Scientific Papers. Series E. Land Reclamation, Earth Observation & Surveying, Environmental Engineering. Vol. XIV, 2025
Print ISSN 2285-6064, CD-ROM ISSN 2285-6072, Online ISSN 2393-5138, ISSN-L 2285-6064

ADVANCING CADASTRAL UPDATES AND GIS SPATIAL ANALYSIS FOR FORESTED AREAS

Iulia COROIAN[1], Silvia CHIOREAN[1], Rodica SOBOLU[1], Diana FICIOR[1], Paul SESTRAS[1, 2], Luca-Pavel RUS[1], Catalin-Stefanel SABOU[1], Luisa ANDRONIE[1]

[1]University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, 3-5 Calea Mănăștur Street, 400372, Cluj-Napoca, Romania
[2]Academy of Romanian Scientists, 3 Ilfov Street, District 5, 060044, Bucharest, Romania

Corresponding author emails: silvia.chiorean@usamvcluj.ro, diana.ficior@usamvcluj.ro

Abstract

This article explores innovative approaches to improving cadastral systems and utilizing Geographic Information System (GIS) tools for forest management. It emphasizes the importance of accurate and up-to-date cadastral records to support sustainable forest management, land ownership clarity, and environmental preservation. The study outlines methodologies for integrating cadastral updates with advanced GIS spatial analysis techniques, enabling the efficient mapping and monitoring of forested areas. Key applications include assessing land use changes, detecting illegal activities, and planning conservation efforts. The research highlights how GIS tools enhance spatial data visualization, offering insights into forest density, composition, and land-use dynamics. By analysing case studies from forested regions, the article demonstrates practical implementations and benefits, including improved decision-making for policymakers, forest managers and environmental stakeholders. The integration of cadastral updates and GIS-based analysis represents a significant step toward ensuring the sustainable management of forested areas, balancing ecological protection with economic and social considerations.

***Key words**: forested area, GIS, cadastral updates.*

INTRODUCTION

Given the rapid growth of the global population, land emerges as a critical resource requiring strategic management. In this context, ensuring legal assessment, clear definition, and accurate registration of real estate is essential - especially when advancing cadastral updates and GIS spatial analysis for forested areas, where precise land delineation supports sustainable planning and resource protection (Chiorean et al., 2024).
The Geographic Information System (GIS) is a contemporary tool widely applied across various domains for managing both attribute and spatial data, including demographic information, playing a vital role in advancing cadastral updates and spatial analysis for forested areas by enabling precise mapping, monitoring, and informed decision-making.
The primary objective of this study is to develop updated cadastral documentation for a land parcel within the Administrative-Territorial Unit (ATU) Telciu and to conduct a spatial analysis within a Geographic Information System (GIS) framework. The spatial and raster analyses focus on evaluating the forested area and timber volume, encompassing a precise assessment of forest extent, species composition, and available timber resources. To achieve this, an accurate delineation of property and forest boundaries was performed using advanced measurement techniques and high-precision GPS equipment, ensuring a clear and reliable definition of land contours. Additionally, a photogrammetric flight was conducted to obtain high-resolution imagery of the terrain. The data acquired through photogrammetric processing in Agisoft Metashape has been integrated into ArcGIS Pro for in-depth spatial analysis. The results are to be disseminated via ArcGIS Online, enabling interactive visualization and efficient data sharing with both stakeholders and the broader public. This approach enhances the accessibility and interpretability of geospatial information. Ultimately, the study is set to result in the development of accurate and up-to-date cadastral documentation, incorporating all

analyzed and processed data. This documenttation comprises detailed cadastral maps and technical reports, prepared in accordance with current regulations and standards, thereby ensuring precise property registration and long-term availability of data for land management and administrative purposes.

The inherent nature of agricultural activities means that risks and uncertainties are a constant presence in agricultural value chains. Therefore, it is crucial for decision support models in farming to incorporate risk management metrics and strategies. This becomes particularly relevant in the context of advancing cadastral updates and GIS spatial analysis for forested areas, where accurate spatial data and land parcel information can significantly enhance risk assessment and support more resilient decision-making in forest-related agricultural systems.

MATERIALS AND METHODS

Telciu is located in Bistrița-Năsăud County, in the Transylvania region of Romania. The locality is situated at coordinates 47°24'N 24°53'E and covers an area of 291.42 km². It is traversed by two rivers, Sălăuța and Telcișor, which originate from the Rodna and Țibleș Mountains. The commune of Telciu consists of the villages of Telciu, Fiad, Telcișor, and Bichigiu. It borders the localities of Romuli, Dragomirești (Maramureș), Rebra, Rebrișoara, Coșbuc, Runcu Salvei (Salva), Suplai, and Zagra (Figure 1).

