



Assessing the impacts of invasive and expansive plant species on mountain grasslands using unmanned aerial vehicles and botanical field surveys

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Introduction

Invasive and expansive plant species increasingly threaten highly specialised mountain communities by reducing biodiversity and driving taxonomic and functional homogenisation. Their spread is promoted by land-use change, including tourism development and the abandonment of traditional management. This two-year interdisciplinary project TACR SS07020317 combines botanical field surveys with innovative geospatial methods to assess the distribution, impacts, and management responses of three alien invasive plant species *Rumex alpinus*, *Telekia speciosa*, and *Lupinus polyphyllus*, and two native expansive plant species *Veratrum album* and *Senecio nemorensis* agg. in the Krkonoše and Orlické Mountains (Czech Republic, Central Europe).

Methods

Botanical field survey



- 112 permanent vegetation plots (25 m² with nested 10 m² subplots) across 16 sites
- Cover of all vascular plant species and key traits of invasive and expansive species (height, LAI, phenology, vitality) recorded in 2024–2026
- Real-world management regimes monitored throughout the season (mowing, grazing, mulching, hand-pulling, and herbicide application)
- Mixed-effects models and multivariate analyses used to assess impacts on species richness, diversity, and community composition, accounting for site identity and repeated sampling (2024–2025)

Alien invasive plant species



Geospatial methods



- Multispectral UAV imagery and high-precision botanical ground-truth data collected across key phenological stages (2024–2026) for species detection and assessment of management effectiveness.
- >5,200 GNSS-referenced training and validation polygons (including true absences)
- Deep-learning species detection using U-Net and DeepLabV3
- 43 RGB and 43 multispectral UAV datasets at 1-cm resolution

Results

Effects of dominant species on plant community

- Dominant species alter community composition without affecting species richness.
- Shannon diversity decreases under *Lupinus polyphyllus* (both scales) and *Telekia speciosa* (small plots only).
- Strongest compositional shifts were caused by *Rumex alpinus* and *Telekia speciosa*, while other species showed weak or non-significant effects.

UAV-based vegetation mapping using deep learning

- High-accuracy UAV mapping (>90%, 15 sites) provides a validated baseline for species distribution and assessment of vegetation changes.
- Multi-temporal UAV surveys (2024–2025, 1 cm resolution) capture seasonal and interannual vegetation dynamics across habitats.
- Early-season imagery increases species detectability.
- AI-assisted workflow (U-Net, DeepLabV3) generates training data directly from UAV imagery, reducing manual effort while preserving botanist-level mapping detail.
- High-resolution UAV dataset (1 cm, 15 sites, 2024–2025) includes >50 billion image-derived values, a 50+ GB orthomosaic archive, and centimeter-level geometric accuracy (0.8–1.7 cm).
- The assessment of the dominant species' response to various management practices is still in progress.



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Continuous sheep
grazing (3 years)
→ *Lupinus*
disappeared

Method: U-Net +
backbone: ResNet-34
F1-score: 0,82

