Transilvania University of Brașov
INTERDISCIPLINARY DOCTORAL SCHOOL

ADMISSION TO DOCTORAL STUDIES Session September 2025

Field of doctoral studies: Forestry
Doctoral supervisor: Prof.dr. Mihai Daniel Niță

TOPICS FOR THE ADMISSION TO DOCTORAL STUDIES

TOPIC 1: *Forests, human interventions, and the water cycle: A comparative study of forested watersheds in Romania and Sri Lanka*

Overview

Forests are essential regulators of the water cycle, contributing to soil moisture retention and safeguarding surface water quality, particularly within forested watersheds. In recent decades, direct and indirect human interventions—ranging from forest harvesting operations to agricultural encroachment—have increasingly disrupted these hydrological services. This research proposes a comparative study between temperate (Romania) and tropical (Sri Lanka) forested watersheds to evaluate the dual roles of forest structure and land-use interventions in influencing water balance and water quality.

The study will combine field measurements, remote sensing techniques, and satellite-derived soil moisture datasets to assess ecosystem responses in two contrasting ecological and socio-economic contexts. A specific focus will be placed on understanding how forest operations—such as thinning, road construction, and harvesting—affect stream water quality and sediment dynamics. Simultaneously, the study will monitor undisturbed reference catchments to establish baselines for hydrological function in natural forest systems. The overarching aim is to develop a comparative, evidence-based foundation for sustainable forest and watershed management.

Objectives

The primary objective of this research is to investigate how forest structural variability and anthropogenic activities influence water quality and soil moisture dynamics in forested watersheds. One aim is to understand the role of tree height, basal area, canopy cover, and forest age in regulating soil water retention. This relationship will be assessed using a combination of in-situ soil moisture sensors and satellite-derived soil moisture data. A second aim is to quantify how forest cover changes and ongoing forestry operations impact key water quality parameters such as turbidity, nutrient loading, and sediment transport.

Another important goal is to compare water-related forest ecosystem services between undisturbed catchments and watersheds undergoing human intervention. By monitoring both natural and managed systems, the research will differentiate between baseline ecological functioning and the effects introduced by logging or land-use conversion. Ultimately, the project will develop science-based recommendations for forestry practices that maintain or improve water quality and hydrological balance in forest landscapes.

Methods

The experimental design will involve field research in both Romania and Sri Lanka, with selected study sites including old-growth, secondary, and plantation forests. These will be paired with downstream transitional zones where water quality changes can be observed. In each forest

site, key structural variables such as tree diameter at breast height (DBH), canopy cover, basal area, and tree height will be recorded using traditional forest inventory techniques, and where available, LiDAR (terrestrial or UAV-based) will be used to capture 3D forest structure.
Soil moisture will be monitored using sensors installed at multiple depths to detect variations over time and between forest types. To complement ground-based measurements, satellite soil moisture data—such as that provided by the Soil Moisture Active Passive (SMAP) mission and ESA Climate Change Initiative (CCI)—will be integrated to assess spatial and temporal trends across the landscape scale. These data sources will help bridge the gap between plot-level observations and regional-scale forest-water interactions.
Water quality will be monitored by collecting samples upstream (in forested areas) and downstream (in areas influenced by land use or forest management). Parameters to be measured include pH, conductivity, turbidity, temperature, nitrate and phosphate concentrations, and total suspended solids (TSS). Sampling will be conducted at regular intervals and after specific forestry operations to evaluate immediate and long-term effects on water quality. The availability of catchments with active forest operations will guide the experimental focus in assessing the direct impact of logging on stream integrity.
Remote sensing and GIS techniques will support land-use classification, forest cover monitoring, and change detection. Imagery from Sentinel-2 and Landsat will be used to map land cover and disturbances using vegetation indices such as NDVI and NBR. Geospatial analyses will also be used to delineate watershed boundaries, monitor road expansion, and estimate forest loss. Statistical analyses will include correlation studies, regression modeling, and multivariate approaches to assess the relationships between forest variables, land-use dynamics, and hydrological responses.

Expected Outcomes
This research will provide a detailed understanding of the relationship between forest structure and soil moisture retention, based on both field and satellite data. It will generate empirical evidence showing how forest operations alter water quality by influencing sediment load and nutrient concentrations in streams. The comparison between Romanian and Sri Lankan watersheds will yield insights into how climate, forest type, and management intensity interact to shape hydrological outcomes.
The research will also offer a set of indicators and thresholds to guide sustainable forest operations, with emphasis on minimizing negative impacts on water quality. By including undisturbed forest catchments in the analysis, the project will establish ecological baselines necessary for evaluating intervention effects. The final outcome will be a comparative framework and a set of practical recommendations for forestry and water authorities to integrate hydrological considerations into forest management planning.

