions, are also considered important.		
8. Climate Change: A Multi-Scale Approach at the Renon Supersite **Project description:** Evergreen needleleaf forests play a key role in the global carbon cycle, acting as highly effective systems for atmospheric CO_2 sequestration. Understanding how these ecosystems respond to ongoing changes in climate and atmospheric composition is essential for constraining future carbon–climate feedback. However, the processes linking tree physiology, growth, and environmental stress remain incompletely understood, particularly due to the limited availability of long-term observations. This project builds on a 26-year dataset from the Renon ecosystem station (Italy), part of the ICOS research infrastructure. The study aims to identify the main drivers of tree	Prof. L. Montagnani	

growth, carbon uptake and emission by integrating observations across multiple spatial scales. Tree-level measurements (tree-ring series, sap flow, and dendrometric data) will be combined with ecosystem-scale eddy covariance fluxes and landscape-level information on soil carbon stocks and vegetation structure across a four-square-kilometre area. By linking long-term observations with current measurements, the project will investigate how environmental variability and stressors affect plant physiological processes and ecosystem functioning. The integration of multi-scale datasets will support a more comprehensive understanding of forest responses to climate change. **Required qualifications:** The PhD student will conduct research on the interactions between plant physiological processes and environmental drivers in mountain forest ecosystems, adopting a multi-scale and data-integrative approach. Candidates should have a solid background in plant physiological ecology, ecosystem ecology, or related fields, along with quantitative and computational skills. **Preferred qualifications:** Experience in handling ecological datasets and familiarity with tree-ring analysis, sap flow measurements, or eddy covariance data are considered advantageous. Proficiency in programming languages such as Python, R, or MATLAB for data analysis and modelling is desirable. The ability to work in an international and interdisciplinary research environment, as well as the willingness to conduct fieldwork in cold conditions, are considered a plus.		
9. Functional Ecology of Endemic Plant Species of the South-Eastern Alps **Project description:** The South-Eastern Alps, including the Dolomites, constitute a hotspot of plant diversity, hosting a large proportion of Alpine endemics. For the endemic plant species that are restricted to these mountain ranges, they represent their only area of occurrence worldwide. In contrast, their closely related congeneric species with ecologically similar niches are more widespread and more frequent within their distribution ranges, creating a unique study system to address fundamental ecological questions about endemism.	Prof. C. Wellstein	

We propose to carry out a globally unique study aimed at elucidating the mechanisms underlying plant endemism by investigating the functional ecology of some of the most emblematic endemic species and their congeneric counterparts in the South-Eastern Alps. The project will build on existing databases on population occurrence, genetic diversity, and biogeography of these Alpine species. We will collect field data on physico-chemical conditions, climatic environment, and vegetation, and we will conduct measurements on plant functional traits both in the field and in the laboratory. Trait measurements will also incorporate herbarium specimens and innovative methodological approaches. Data will be analysed using advanced statistical methods, and the results will be disseminated through international peer-reviewed journals. The findings will further contribute to evidence-based nature conservation planning and management. **Required qualifications:** The PhD student will carry out research in botany, functional plant ecology, and environmental studies in mountain ecosystems. Candidates should have a solid knowledge of the Alpine flora, experience in mountain fieldwork, a background in plant ecology, and skills in statistical data analysis, preferably using the R software environment.		
10. Advancing forest ecology by means of ground robotics and multi-modal data fusion **Project description:** This interdisciplinary PhD project will investigate the integration of ground-based robotic platforms with multi-modal sensing to advance forest ecology, with a focus on linking functional traits to ecosystem functioning. The project aims to connect high-resolution measurements of forest structure, spectral traits, and microclimatic conditions (e.g., temperature, humidity, radiation) to ecological processes across scales. The research will involve the deployment of a robotic sensing system for data acquisition in complex, GNSS-denied forest environments. Complementary sensors (LiDAR, RGB, hyperspectral/thermal imaging, and environmental probes) will be used to capture structural, spectral, and microclimatic information, enabling the extraction of key functional traits and indicators of ecosystem dynamics.	Prof. E. Tomelleri	Project co-funded by Bruno Kessler Foundation (FBK)

On the robotics side, the work will focus on autonomous navigation and mapping strategies to ensure repeatable and spatially consistent sampling. On the data side, the research will address multi-modal data fusion and scaling, leveraging data-driven methods to support the interpretation of trait–environment relationships and ecosystem functioning. The expected developments and outcomes of the PhD might include: • Protocols for deploying autonomous robotic systems capable of autonomous ecological mapping and monitoring • Novel algorithms for multi-modal data fusion tailored to various forest environments • Improved understanding of links between forest structure, microclimate, and ecosystem functioning • Applications in precision forestry, such as early disease detection, carbon stock estimation, and adaptive management strategies • Different benchmarks/datasets to accelerate research in robotics-enabled forest ecology The PhD will be jointly performed at the University of Bolzano (Italy) – Faculty of Agricultural, Environmental and Food Sciences – and Fondazione Bruno Kessler (Trento, Italy) – 3D Optical Metrology unit. **Required qualifications:** The PhD candidate is expected to have a background in geomatics and/or ecology and an interest in processing and analysing complex datasets.		