CHARLES UNIVERSITY
Faculty of Science

Team of Image and Laboratory Spectroscopy
WWW.TILSPEC.CZ

EARSeL

AALTO 2026

EARSeL Workshop on Imaging Spectroscopy
14th International Workshop · Helsinki 2026
is.earsel.org/workshop/14-IS-Helsinki2026

Monitoring Expansive Species in the Krkonoše Mountains Using Multi-resolution Hyperspectral Image Data

Lucie Kupková[1] · **Lucie Červená**[1] · **Vít Ježek**[1] · **Jakub Lysák**[1] · **Adam Kulich**[1] · **Markéta Potůčková**[1] · **Záboj Hrázský**[1] · **Stanislav Březina**[2]
[1] Charles University Prague, Faculty of Science – Dept. of Applied Geoinformatics and Cartography, Czech Republic
[2] The Krkonoše National Park Administration, Czech Republic

Study Area & Challenge

The **Krkonoše National Park** (Czech-Polish border) harbours extensive species-rich mountain meadows and unique arcto-alpine tundra threatened by expansive grass species encroaching into both habitats, directly threatening biodiversity.

Key challenge: Upscaling accurate plot-level classifications to entire tundra areas while preserving thematic detail – essential for park-wide conservation.

Study site: tundra near **Luční bouda** chalet (50.73°N, 15.70°E). Two 1-ha intensive plots + wider 1.2 km² tundra. Imagery 2019–2021.

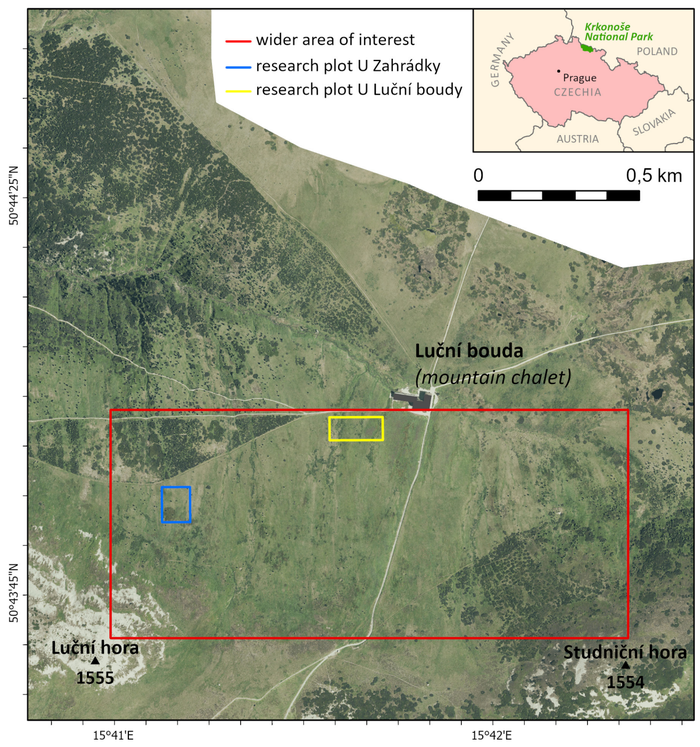

Fig. 1 – Study area: U Zahrádky (blue), U Luční boudy (yellow), wider tundra (red), Krkonoše NP.

Fig. 2 – Arcto-alpine tundra; Luční bouda chalet.

Fig. 3 – Tundra with Sněžka peak.

Target Species

Molinia caerulea	*Nardus stricta*	*Picea abies*
Deschampsia cespitosa	*Avenella flexuosa*	*Pinus mugo*
Calamagrostis villosa	*Vaccinium myrtillus*	

Image Data & Methods

UAV Hyperspectral	UAV Multispectral	Aerial HS (CASI)
Headwall NANO DJI M600 · 3 cm 270 bands Jun/Jul/Aug 2019–2020 MNF 10/30 bands	MicaSense Altum Atmos Marlyn · 6 cm 5 bands (RGB,NIR,RE) September 2021 Single date	Cessna + CASI 60 cm · 48 bands 380–1050 nm September 2020 1.2 km² area
≤95% OA	**≤93% OA**	**≤82% OA**
1-ha plots	1-ha plots	wider area

Raw imagery → Radiometric corr. → MNF (10 bands) → GNSS samples → Classification

Methods: pixel-based **SVM**, **MLC**, **RF** and **OBIA** (reflectance + texture). Multitemporal composites (Jun+Jul+Aug) tested on 1-ha plots. 1/3 training, 2/3 validation.

Classification Accuracy – Overall

Multitemporal UAV hyperspectral composites achieved the highest overall accuracies on both 1-ha plots – outperforming single-date data by up to 27 pp.

Dataset	U Luční boudy (OA %)				U Zahrádky (OA %)			
	MLC	RF	SVM	OBIA	MLC	RF	SVM	OBIA
UAV HS – July	68	86	80	91	86	92	91	93
UAV HS – August	69	87	83	91	87	93	92	94
UAV HS – Multitemporal*	92	95	94	**95**	90	93	94	**95**
UAV MS (single-date)	53	79	75	85	87	88	92	93

* multitemporal composite Jun + Jul + Aug. Best values bold.

