GIS - PREMISE IN THE QUANTITATIVE ASSESSMENT OF THE FOREST FUND

Tudor BORȘAN, Assoc. Prof. PhD. Eng., „1 Decembrie 1918" University of Alba Iulia, Romania, tborsan@uab.ro
Ioan IENCIU, Prof. PhD. Habil. Eng., „1 Decembrie 1918" University of Alba Iulia, Politehnica University of Timișoara, Romania, iienciu@yahoo.com
Luciana OPREA, Prof. PhD. Habil. Eng., „1 Decembrie 1918" University of Alba Iulia, Romania, lucii_oprea@yahoo.com

Abstract: *This paper addresses the characteristics and use of the Geographic Information System (GIS) for quantifying forest lands in Romania and Alba County. Firstly, it presents a characterization of the national forest fund, highlighting its importance and extent throughout the country in the context of environmental conservation and natural resources. The identification of forest lands is analyzed through the utilization of data from the Corine Land Cover (CLC) program, establishing the groundwork for determining the indicator of the percentage of forested areas within the administrative-territorial units (ATUs).*

Keywords: *GIS, Corine Land Cover; Forest land assessment; Sustainable forest resource management*

1. Introduction

Romania is renowned for its valuable natural resources, particularly its extensive stretches of deciduous and coniferous forests. These forest ecosystems not only represent an important habitat for biological diversity but also serve as one of the country's main pillars in the economy. To ensure the sustainable use of these natural resources, proper forest management is essential. Authorities, along with environmental and forestry agencies, implement policies and strategies for forest conservation and sustainable management.

Geographic Information Systems (GIS) play a crucial role in forest land management. Through the use of GIS, geospatial data concerning forests, including vegetation types, soil quality, and other characteristics, are collected, processed, and analyzed efficiently and accurately. By utilizing data from programs like Corine Land Cover (CLC), a detailed assessment of the extension and distribution of deciduous and coniferous forests in different regions of the country can be achieved.

2. Statistical data regarding the national forest fund

At the end of 2021, the national forest fund covered an area of 6,607,000 hectares, representing 27.7% of the total country's area. In comparison, at the end of 2012, the national forest fund occupied an area of 6,529,000 hectares, representing 27.4% of the total country's area. Thus, between 2012 and 2021, the forest fund has consistently increased. The forest fund area as of December 31, 2021, compared to the same date in 2020, recorded an increase of approximately 0.05%. Also, compared to the beginning of the analyzed period in 2012, it recorded an increase of approximately 1.2%. This growth was mainly determined by the reforestation of wooded pastures and the inclusion of degraded lands into the forest fund

according to Law No. 46/2008 - the Forestry Code with subsequent amendments and completions.

Categories of land use/year	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Forest fund – total	6529	6539	6545	6555	6559	6565	6583	6592	6604	6607
Forest area	6373	6381	6387	6399	6406	6406	6418	6427	6449	6450
Coniferous	1945	1937	1930	1931	1929	1924	1917	1915	1916	1919
Deciduous	4428	4444	4457	4468	4475	4482	4501	4512	4533	4531
Other lands (within the forest fund)	156	158	158	156	155	159	165	165	155	157

Table 1 The forest fund area, by land use categories, during the period 2012-2021 (thousand hectares)

Throughout the entire period under analysis, there is a slightly increasing trend in the forested area, with annual increments. In 2021, compared to the previous year, the forest area experienced a modest increase of one thousand hectares (+0.02%). During the same period, coniferous species showed an increase of 3,000 hectares, whereas deciduous species recorded a decrease of 2,000 hectares. These changes are mainly the result of adjustments and reclassifications in forestry plans. Compared to 2012, the forested area has increased by 77,000 hectares (+1.2%).

In 2021, the total forest area was 6,450,000 hectares. Coniferous species covered 1,919,000 hectares, representing 29.8% of the total, while deciduous species covered 4,531,000 hectares, accounting for 70.2% of the total forested area. In comparison, in 2012, the total forest area was 6,373,000 hectares. Coniferous species occupied 1,945,000 hectares, representing 30.5% of the total, while deciduous species covered 4,428,000 hectares, accounting for 69.5% of the total forested area.

