BEYOND PLANTING: INNOVATIVE APPROACHES TO FOREST REGENERATION

Forests face increasing threats from climate change, including rising temperatures, altered precipitation, wildfires, and pest infestations, which disrupt their natural regeneration processes. While seedling planting is a common reforestation approach, it is costly and often shows low survival rates [1,2], prompting interest in direct seeding methods as a more cost-effective alternative.

Drone-based sowing and monitoring are emerging as promising tools, particularly in remote and challenging areas. Leveraging UAVs with multispectral imaging technology enables efficient tracking of forest regeneration success, offering valuable insights into seedling health and site conditions while overcoming the limitations of traditional methods. This study focuses on evaluating forest regeneration success using multispectral data acquired by UAVs to enhance reforestation outcomes.

OBJECTIVES

DRIVING FOREST RECOVERY WITH UAV PRECISION

- operate UAVs (unmanned aerial vehicles) to support precise, large-scale reforestation
- test biodegradable seed carriers for optimized germinaiton
- analyze multispectral data to select ideal sowing sites and monitor growth

EVALUATION OF FOREST REGENERATION SUCCESS USING MULTISPECTRAL DATA ACQUIRED BY UNMANNED AERIAL VEHICLE

KRAUSKOVÁ DOMINIKA, HERBER STANISLAV, MAREŠ VIKTOR, PATOČKA ZDENĚK

Department of Forest Management and Applied Geoinformatics, Faculty of Forestry and Wood Technology, Mendel University in Brno, zdenek.patocka@mendelu.cz

METHODOLOGY

- reforestation sites selected based on vegetation type, topography, and accessibility
- UAV flights planned to acquire high-resolution imagery over selected area
- high-resolution RGB and multispectral images acquired at altitudes of 80, 40, and 25 meters
- training samples of saplings collected using RTK GNSS

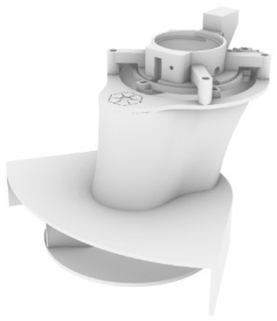
RGB image - altitude of 80 m (pixel resolution 2 cm)

RGB image - altitude of 40 m (pixel resolution 1.2 cm)

RGB image - altitude of 25 m (pixel resolution 0.6 cm)

- several biodegradable materials and seed pods designs have been tested for effective germinaiton

Biodegradable seed capsules mounted on UAV



Dronecoria Seed Sower

- 3D-printed seed dispersal device has been developed, allowing deployment of both small and large seeds across terrain

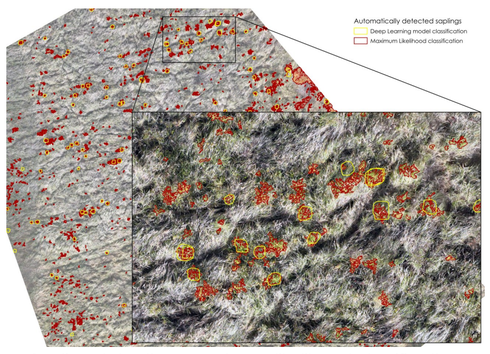
DATA PROCESSING

- high-resolution data processed into multispectral orthophoto mosaics, point clouds, and digital elevation model (DEM)
- outputs supported detailed spatial analysis of terrain features
- automatic classification used to identify ideal sowing spots and current saplings detection

Automatic classificaiton algorithms used:

- Support Vector Machine
- Random Trees
- Maximum Likelihood
- Deep Learning Model

(sapling detection)



Sapling detection - maximum likelihood classification compared to deep learning model

RESULTS

- high-resolution data shows early success in identifying optimal sowing spots and sapling detection
- deep learning models support effective classification of vegetation cover, enabling long-term monitoring

References

1. Banin, Raine E.H., L.M. Rowland, L.M., Chazdon, R.L. et al., 2022. The road to recovery: a synthesis of outcomes from ecosystem restoration in tropical and sub-tropical Asian forests. Phil. Trans. Biol. Sci., 378 (2022), Article 20210090.

2. Summers, B.A. Bryan, M. Nolan, T.J. Hobbs. The costs of reforestation: a spatial model of the costs of establishing environmental and carbon plantings. Land Use Pol., 44 (2015), pp. 110-121. 10.1016/j.landusepol.2014.12.002

https://www.ldf.mendelu.cz

ACKNOWLEDGEMENTS

This research was supported and funded by Internal Grant Agency MENDELU within the project IGA24-FFWT-TP-002 Sowing using unmanned aerial vehicles and biodegradable capsules

MENDELU Faculty of Forestry and Wood Technology