



INNOVATIVE APPROACHE TO FOREST MANAGEMENT IN THE CONTEXT OF THE SUSTAINABLE DEVELOPMENT GOALS

Ljiljana Brašanac-Bosanac^{1*}, Aleksandar Valjarević², Uroš Durlević², Milorad Šolević³
Tatjana Ćirković-Mitrović¹

¹*Institute of Forestry, Belgrade, Serbia*

²*University of Belgrade, Faculty of Geography, Serbia*

³*MB University, Faculty of Business and Law, Belgrade, Serbia*

Abstract: The world and Europe face interlinked challenges that will intensify in the coming decades: increasing demand for food, water, materials and energy while mitigating and adapting to climate change and reversing environmental degradation, including biodiversity loss, nutrient emissions and land degradation. Although forest resources in Serbia are an important resource for economic growth, especially in rural areas, the traditional approach to their management and utilization is still predominant. This approach is characterized by its reliance on timber as the primary forest product, while other forest products are largely neglected and their economic valuation is often non-existent. In addition, a certain amount of wood biomass is left in the forest even though it could be economically exploited or offered to the market with minimal investment in infrastructure and technological solutions that would allow it to be used more effectively. Tackling these major challenges while promoting social, economic and environmental prosperity requires an innovative approach. Continuous transfer of know-how methods, capacity building in the field of forest management through the application of GIS and remote sensing technologies, climate smart forestry and the concept of circular bioeconomy is a possible way to improve the current situation in forestry and achieve some of the sustainable development goals.

Keywords: forest, environment protection, knowledge transfer, innovative approach, sustainability.

* *Corresponding author: brasanlj@yahoo.com*

Ljiljana Brašanac-Bosanac, ORCID: 0000-0002-3324-674X
Aleksandar Valjarević, ORCID: 0000-0003-2997-2164
Uroš Durlević ORCID: 0000-0003-3497-5239
Milorad Šolević, ORCID: 0009-0002-7935-0558
Tatjana Ćirković-Mitrović, ORCID: 0000-0003-2620-1751

1. INTRODUCTION

Global environmental problems cannot be viewed in isolation from the context of development. This fact indicates a need to define a more efficient methodologies, techniques and solutions in order to achieve the 17 goals of sustainable development (SDG). Each SDG including specific targets has the timeline until the year 2030 to bring in positive development globally. Since the concept of sustainable development represents the consensus of human, social, economic, technological, cultural development and preservation, balancing all these aspects should ensure human well-being. In the recent period the concept of sustainable development has become a prevailing philosophy (especially in EU countries), which is being imposed on developing countries through a series of practical measures and regulations and incorporated into the programs of multilateral organizations, particularly the UN system.

Forests and forestry make a strong and important contribution to achieving the Sustainable Development Goals. Forests are a renewable resource that provides wood, non-timber products and many ecosystem goods and services (Brašanac-Bosanac et al., 2014). They have a positive impact on air, water, soil, climate, flora and fauna, and the area in general, protecting settlements, buildings, roads and agricultural land from erosion, torrents, floods, avalanches, wind, etc. Despite their important role as planetary life support systems and significant progress in sustainable forest management, the global forest area continues to decline (SDG Report, 2024). New methods, measures and strategies, as well as multidisciplinary and innovative approaches, such as the use of geographic information systems and remote sensing technologies, climate-smart forestry and the concept of a circular bioeconomy, can balance the need for wood consumption and production, protect biodiversity and vitality and provide other important ecosystem and social services of forests in the environment.

The article explains what the concept of Climate-Smart Forestry (CSF) is and what is meant by the concept of the Circular Bioeconomy (CB). The importance of Geographic Information Systems (GIS) is also emphasized. Finally, the main principles and rules to be applied in forest management in the context of achieving the Sustainable Development Goals are presented.

2. LITERATURE REVIEW

Many authors were researching how canforest contribute to the achievement of sustainable development goals. According to Gustavsson et al. (2021) and Nabuurs et al. (2018), using wood sustainably for long-lived products that can substitute non-renewable, carbon-intensive materials, can help to decarbonize the global economy, which is one of very important SG goals. Nabuurs et al. (2013) indicate that forest growth declines in aging forests, which leads to diminishing removals of CO₂ from the atmosphere. Also, many existing climate impact studies suggest an increasing risk from abiotic and biotic disturbances (Seidl et al., 2017). Besides harvesting wood, active forest management allows for quicker and more controlled adaptation of forests to climate change (e.g., selection of tree species and provenances) to ensure resilience of forest ecosystems (Schoene & Bernier 2012).