The initial phase of the study involved defining the study area, with a specific focus on the targeted forest (Figure 2).

Data processing was conducted using ArcGIS Pro and ArcGIS Online, ensuring the integration and standardization of all raster and vector datasets. These datasets were harmonized in terms of spatial resolution, coordinate reference system (Stereographic 1970, Romania's national projection system), and the extent of the study area. The Digital Elevation Model (DEM) and Digital Surface Model (DSM) were utilized to generate thematic maps representing slope, aspect, curvature, and hill shade, which provided a detailed understanding of the terrain characteristics. The results were synthesized through spatial analysis, facilitating the classification of the study area, forest structure assessment, and the evaluation of tree volume and height.

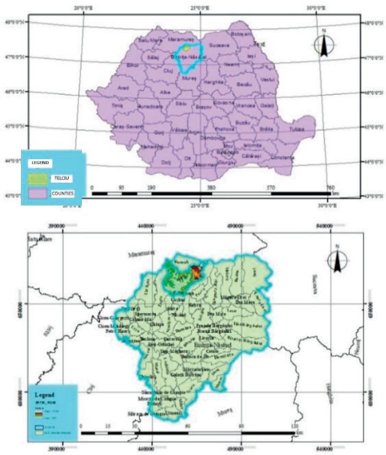

Figure 1. Macrolocalization of Bistrița-Năsăud County

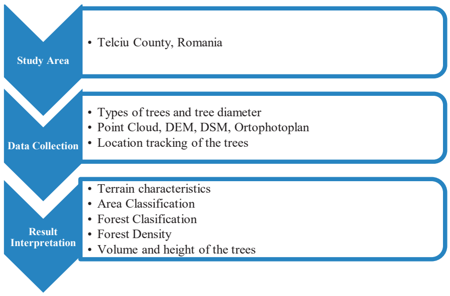

Figure 2. Research methodology

For the study of the proposed objective, the following equipment and instruments were used to conduct field measurements, delineate and map the forest, and inventory the trees: GPS V200, DJI MAVIC 3M drone, forestry calliper, and forestry measuring tape. Additionally, various specialized software tools were employed to ensure the collection, processing, and analysis of the data required for forest evaluation. For effective forest management, ArcGIS Online was utilized: a secure cloud-based platform for mapping and spatial analysis, provided as a software-as-a-service solution. This platform enables organizations to leverage geospatial insights through its scalable and resilient technology, supporting the collection, management, and analysis of geospatial data. By facilitating data-driven decision-making,

Scientific Papers. Series E. Land Reclamation, Earth Observation & Surveying, Environmental Engineering. Vol. XIV, 2025
Print ISSN 2285-6064, CD-ROM ISSN 2285-6072, Online ISSN 2393-5138, ISSN-L 2285-6064

ArcGIS Online allows for seamless sharing of maps and applications. With a configurable sharing model and a wide range of integrated applications and analytical tools, the platform enhances collaboration and efficiency among users.

RESULTS AND DISCUSSIONS

As part of the cadastral documentation preparation, a property data update file was compiled, encompassing operations such as boundary and area modifications, land use category updates, and corrections to other critical property information. These procedures require the submission of specific supporting documents and may involve multiple types of technical updates simultaneously. The resolution of such requests is conducted while preserving the area determined through measurements as recorded in the land registers, thereby ensuring the accuracy and currency of cadastral data. The reception and registration request form is intended to facilitate the update of cadastral information, including revisions to land use classifications and parcel identifiers. The approved updates are subsequently integrated into the national cadastral and land registration system. The property is not subject to litigation/is subject to litigation with the property ID [property ID], case number [case number], court [name of the court], subject [subject of the dispute].

After updating the land use categories, the property located in the outskirts of Telciu, Bistrița-Năsăud County, is described as follows: it consists of three distinct parcels. Parcel 1 has an area of 4,944 sqm and is classified as PD (forest). Parcel 2 has an area of 8,027 sqm and is classified as F (hayfield). Parcel 3 has an area of 2,522 sqm and is also classified as PD (forest). Following the update process, the total measured area of the property remains 15,495 square meters, as illustrated in Figure 3. In the absence of leaves, flowers, and fruits, species identification relies primarily on the morphological characteristics of bark and branches. During the winter season, features such as bark texture, color, and pattern serve as key diagnostic traits for differentiating between species (Figure 4; Mikita et al., 2016).