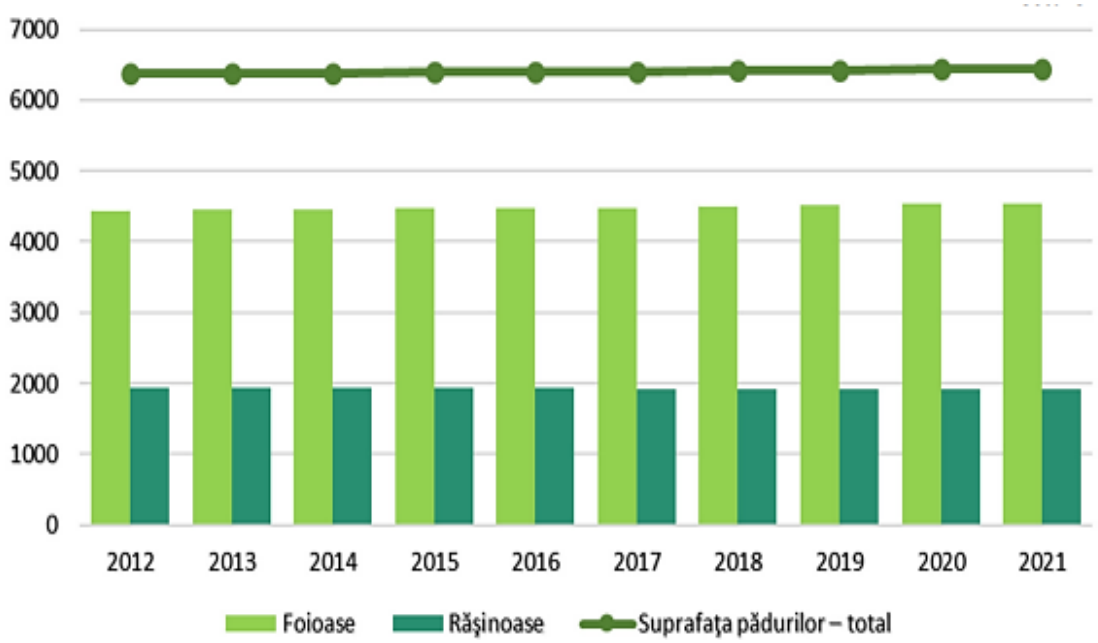

Fig. 1 The forest area, by groups of forest species, during the period 2012-2021 (thousand hectares)