International Relevance
This topic addresses global challenges in forest and water governance, particularly the growing need to harmonize forest exploitation with the conservation of water-related ecosystem services. It contributes directly to Sustainable Development Goals, including SDG 6 (Clean Water and Sanitation), SDG 13 (Climate Action), and SDG 15 (Life on Land). The project will also support implementation of the EU Forest Strategy, the Water Framework Directive, and Sri Lanka's national forest and watershed policies. Through its comparative design, the research promotes international knowledge exchange and offers transferable insights for temperate and tropical forestry systems alike.

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☐ Professional Doctorate (full-time or part-time)

☒without tuition fee (state budget funded)
☒ with tuition fee or with funding from other sources than the state budget

TOPIC 2: *Quantifying human influence on forest structure and plant diversity: A comparative study between Postăvaru Mountain, Romania and Suhuma Forest Reserve, Ghana*

Overview

Human activities such as logging, tourism, and agricultural expansion have significantly influenced forest ecosystems across the globe, altering both structural characteristics and biodiversity patterns. This research proposes a comparative study of two ecologically distinct yet human-impacted forests: Postăvaru Mountain in Romania and the Suhuma Forest Reserve in Ghana. While Postăvaru represents a temperate mixed montane forest with increasing recreational pressure, Suhuma lies in the moist semi-deciduous zone of southwestern Ghana and is shaped by selective logging and shifting cultivation. Both regions are valuable case studies for understanding the long-term effects of land-use change and human intervention on

forest composition and structure.
The study integrates satellite remote sensing data and field surveys to assess how land-use and land-cover (LULC) changes have altered forest structure and plant diversity over the past five decades. Structural metrics derived from LiDAR satellite data (GEDI) will be paired with ground-based vegetation surveys in plots stratified across disturbance gradients. The aim is to quantify human-induced transformations and identify patterns in vegetation stratification, species richness, and canopy complexity, ultimately providing insights for forest conservation in two contrasting biogeographical zones.

Objectives
The primary objective of this study is to quantify the degree to which human intervention has modified forest structure and plant diversity in Postăvaru Mountain and the Suhuma Forest Reserve. This involves analyzing long-term LULC dynamics, identifying trends in structural complexity, and assessing the resulting changes in species composition.
A first goal is to detect and map changes in land cover and forest extent between the 1970s and 2024 using multitemporal satellite imagery and data products such as those from Global Forest Watch. The second goal is to assess how these landscape-level trends have translated into structural changes, such as shifts in tree size distribution, vertical stratification, and overall vegetation diversity. Field-based data collection will focus on documenting species presence, abundance, and forest structural parameters using the Braun-Blanquet method and standard forestry inventory protocols.

Methods
LULC change analysis will be conducted using multi-temporal satellite data, including Corona Spy Satellite for 1960s-1980s Landsat 5 for the 1980s - 1990s, Landsat 8 for 2013–2020, and Sentinel-2 for 2015–2024. Supervised classification methods will be used to create LULC maps at different time points, followed by post-classification comparison to detect areas of deforestation, regrowth, and land conversion. This temporal analysis will be further supported by Global Forest Watch datasets to integrate forest loss/gain trends over the long term.
To assess forest structure from space, data from NASA's Global Ecosystem Dynamics Investigation (GEDI) LiDAR mission will be used. GEDI provides canopy height, vertical vegetation profiles, and foliage height diversity metrics that will be extracted for plot locations in both study areas. Field plots will be distributed across forest development stages (e.g., old-growth, secondary, and disturbed stands) and stratified by elevation, canopy cover, and accessibility.
Within each plot, tree species will be identified, and measurements of diameter at breast height (DBH) will be taken. The vertical profile of each plot will be described by noting the presence and dominance of canopy, understory, and ground vegetation layers. Vegetation composition will be recorded using the Braun-Blanquet method to derive diversity indices and vegetation cover estimates. The data will be used to calculate structural diversity indices and to compare human impact gradients across both locations.

Expected Outcomes
The study will produce high-resolution maps of land-use and forest cover change for both study areas over the past five decades. It will also generate a comparative dataset of forest structure metrics derived from GEDI LiDAR and field measurements. These datasets will reveal how forest height, canopy layering, and species composition have responded to varying intensities and types of human pressure.
By comparing forest systems in a temperate and a tropical context, the research will provide insights into the resilience and vulnerability of different forest types under similar anthropogenic drivers. The analysis will contribute to understanding how structural diversity

and plant composition reflect historical and current land-use practices. Ultimately, the study will support informed decision-making for forest conservation and sustainable management in Europe and West Africa.

International Relevance

This PhD research addresses urgent global concerns about biodiversity loss and forest degradation by integrating geospatial technologies with ecological field methods. It contributes directly to international efforts such as the UN Decade on Ecosystem Restoration and supports monitoring of the Sustainable Development Goals, particularly SDG 15 (Life on Land). The comparative nature of the study promotes knowledge exchange between temperate and tropical forest regions and provides a scientific basis for conservation strategies that account for both ecological and social dimensions of forest change.

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Doctoral supervisor,	Coordinator of the field of doctoral studies,
Prof. Dr. Nita Mihai Daniel	Prof. Dr. Ionescu Ovidiu
Signature	Signature