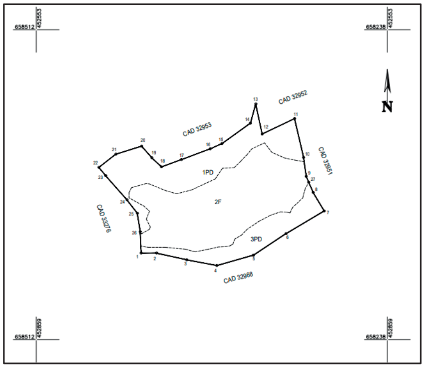

Figure 3. Delimitation Plan after Update

Figure 4. Types of trees

Figure 5. Determination of tree diameter

Figure 5 presents the methodology and equipment utilized for measuring tree diameter, employing the traditional approach. This method involves the use of a specialized forestry instrument, the caliper, to obtain precise diameter measurements. In the context of tree height measurement, the described method utilizing a forestry tape requires ascending the tallest tree to obtain a direct measurement, which serves as a reference for estimating the height of other trees. While this approach can provide practical and accurate results, it presents considerable safety risks due to the necessity of climbing tall trees. To enhance both accuracy and safety, tree height was determined using data derived from photogrammetric processing (Figure 6) (Meng et al., 2019).

To conduct the planned study, a photogrammetric flight was performed using the DJI Phantom 4 RTK drone. This drone is widely utilized for photogrammetric applications due to its high-resolution camera and integrated sensors, which collectively ensure superior imaging performance. The advanced technology incorporated in this drone enables data acquisition with centimetre-level accuracy, eliminating the necessity for additional ground control points. Equipped with an integrated RTK module, the drone provides real-time positioning data, ensuring absolute geo-tagging of the captured images. Additionally, to optimize flight safety and enhance data precision, the DJI Phantom 4 RTK records satellite observation data, which can be post-processed (PPK) (Risna et al., 2023). The photogrammetric data was processed using Agisoft Metashape software, involving the reconstruction of previously acquired images to generate a dense point cloud (Soubry et al. 2021).

Figure 6 illustrates the resulting 3D model/point cloud, which consists of a set of data points within a three-dimensional coordinate system (X, Y, Z axes). Each point corresponds to a precise spatial measurement on the surface of the object (Coroian et al., 2021).

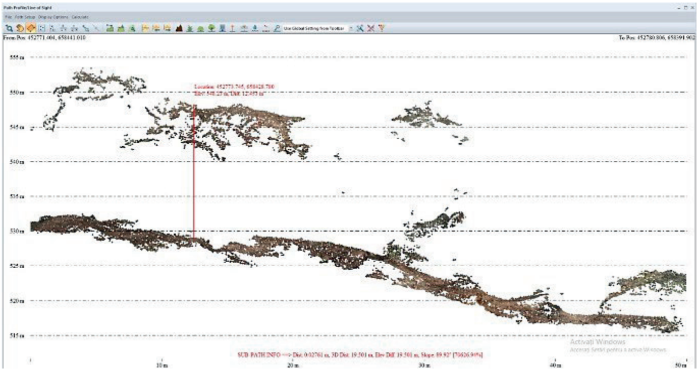

Figure 6. Point Cloud of the terrain

In contrast, Figure 7 illustrates a more efficient and safer approach for measuring tree height by utilizing Point Cloud technology. This method leverages photogrammetrically acquired data to generate an accurate three-dimensional model of the studied area, enabling precise height measurements (Zlinszky et al., 2015).

Figure 7. Point Cloud

Figure 8 presents the orthophoto map, an aerial image that has been geometrically corrected to remove distortions caused by aircraft tilt during image acquisition, variations in photogrammetric scale, and topographic relief differences (Qiu et al., 2018).

Figure 8. Ortophotomap

For the forest monitoring system, a technology was employed that enables real-time tree localization and tracking using ArcGis Online (Figure 9) (Boroushaki et al., 2010).

Utilizing a mobile device, the precise position of each tree is determined with centimetre-level accuracy through integrated GPS technology. During field data collection, trees are documented through photographs and videos captured with the mobile device's camera, ensuring a comprehensive visual record for identification and assessment (Brovelli et al., 2016). Additionally, a digital field notebook is used to record essential attributes for each tree, including species, diameter, height, and volume (Li et al., 2011).