95%	82%	>77%	+27 pp.
Best UAV HS OA	CASI aerial (RF)	F1 expansive spp.	Multitemp. gain

Per-Species F1-Scores

Species abundance is the decisive factor – rare classes yield low F1 despite advanced methods.

Low abundance severely limits F1-score. Sufficient training samples per category are critical.

Wider Tundra: CASI vs. UAV MS

For the 1.2 km² tundra, RF best for CASI; OBIA best for multispectral. CASI F1-scores comparable to multitemporal PlanetScope (Kupková et al. 2023, RSE 294) but with far more spatial detail.

Data type	MLC (%)	RF (%)	OBIA (%)
CASI aerial hyperspectral	72	**82**	80
UAV multispectral (Altum)	67	78	**83**

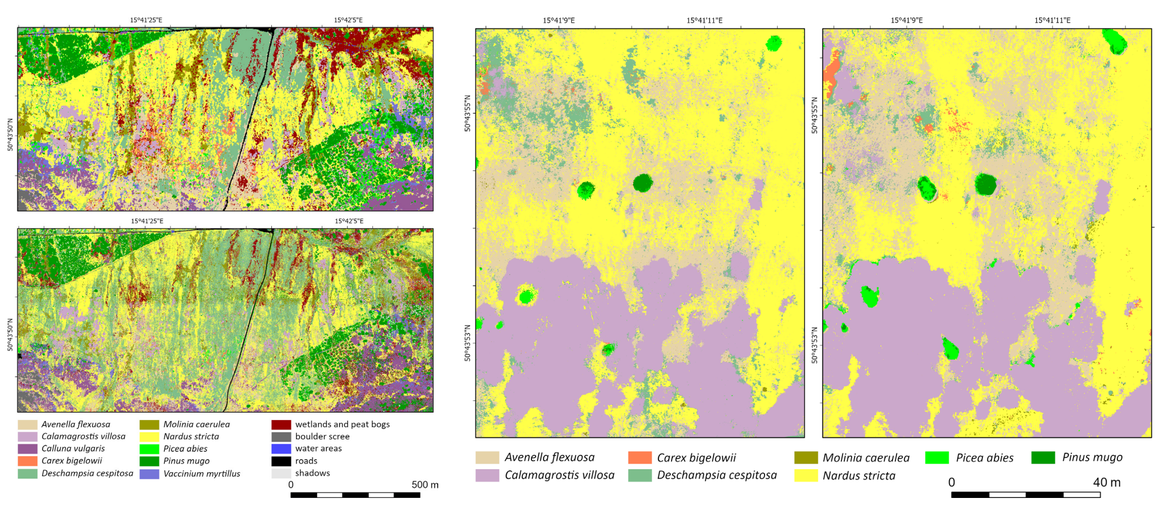

Fig. 4 – Left: Classification – UAV HS OBIA (top) vs. UAV MS OBIA (bottom), plot "U Luční boudy". Right: Map outputs from SDM classifier for small plot U Zahrádky – UAV hyperspectral multitemporal data (left image) and UAV multispectral data (right image).

Hyperspectral vs. Multispectral

UAV HS Multitemporal	UAV MS Single-date	Aerial HS (CASI)	Satellite MS (PlanetScope)
✓ Highest accuracy (>90%) ✓ Best for rare species ✓ Fine spectral discrimination × High acquisition cost × Limited area coverage	✓ Cost-effective ✓ Wide area possible ✓ Comparable on simple plots × Lower spectral resolution × Weaker rare-species ID	✓ Park-wide coverage ✓ Rich spectral information ✓ Better than PlanetScope × Single date only × Coarser spatial resolution	✓ Free, park-wide, multitemporal × Insufficient accuracy × Poor species separation × Coarse class mapping only

Key Conclusions

Multitemporal beats single-date	OBIA leads on UAV data	Species abundance is decisive	Park-wide upscaling is feasible
Adding Jun, Jul & Aug composites boosts OA by up to 27 pp. – critical for phenologically similar grass species.	Object-based analysis outperforms pixel classifiers for high-resolution UAV imagery; RF achieves the highest accuracy for CASI aerial data.	Rare species achieve low F1 despite advanced methods. Dense field sampling per category is essential.	CASI hyperspectral data bridges the gap between plot-level and park-wide monitoring of expansive grasses.

✓ By enabling detection and mapping of expansive species threatening biodiversity at tundra scale, hyperspectral image data provide a powerful tool for conservation planning and ecosystem management.
✓ Hyperspectral data provide a powerful tool for detecting and mapping expansive species at tundra scale – enabling park-wide conservation planning.

Acknowledgements
Supported by the Technology Agency of the Czech Republic:
- Monitoring the spread and management of invasive and expansive species using advanced earth observation methods (SS07020317)
- Innovative Monitoring of Alien Species and Assessment of Their Long-term Spread into Non-intervention Areas: Effects of Anthropogenic Disturbances and Climate Change (SQ02010073)

Contact & Team
Corresponding author: lucie.kupkova@natur.cuni.cz
TILSPEC Research Team – www.tilspec.cz
Dept. of Applied Geoinformatics & Cartography, Charles University Prague
Key reference: Kupková et al. (2023). Remote Sensing of Environment, 294, doi.org/10.1016/j.rse.2023.113645