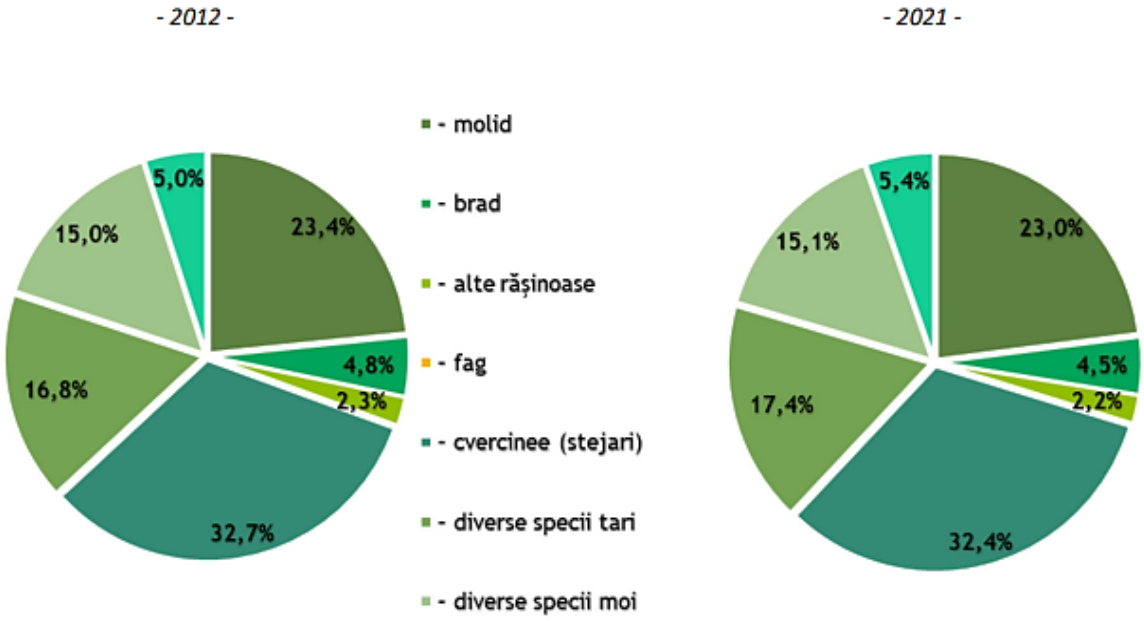

Fig. 2 The structure of forests, by forest species

In 2021, the forest fund was predominantly concentrated in the Central Development Region, accounting for 19.2% of the total national forest fund, followed by the North-East region with a share of 18.2%. Next in importance were the West Development Region, holding 16.2% of the total, North-West (15.3%), South-West Oltenia (12.3%), South Muntenia (10.0%), South-East (8.4%), and Bucharest-Ilfov with 0.4% of the total national forest fund. During the same year, the counties with the largest forest fund areas recorded were: Suceava, with 438,000 hectares, followed by Caraș-Severin, recording 434,000 hectares, then Hunedoara with 316,000 hectares, Argeș with 277,000 hectares, Vâlcea with 274,000 hectares, Bacău with 273,000 hectares, Harghita with 264,000 hectares, Neamț with

262,000 hectares, and Maramureș with 260,000 hectares. These counties accounted for the most extensive forest areas in Romania that year.