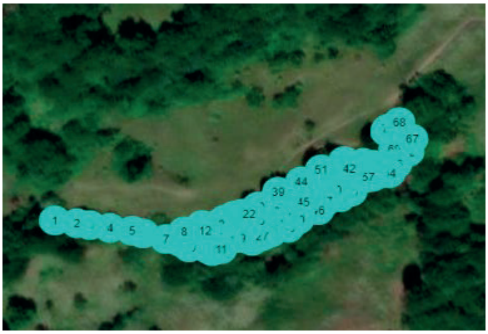

Figure 9. Real-time location tracking

Table 1 presents the classification of the study area, which has been categorized into three distinct land types: Upper Forest, Lower Forest, and Meadow (Figure 10). The Upper Forest covers 4,944.47 square meters, making up 32% of the total land area. The Lower Forest occupies 2,522.89 square meters, which constitutes 16% of the total. The Meadow extends over 8,027.37 square meters, accounting for the remaining 52%. Altogether, these areas sum to a total of 15,495 square meters.

Table 1. The classification of the area

Land use category	Area
The Upper Forest	4944 (32%)
The Lower Forest	2523 (16%)
Meadow	8027 (52%)
Total Area	15495

Figure 10. Thematic Map for area classification

Using the data presented in the Tables 2 and 3, a direct comparison can be made between the upper and lower forest in terms of species diversity and tree abundance. The upper forest comprises four tree species beech, hornbeam, maple, and willow while the lower forest contains only three species: beech, maple, and willow. Additionally, differences are observed in the number of trees per species. The upper forest consists of 48 beech trees, 39 hornbeams, 12 maples, and 2 willows, amounting to a total of 101 trees (Table 2). In contrast, the lower forest contains 45 beech trees, 16 maples, and 11 willows, summing up to 72 trees (Table 3) (Cammerino et al., 2023).

Table 2. The Upper Forest Classification

The Upper Forest	Area
Beech	48 (48%)
Hornbeam	39 (39%)
Maple	12 (12%)
Willow	2 (2%)
Total	101

Table 3. The Lower Forest Classification

The Lower Forest	Area
Beech	45 (63%)
Maple	16 (22%)
Willow	11 (15%)
Total	72

Figure 11 presents the forest classification, in which four tree species have been identified: beech, hornbeam, willow, and maple.

Scientific Papers. Series E. Land Reclamation, Earth Observation & Surveying, Environmental Engineering. Vol. XIV, 2025
Print ISSN 2285-6064, CD-ROM ISSN 2285-6072, Online ISSN 2393-5138, ISSN-L 2285-6064

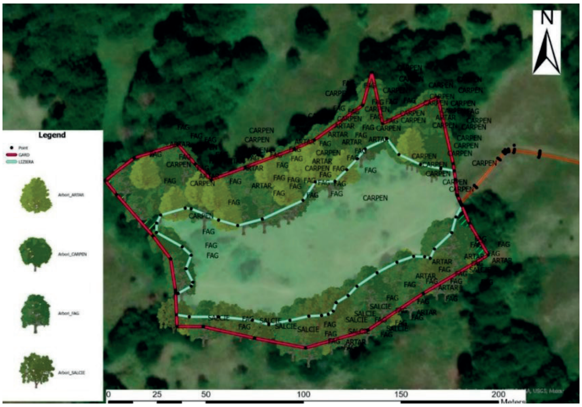

Figure 11. Thematic Map for forest classification

In assessing forest density, the analysis was conducted based on the volume of each tree species. Figure 12 visually represents forest density using a color-coded classification, as indicated in the legend. Areas with high tree density, where trees are closely spaced and create a shaded environment, are depicted in yellow. Conversely, regions with low tree density, characterized by widely spaced trees and a more open landscape, are represented in gray blue. This colour differentiation facilitates a rapid and clear interpretation of the spatial distribution of tree density within the forest. Identifying areas of higher density enables the planning of thinning operations to promote the optimal growth and diameter expansion of the remaining trees (Chakhar et al., 2008).

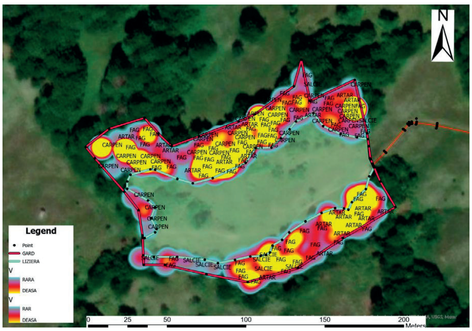

Figure 12. Thematic Map for forest density classification

Using the graphs presented in Figure 13 and Figure 14, a comparative analysis of the timber volume between the Upper Forest and the Lower Forest was conducted. The volume was calculated based on Huber's Theory, allowing for an objective assessment of the differences in timber mass between the two forest areas.

