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		
Title	**Supervisor(s)**	**Notes**
10. Enhancing Forest Productivity and Resilience: Exploring Tree Water Sources and Limitations at Renon Supersite **Description.** Forests play a crucial role in the terrestrial water cycle, regulating exchanges of water between the land surface and the atmosphere. However, as environmental disturbances become more frequent, forest hydrological cycles may shift. Alterations in canopy cover influence the water inputs to soils, affecting ecosystem function. Vapor pressure deficit and soil water availability are two key interacting factors that constrain transpiration and vegetation productivity. However, the relative importance of these factors in driving water and carbon flux responses to forest disturbances remains unclear. Stable water isotopes serve as tracers of hydrologic processes and can provide insights into ecosystem-atmosphere water exchange. This study investigates the water sources at the Renon Supersite to disentangle the effects of atmospheric and soil water deficits on tree and canopy functioning. By integrating productivity estimates from sap flow measurements, ^{13}C-derived water-use efficiency, and meteorological data with eddy covariance fluxes, this research aims to improve our understanding of plant functional traits and their role in forest ecosystem processes. **Key words**: Climate change, Forest productivity, Stable isotopes, Canopy interception, Tree transpiration. **Required knowledge:** The PhD student will conduct research on the interactions between ecophysiological processes and environmental drivers in mountain environments, adopting interdisciplinary methodologies. Candidates should have advanced understandings of forest ecophysiology, forest hydrology, and forest productivity. Preferred qualifications include the ability to work in an interdisciplinary team and experience with eco-physiological instrumentation and proficiency in Python, R, or MATLAB for data processing and statistical analysis. Experience with stable isotope analyses is also advantageous.	Prof. R. Tognetti and Prof. L. Montagnani	

11. Informing Post-Disturbance Forest Management: Examining Decomposition Dynamics and Their Effects on Forest Regeneration **Description.** Recent increases in forest tree mortality are expected to enhance deadwood abundance, potentially leading to elevated atmospheric CO_2 levels. Litter decomposition plays a crucial role in nutrient cycling and storage within forest ecosystems. However, the mechanisms driving decomposition processes in mountain forests—particularly in human-modified landscapes—remain poorly understood. This research quantifies decomposition dynamics and their relationships with environmental conditions across varying forest structures and management practices, utilizing chronosequences and long-term experimental plots. This study investigates decomposition alongside vegetation dynamics and soil physicochemical and biochemical properties. As forest canopy structure develops following disturbance, it may influence ecosystem functions by altering abiotic conditions. However, additional abiotic factors independent of canopy structure may also regulate decomposition. This study aims to elucidate how forest structure and environmental variables shape decomposition processes through their effects on soil biogeochemistry. **Key words**: Deadwood degradation, Forest regeneration, Litter decomposition, Stand structure, Soil biogeochemistry. **Required knowledge**: The PhD student will conduct research on the interactions between biogeochemical processes and environmental drivers in forest ecosystems, adopting interdisciplinary methodologies. Candidates should have advanced understandings of disturbance ecology, soil biogeochemistry, and stand mensuration. Preferred qualifications include the ability to work in an interdisciplinary team and experience with laboratory analysis, as well as proficiency in Python, R, or MATLAB for data processing and statistical analysis. Experience with LiDAR measurements is also advantageous.	Prof. R. Tognetti and Prof. L. Montagnani	
12. Identifying tipping point in climate change and consequences on alpine hazards **Description.** The Alps are undergoing accelerated climate change, characterized by rising temperatures and an increasing frequency of extreme precipitation events. These changes push the region closer to critical tipping points, where self-reinforcing feedback loops could make risk management exceedingly difficult. Understanding and analyzing the processes driving these dynamics are crucial for developing timely interventions to mitigate negative trends. This project leverages climate and hydrological monitoring data from South Tyrol to create conceptual	Dr. M. Zebisch and Dr. A. Andreoli	Project co-funded by Eurac Research

models for Alpine river basin management. By identifying key tipping points, these models will inform proactive strategies to prevent their crossing. Ultimately, the models will provide alternative management approaches to enhance climate resilience and mitigate hazards and risks in Alpine river basins. **Key words:** Climate change and resilience, Tipping points, Alpine watersheds, Hydrogeological processes, Natural hazard and risk mitigation **Required knowledge:** The PhD student will conduct research on the interactions between climate forcing and geomorphological processes in mountain environments, adopting various interdisciplinary methodologies. Candidates should have advanced understandings of climate change processes, precipitation patterns, and river basin dynamics in mountain environments. Ability to work in Interdisciplinary team and experience with Python, R, or MATLAB for large data set processing, statistical analysis, simulation, and model development are preferential.		
13. The challenge of sustainable forest rejuvenation under ungulates browsing in mountain landscapes **Description.** Combining existing data on population densities of ungulates, land-cover types, vegetation and climate with field work, the PhD student will study the interactions of browsing and forest rejuvenation in mountain landscapes of the Southeastern Alps. The analysis of ongoing dynamics touches traditional land-use practices and their modern development in one of the most emblematic mountain regions worldwide. Results of the study will contribute to closing research gaps of ecological sustainability and be integrated into management strategies and forest practices. **Keywords:** Sustainability, browsing, forest rejuvenation, landscape ecology. **Required knowledge:** candidates should possess a basic knowledge in plant, ecosystem and landscape ecology. Quantitative skills (statistics in R, (Q)GIS), experience in forest or animal ecology and willingness to do field work in a high mountain environment are beneficial.	Prof. C. Wellstein/R. Tognetti/L. Montagnani/T. Zanon.	