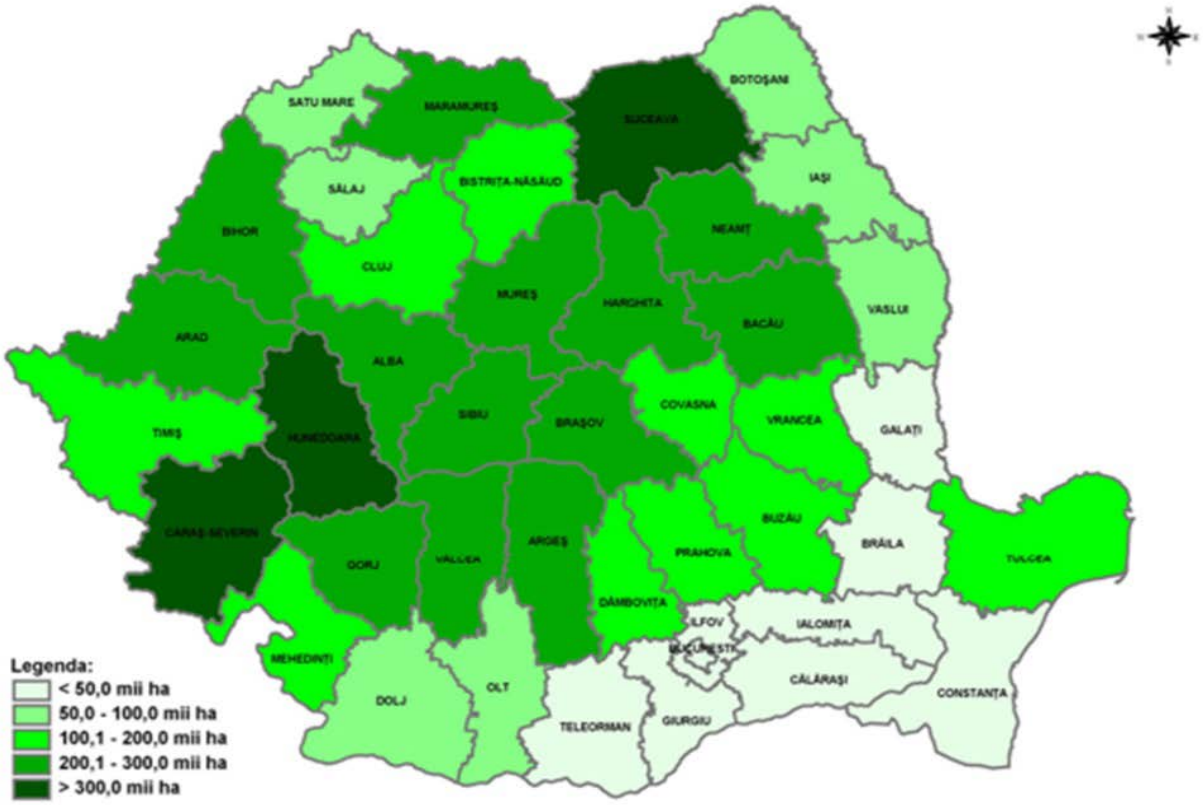

Fig. 3 The forest fund area by counties at the end of the year 2021

3. Statistical data regarding the forest fund of Alba County

The total area of the state-owned forest fund, managed by the National Forest Administration Romsilva through Alba Forestry Directorate, within seven forestry units, was 79,545 hectares as of December 31, 2018, representing approximately 38% of the national forest fund in Alba County. Out of this area, land covered with forests totaled 77,297 hectares and was divided into the following categories:

- Conifers - 33,369 hectares
- Beach - 27,911 hectares
- Oak - 7,729 hectares
- Various other hard species - 7,659 hectares
- Various soft species - 629 hectares

The forests classified in functional group I, which have special protective functions, represent 64% of the total, i.e., 49,778 hectares. Conversely, forests classified in functional group II constitute 36% of the total, covering an area of 27,519 hectares. In addition to forested areas, the state-owned forest fund also includes other land use categories, totaling 2,248 hectares, which include:

- Land serving silvicultural needs - 22 hectares
- Land serving forestry administration needs - 395 hectares
- Land occupied by buildings and their related yards - 410 hectares
- Land in the regeneration class - 148 hectares
- Ponds and streambeds - 4 hectares

- Unproductive land - 758 hectares
- Occupations and disputes - 511 hectares

As of December 31, 1990, the entire national forest fund was under state public ownership. However, due to the implementation of laws regarding the restitution of property rights over land funds, as well as other land movements, by December 31, 2018, the state-owned forest fund managed by the Alba Forestry Directorate decreased by 128,225 hectares. This reduction in the forest fund was the result of various processes involving changes in ownership and land use within this fund, including land restitutions to former owners, changes in land use, and other modifications affecting the ownership of forest lands.

4. Results and discussions

Timely detection and provision of accurate information regarding land use changes and its coverage are crucial for understanding the interactions between human activities and the natural environment. These data are essential for improving decision-making processes and adequate resource management. They represent valuable sources of information that provide insights into landscape evolution.

The Corine Land Cover (CLC) database constitutes an essential repository of information that facilitates the detection and monitoring of land use, highlighting changes in its coverage. Land cover is defined as a set of natural and human characteristics resulting from land use. The data provided by CLC enable the construction of a detailed profile of land cover.

By utilizing the Geographic Information System (GIS) for processing the CLC dataset layer, studies have been conducted at a regional (county) level.

These studies have provided valuable insights into understanding changes in land use and assessing how these changes influence the landscape and the surrounding environment. Extracting forest-related data from image compositions or Corine Land Cover (CLC) data requires the use of image processing and geospatial data techniques:

- Firstly, access to recent satellite images or CLC data containing information about the region of interest is required;
- Satellite images often require processing such as radiometric correction, cloud removal, quality enhancement, and recalibration to be usable for extracting desired information. This is achieved using specialized image processing software;
- Image segmentation involves identifying and delineating areas that exhibit similar characteristics (e.g., forests) compared to the rest of the land. This can be accomplished through image segmentation and classification algorithms that can highlight regions corresponding to forests;
- After segmentation, image classification algorithms are applied to assign labels to different land categories, including forests, based on the identified characteristics within the composition;
- It is important to validate the results obtained from forest data extraction to ensure accuracy and consistency of the information. This may involve comparing the results with field data or other reference sources to confirm the correctness of the classification.