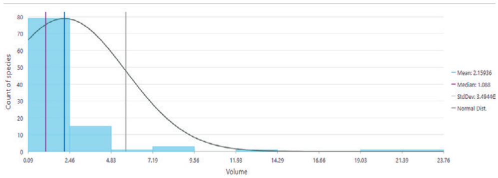

Figure 13. Volume of Upper Forest

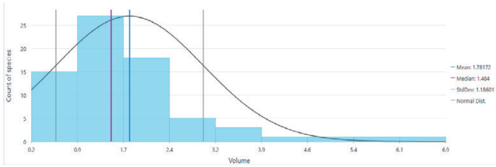

Figure 14. Volume of Lower Forest

In the Upper Forest, the predominant timber volume ranges from 0.09 m^3 to 2.46 m^3, encompassing most tree species, with a total of 79 trees within this range. Conversely, in the Lower Forest, the dominant volume falls between 1.1 m^3 and 1.5 m^3, with 19 trees recorded in this interval.

Additional comparisons, displayed on the right side of each graph, include the mean and standard deviation. These statistical indicators provide further insights into the distribution of timber volumes, highlighting differences in variability and central tendencies between the two forest areas.

Figure 15 represents the tree heights in both the upper and lower forests. As shown in the legend, the heights are categorized into five distinct ranges, each represented by a specific colour: white for trees ranging from 10 to 14 meters, green for those between 15 and 18 meters, light blue for trees between 19 and 21 meters, blue for heights between 22 and 26 meters, and dark blue for towering trees measuring between 26 and 30 meters. This color-coded classification offers a clear and visually informative representation of the variation in tree heights across the two forests (Sestras et al., 2019).

Figure 15. Thematic Map for tree height classification

Using the graphs provided below (Figure 16 and Figure 17), a direct comparison can be made between the Upper Forest and the Lower Forest with respect to tree heights, categorized into five distinct classes.

Further comparisons are provided through the mean values and standard deviations, offering additional insights into the distribution of tree heights in both forests and emphasizing the differences in variability and central tendencies between the Upper Forest and the Lower Forest (Felicisimo et al., 2002). Figure 18 illustrates the tree diameters in both the Upper and Lower Forests. According to the legend: in the Upper Forest, tree diameters range from 0.10 meters to 1.1 meters, with a gradual colour transition from white to dark green and in the Lower Forest, tree diameters range from 0.16 meters to 0.58 meters, following a similar colour progression from white to dark green. This color-coded representation emphasizes the variation in three sizes across both forests, offering a clear and visually informative view of their structural composition (Curovic et al., 2020).

Using the graphs from Figure 19 and Figure 20, a direct comparison can be made between the central tendencies of diameter distributions in the Upper and Lower Forests. In the Upper Forest, the most common diameter range is between 0.1 meters and 0.3 meters, encompassing 69 trees. In contrast, in the Lower Forest, the predominant diameter range is between 0.24 meters and 0.33 meters, with 31 trees within this range. Additional comparisons, including mean values and standard deviations, offer further insights into the distribution of tree diameters in both forests.

