Comparative analysis of SLAM and TLS LiDAR technologies for biodiversity relevant information extraction over two Natura 2000 Sites in Greece

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INTRODUCTION

Biodiversity monitoring is a critical global priority, requiring reliable and precise information on forest and tree attributes to ensure sustainable management and biodiversity conservation.
Remote Sensing (RS) technologies, and particularly LiDAR (Light Detection and Ranging), have emerged as transformative tools in forest monitoring, offering high-resolution 3D data acquisition and the ability to capture complex forest structures with great precision. However, effectively surveying dense and heterogeneous forest environments remains a significant challenge. The study, conducted as part of the hELlenic BIOodiversity Information System (EL-BIOS). This research encompasses selected three 0.1 ha plots, distributed in two distinctive protected areas: the **Kotychi–Strofylia National Park,** south Greece and the **Northern Pindos National Park,** north Greece.

The **aim of the study** is to assess the potential of SLAM and TLS technologies in accurately estimating forest structural parameters relevant to biodiversity monitoring. Specifically, the **objectives** include collecting high-resolution 3D point cloud data using both methods, extracting key forestry metrics such as tree height and diameter at breast height (DBH) using open-source tools: **LAStools** and **3D-Forest**, optimizing algorithm configurations for individual tree detection, and validating LiDAR-derived outputs against traditional field measurements. Through this approach, the study assesses SLAM's feasibility as a fast, portable, and cost-effective alternative to TLS, highlighting the potential of 3D scanning for large-scale biodiversity monitoring and forest management.

CITATIONS

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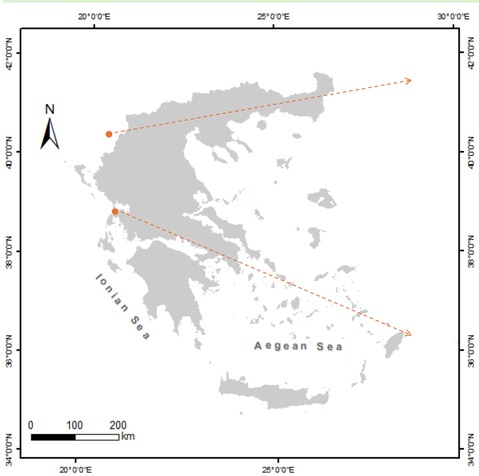
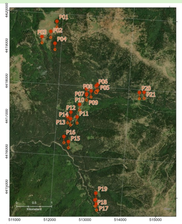
Trochta, J., Krůček, M., Vrška, T., & Král, K. (2017). 3D Forest: An application for descriptions of three-dimensional forest structures using terrestrial LiDAR. *PLOS ONE*, *12*(5), e0176871. https://doi.org/10.1371/journal.pone.0176871

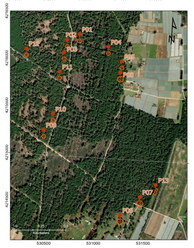
Panagiotidis, D., Abdollahnejad, A., & Slavík, M. (2021). Assessment of Stem Volume on Plots Using Terrestrial Laser Scanner: A Precision Forestry Application. Sensors, 21(1), 301. https://doi.org/10.3390/s21010301

STUDY AREA & DATA



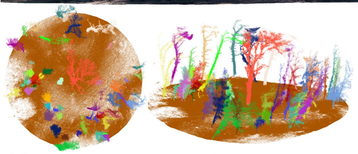


Pindos National Park, North Greece

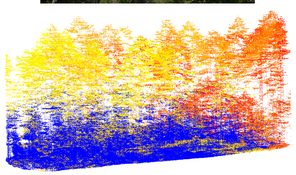


Kotychi–Strofylia National Park, South Greece

Field view of the plot (P14), in Pindos

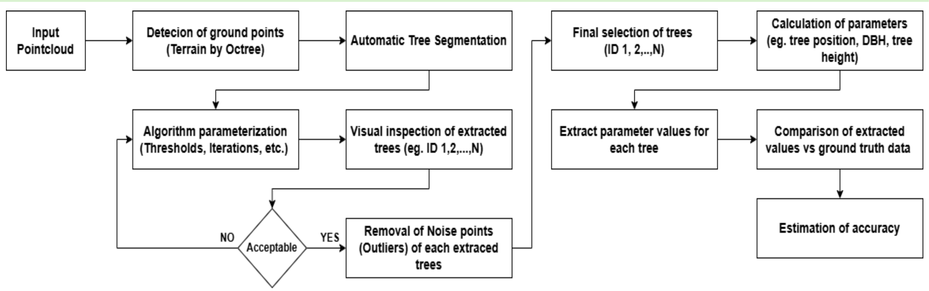


3D visualisation structure of trees in a selected plot using TLS dataset in Pindos (top), automated segmented trees from SLAM dataset in Kotychi-Strofylia (bottom)



Example plot (P14) with high black Pine trees, in Pindos

ANALYSIS WORKFLOW



RESULTS

Area	Plot	Max DBH			Min DBH			Mean DBH			Sum DBH		
		SLAM	TLS	Field	SLAM	TLS	Field	SLAM	TLS	Field	SLAM	TLS	Field
National Park Kotychi-Strofylia	P01	119.2	110	70	3.6	18	4	39.3	58.23	24.71	1022.8	2029	1038
	P09	68.2	92.4	66	9	18	8	35.4	47.2	34.84	1168.6	1463.2	1324
National Park Pindos	P14	84.84	85.6	88.3	5.99	4.8	5.2	42.36	38.60	37.18	2627	3826	4385.8

Area	Plot	Max Height			Min Height			Mean Height			Sum Height		
		SLAM	TLS	Field	SLAM	TLS	Field	SLAM	TLS	Field	SLAM	TLS	Field
National Park Kotychi-Strofylia	P01	15.4	18.06	26.2	4	3	6.5	10.4	11.17	14.8	289.82	223.49	622
	P09	16	20.33	20	6	1.5	11	10.3	9.68	15.08	338.59	280.71	573
National Park Pindos	P14	18.85	26.35	43.1	8.8	9.2	9.8	14.84	18.95	24.66	1736	2602	2910.6

Area	Plot	Tree number			Overall Accuracy (%)	
		SLAM	TLS	Field	SLAM vs Field	TLS vs Field
National Park Kotychi-Strofylia	P01	28	30	42	66.67	71.43
	P09	26	32	38	68.42	84.21
National Park Pindos	P14	77	92	118	65.25	77.97

CONCLUSIONS

- **TLS and SLAM** are effective alternatives to traditional forest inventory, offering faster data collection
- **TLS** was more accurate in Pindos due to taller, complex trees, while **SLAM** performed comparably in Strofylia's shorter, simpler forest structure.
- **TLS** achieved an accuracy of **approximately 75%** in tree detection, while **SLAM** ranged **between 60% and 65%**

ACKNOWLEDGEMENTS

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