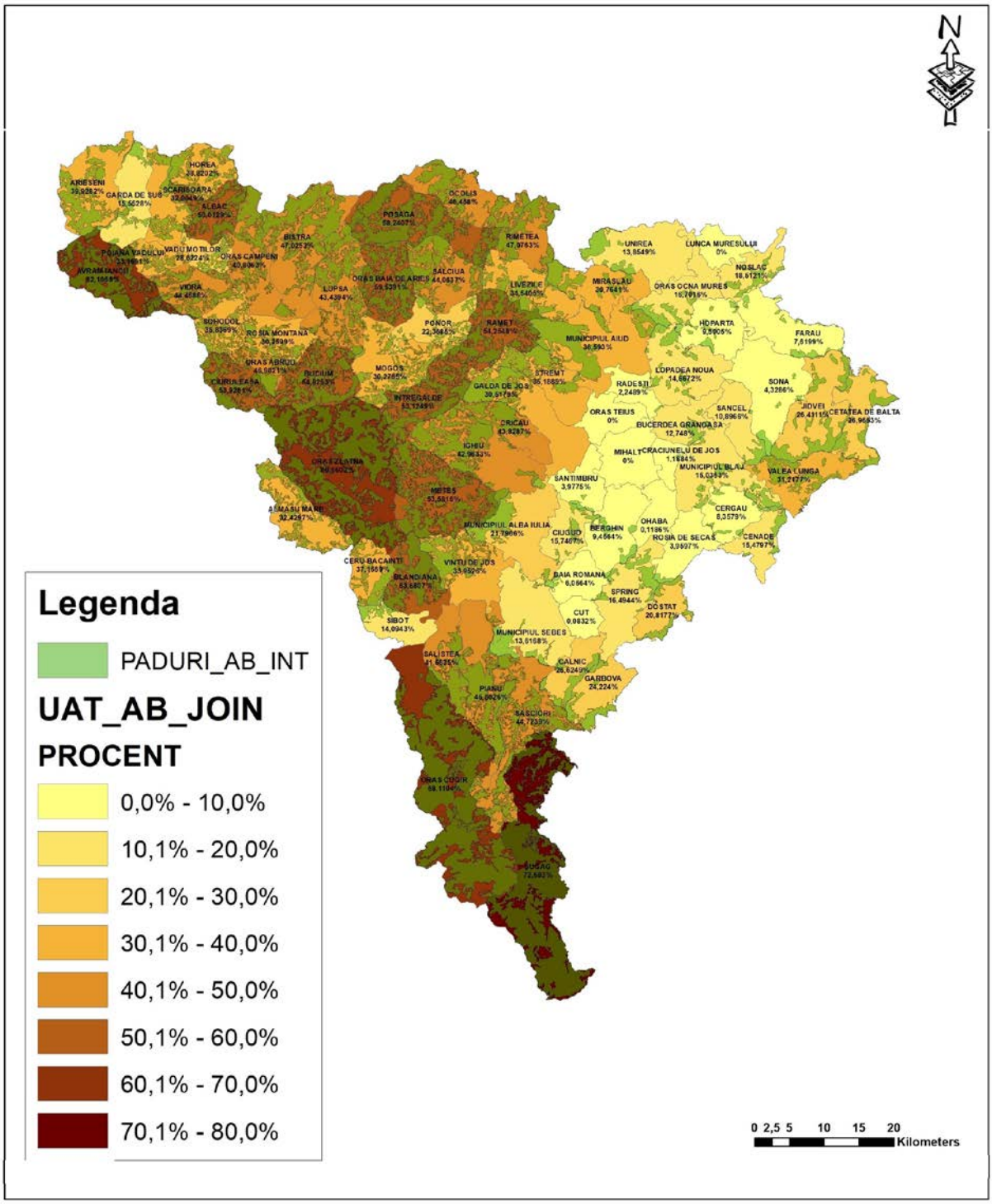

Fig. 4 The distribution of forests in Alba County

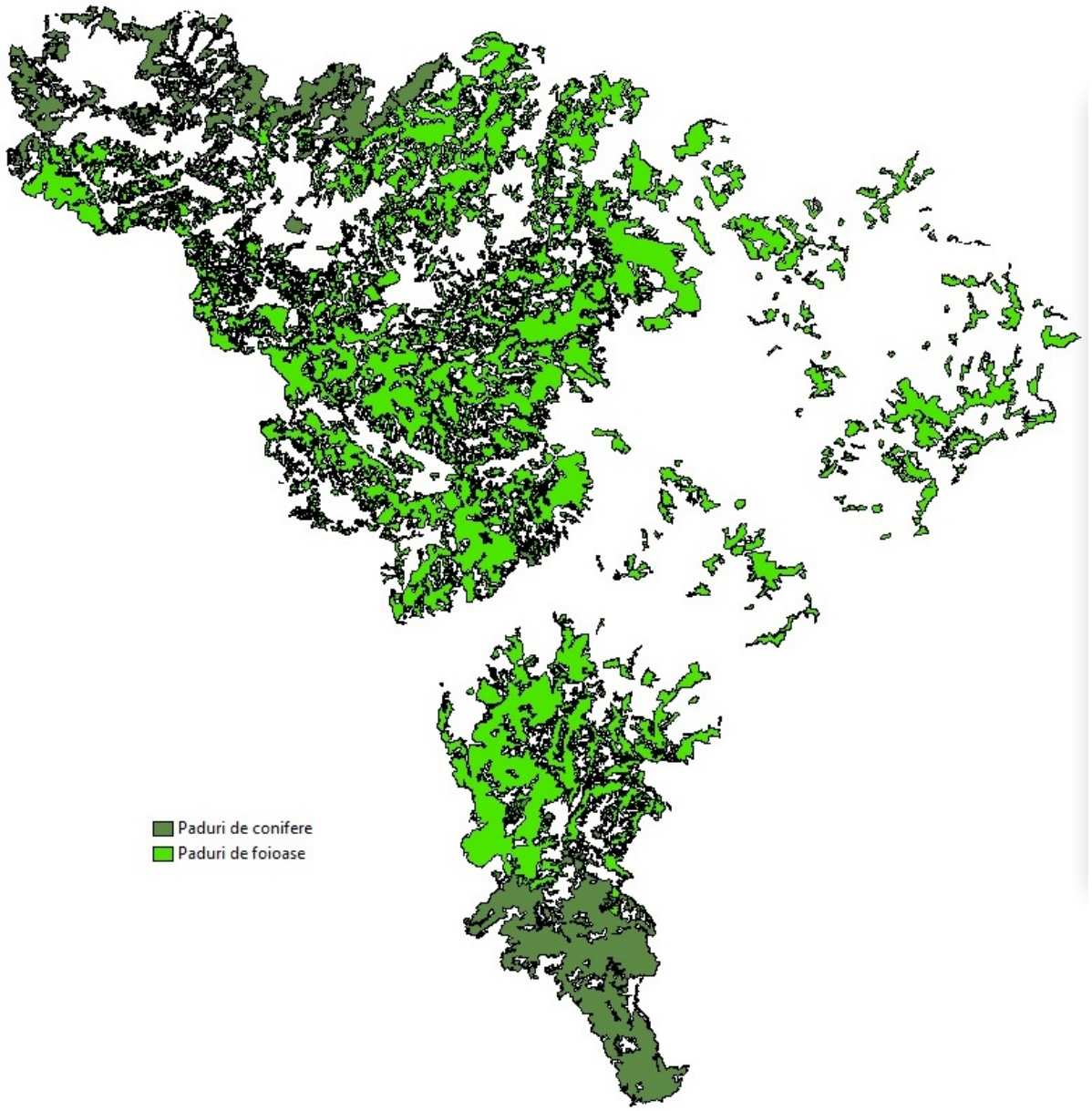

Fig. 4 The classification of forests

5. Conclusions

The data from the period 2012-2021 show a consistent trend of increasing the national forest fund. This increase is the result of reforestation of wooded pastures and the inclusion of degraded lands in accordance with legislation. Changes in the forest structure, highlighted by the growth of coniferous species and the decline of deciduous species in 2021, reflect adaptations and readjustments in forestry plans. Additionally, the overall percentage of forests has risen from 27.4% to 27.7% of the total country's area during the analyzed period, with counties like Suceava and Caraș-Severin demonstrating their significance within the national context due to their large forested areas.

The reduction of the forest fund in Alba County by 128,225 hectares from 1990 to 2018 underscores the complex changes in forest land ownership and usage.

GIS can provide competent institutions with powerful tools for planning and decision-making based on geospatial data. Through analysis and visualization of data, areas with high potential

for regeneration or the implementation of conservation measures can be identified. Furthermore, the impact of various activities on the environment can be assessed, and optimal strategies for forest management and protection can be developed.

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