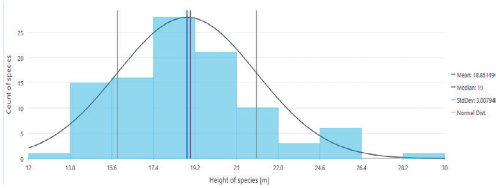

Figure 16. Tree Height in the Upper Forest

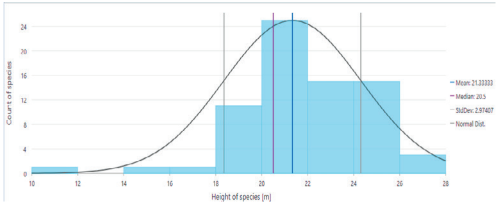

Figure 17. Tree Height in the Lower Forest

Figure 18. Thematic Map for Tree Diameter Classification

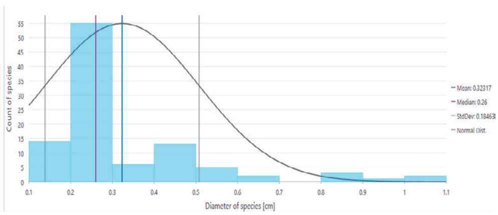

Figure 19. Diameter of the Upper Forest

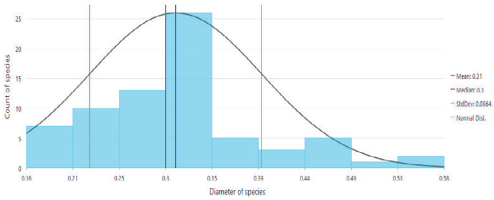

Figure 20. Diameter of the Lower Forest

Figure 21 presents the Digital Elevation Model (DEM), which offers detailed information exclusively about the terrain. This DEM is critical for understanding the area's topography. According to the legend, the elevation difference spans 255 meters, from the lowest to the highest point. This substantial variation in elevation is fundamental for various geospatial analyses and can impact a range of applications, from infrastructure planning to natural resource management.

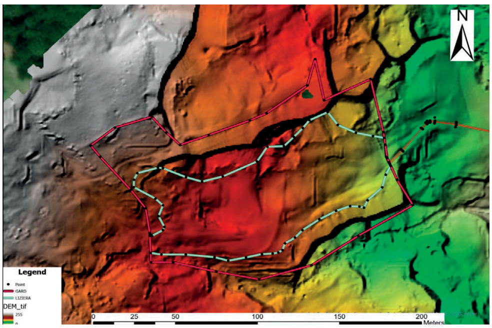

Figure 21. DEM - Digital Elevation Model

Figure 22 presents the Digital Surface Model (DSM), which depicts the elevations of all surface features within the terrain. Unlike the Digital Elevation Model (DEM), the DSM incorporates not only the ground level but also the heights of structures such as buildings, trees, and other forms of vegetation.

The DSM essentially captures all surface elements, providing a comprehensive and detailed representation of the topography and all objects located above the ground.

It offers valuable insights into the canopy structure, including its height and density. These models are particularly useful for monitoring temporal changes, such as deforestation, reforestation, and forest health.

Figure 23 illustrates the aspect, which indicates the orientation of slope exposure. This information is essential for planning future afforestation efforts, as it influences microclimatic conditions, soil moisture distribution, and species selection (Pasqualini et al., 2011).

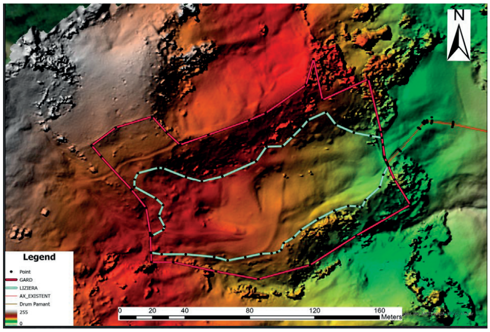

Figure 22. DSM - Digital Surface Model

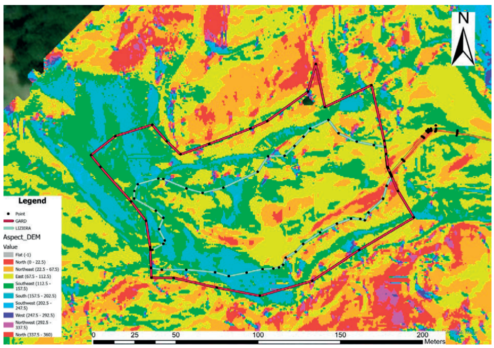

Figure 23. Aspect

Figure 24 presents the Curvature tool, which facilitates the analysis of landforms and geological processes. This tool is instrumental in land use planning, natural resource management, and environmental studies. By utilizing curvature analysis, a detailed assessment of terrain morphology can be conducted, providing essential data for various geological and environmental applications.

Figure 25 presents the HillShade tool, which generates a shaded relief raster from a surface raster by simulating the effects of a light source and shadow formation. This tool assumes a distant light source to create a realistic terrain representation. The resulting raster contains integer values ranging from 0 to 255, indicating the intensity of light and shadow distribution across the terrain, enhancing the visualization of topographic features.

Scientific Papers. Series E. Land Reclamation, Earth Observation & Surveying, Environmental Engineering. Vol. XIV, 2025
Print ISSN 2285-6064, CD-ROM ISSN 2285-6072, Online ISSN 2393-5138, ISSN-L 2285-6064

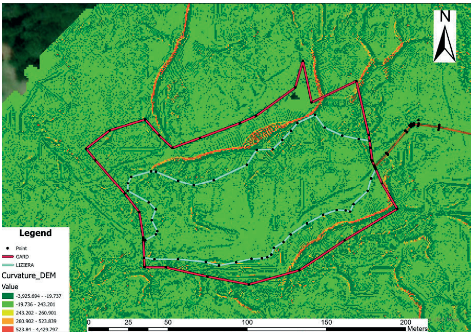

Figure 24. Curvature

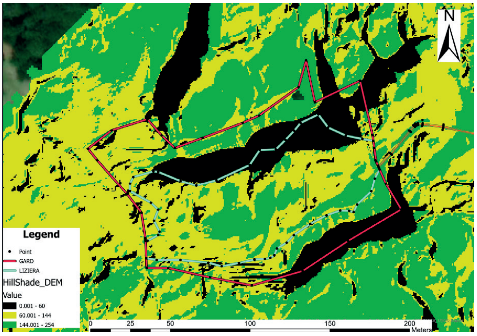

Figure 25. HillShade

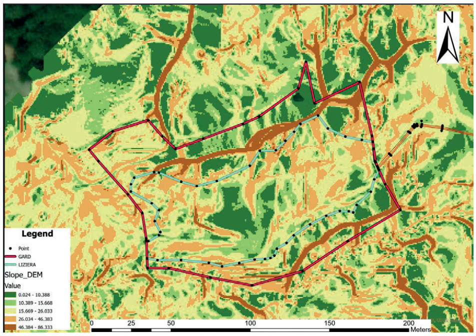

Figure 26. The terrain slope

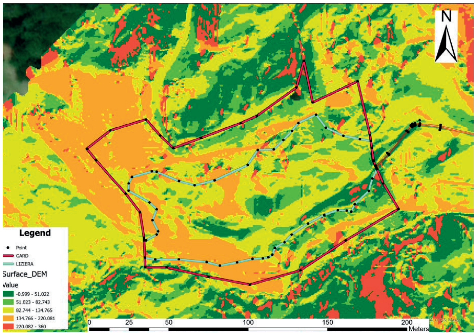

Figure 27. Surface parameters aspect

Figure 26 illustrates the terrain slope. According to the legend, the slope is categorized into five classes based on degrees of inclination. The green range represents slopes between 0 and 11 degrees, while the brown range corresponds to slopes between 47 and 87 degrees.
The Surface Parameters tool in ArcGIS Pro is a key resource for analyzing raster surface characteristics, including aspect, slope, and curvature. These parameters provide crucial information about terrain orientation and inclination across different locations. For example, the aspect defines the direction of the terrain slope and is classified into five categories, expressed in degrees, as indicated in the Surface result legend.
Figure 27 illustrates the natural risk assessment, which supports informed decision-making and strategy development. Areas highlighted in red represent risk zones located outside the studied terrain but requiring stabilization measures, such as planting deep-rooted trees to enhance slope stability.

CONCLUSIONS

The integration of advanced software tools, GPS technology, and traditional forestry methods enabled precise delineation of property and forest boundaries, ensuring accurate measurements and mapping. Modern inventory technologies, including mobile applications, specialized forestry tools, and Point Cloud technology, facilitated an efficient and secure assessment of forest resources.
By utilizing ArcGIS Online and smartphone-based geolocation, a detailed forest inventory was created, documenting essential attributes such as species, diameter, height, and volume. Photogrammetric flights and subsequent data processing yielded high-precision results, contributing to effective land and forest management. Geospatial analyses provided key topographic insights: the Digital Elevation Model (DEM) revealed a 255-meter elevation difference between the lowest and highest points, the Digital Surface Model (DSM) captured terrain objects such as buildings and vegetation, aiding in monitoring deforestation,

reforestation, and forest health, aspect analysis provided slope exposure data, supporting afforestation and land management planning, contour lines illustrated terrain relief, while curvature analysis enhanced the understanding of landforms and geological processes, slope classification divided the terrain into five categories based on incline, aiding in landscape and the Surface Parameters tool in ArcGIS Pro enabled the evaluation of aspect, slope, and curvature, offering essential data for environmental and resource management applications.

These comprehensive assessments support sustainable forestry practices, informed decision-making, and effective land use planning.

ACKNOWLEDGEMENTS

This research was carried out with the support of the Ministry of Education and was financed through the CNFIS-FDI-2024-F-0195 project, funded by the National Council for Financing Higher Education (CNFIS).

REFERENCES

Boroushaki, S., & Malczewski, J. (2010). A WebGIS-based collaborative multicriteria decision analysis. *Journal of the Urban and Regional Information Systems Association, 22*(1), 23–32.

Brovelli, M. A., Minghini, M., & Zamboni, G. (2016). Public participation in GIS via mobile applications. *ISPRS Journal of Photogrammetry and Remote Sensing, 114*, 306–315. https://doi.org/10.1016/j.isprsjprs.2015.06.008

Cammerino, A. R. B., Ingaramo, M., Piacquadio, L., & Monteleone, M. (2023). Assessing and mapping forest functions through a GIS-based, multi-criteria approach as a participative planning tool: An application analysis. *Forests, 14*(1), Article 1. https://doi.org/10.3390/f14010001

Chakhar, S., & Mousseau, V. (2008). GIS-based multicriteria spatial modelling generic framework. *International Journal of Geographical Information Science, 22*(11–12), 1159–1196. https://doi.org/10.1080/13658810701739099

Chiorean, S., Coroian, I., Sălăgean, T., Nap, M. E., Deak, J., & Lupuț, I. (2024). Global trends on research towards the valuation process of agricultural land. *Scientific Papers Series Management, Economic Engineering in Agriculture & Rural Development, 24*(2), [page numbers].

Coroian, I., Nap, M. E., Pop, I., Matei, F., Sălăgean, T., Deak, J., Chiorean, S., Suba, E. E., Luput, I., & Ficior, D. (2021). Using GIS analysis to assess urban green space in terms of real estate development. *Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca. Horticulture, 78*(1), [page numbers].

Curovic, M., Spalevic, V., Sestras, P., Motta, R., Dan, C., Garbarino, M., ... & Urbinati, C. (2020). Structural and ecological characteristics of mixed broadleaved old-growth forest (Biogradska Gora-Montenegro). *Turkish Journal of Agriculture and Forestry, 44*(4), 428–438. https://doi.org/10.3906/tar-1912-62

Felicísimo, Á. M., Francés, E., Fernández, J. M., González-Díez, A., & Varas, J. (2002). Modeling the potential distribution of forests with a GIS. *Photogrammetric Engineering & Remote Sensing, 68*(5), 455–461.

Li, C., & Jiang, Y. (2011). Development of mobile GIS system for forest resources second-class inventory. *Journal of Forestry Research, 22*, 263–268. https://doi.org/10.1007/s11676-011-0169-z

Meng, Y., Cao, B., Dong, C., & Dong, X. (2019). Mount Taishan forest ecosystem health assessment based on forest inventory data. *Forests, 10*(8), Article 685. https://doi.org/10.3390/f10080685

Mikita, T., Janata, P., & Surový, P. (2016). Forest stand inventory based on combined aerial and terrestrial close-range photogrammetry. *Forests, 7*(3), Article 40. https://doi.org/10.3390/f7030040

Pasqualini, V., Oberti, P., & Vigetta, S. (2011). A GIS-based multicriteria evaluation for aiding risk management in *Pinus pinaster* Ait. forests: A case study in Corsican Island, western Mediterranean region. *Environmental Management, 48*, 38–56. https://doi.org/10.1007/s00267-011-9655-y

Qiu, Z., Feng, Z., Jiang, J., Lin, Y., & Xue, S. (2018). Application of a continuous terrestrial photogrammetric measurement system for plot monitoring in the Beijing Songshan National Nature Reserve. *Remote Sensing, 10*(4), Article 562. https://doi.org/10.3390/rs10040562

Risna, R. A., Prasetyo, L. B., Lughadha, E. N., Aidi, M. N., Buchori, D., & Latifah, D. (2023). Forest resilience research using remote sensing and GIS – A systematic literature review. *IOP Conference Series: Earth and Environmental Science, 1266*, [page/article number]. https://doi.org/10.1088/1755-1315/1266/1/012001

Sestraș, P., Sălăgean, T., Bilașco, S., Bondrea, M. V., Naș, S., Fountas, S., & Cîmpeanu, S. M. (2019). Prospect of a GIS-based digitization and 3D model for better management and land use in a specific micro-areal for crop trees. *Environmental Engineering and Management Journal, 18*(6), 1269–1277.

Soubry, I., Doan, T., Chu, T., & Guo, X. (2021). A systematic review on the integration of remote sensing and GIS to forest and grassland ecosystem health attributes, indicators, and measures. *Remote Sensing, 13*(7), https://doi.org/10.3390/rs13071271

Zlinszky, A., Heilmeier, H., Balzter, H., Czúcz, B., & Pfeifer, N. (2015). Remote sensing and GIS for habitat quality monitoring: New approaches and future research. *Remote Sensing, 7*, 7987–7994. https://doi.org/10.3390/rs70607987