Successful applying Climate-Smart Forestry strategies and of Bioeconomy concept need to balance short- and long-term sustainable development goals, as balancing the need for wood production, the protection of biodiversity, health and vitality and the provision of other important ecosystem and social services in a dynamic environment (Verkerk et al., 2020; Bowditch et al., 2020).

3. DATA AND METHODOLOGY

The problem-oriented approach to the importance of forests and forestry for achieving sustainable development goals involved the use of numerous analytical tools to clearly identify opportunities, limitations and possible conflicts and to define measures to resolve them.

It is clear that we are in recent period facing a numerous set of challenges (COVID-19, climate changes, wars, earthquakes, etc) which directly impacted on sustainable development goals. These challenges cannot be tackled independently in one area or sector (e.g. economy, industry, forestry, agriculture, environmental protection, etc.).

The study was performed using the analysis method with descriptive, integral and participatory approaches. The importance of an innovative approach to this problem is related to identifying the set of indicators suitable to monitor the performance of the forest-based sector by applying the analysis method with a descriptive approach. The application of an integral approach meant the analyses of current laws, regulations, guidelines and recommendations on sustainable development. The introduction of new indicators and harmonization with European frameworks, policies and planning practices at all levels of decision-making was also applied.

Complex conditions and a multitude of conflicting interests and factors characterize forestry. To gain a deeper insight and assess the feasibility of the planned solutions, we therefore had to apply a participatory approach. This approach was achieved by analysing the legal and planning provisions on different aspects and sectors of forestry at the national level.

Different scientific methods were applied in the study following the needs and objectives of the research. To study the content of documents, content analysis was applied as a kind of partial analysis (Milosavljević & Radosavljević, 2008). Some authors (Bulmer, 1977; Neumann, 2014) classify content analysis into a group of nonreactive methods since it does not involve direct collection of data from the research subjects. Concerning specific scientific methods, the analytical method was used (Miljević, 2007) to study strategic and legislative framework. This research also included review analysis (Wunder et al., 2008) of the elements in the field of Climate-smart forestry and Circular bioeconomy.

The results and discussion presented in the paper are based on different international declarations, legal regulations and acts. The conclusions were based on collected literature data and knowledge transfer of researchers.

4. RESULTS AND DISCUSSION

4.1. Sustainable Development Goals

The United Nations Sustainable Development Goals (UN SDGs), established in 2015, are a universal call to action to end poverty, protect the planet, and ensure that all people enjoy peace and prosperity by 2030. These 17 interconnected goals provide a blueprint for a more sustainable future for all. The 17 SDGs are comprehensive and interlinked, spanning economic, environmental, and social needs (Figure 1).



Figure 1. Sustainable Development Goals (17) (Key Sustainability, 2023)

According to Ljesević (2001), the model of sustainable development is based on the following premises:

- economic and technological efficiency based on labour productivity and rationality;
- rational exploitation of natural resources and compliance with the possibilities of natural potentials and ecological capacities and geographical diversity of space;
- balanced demographic development and adequate spatial distribution of the population;
- social security and the possibility of meeting social needs;
- humaneness of development (satisfaction of educational, health, religious needs and rights);
- efficient use and protection of space, especially valuable territories that are of national and general social interest;
- possibility of satisfying cultural needs;
- protection and improvement of the environment in terms of the functioning of health, life and work, but also the cultural, aesthetic and recreational needs of the population;
- protection of natural and cultural-historical assets and other national and state-building values, both in the sense of satisfying scientific and educational needs, as well as in order to preserve biodiversity.

Forests are a major environmental entity and although forestry is not mentioned as a specific goal, it is included under the definition SDG15 titled *Life on Land*. Within SDG15 sustainable management of forests (SFM) and conservation of terrestrial ecosystems with their biodiversity has been explicitly recognized. SDG15 aims to “protect, restore and promote

sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt/reverse land degradation and halt biodiversity loss”. But how do we measure development in different countries spread across different continents, for example in Asia, Europe and Africa, with the standard global SDG indicator scales? Again, forests being a central element with many of the other goals on poverty, hunger, health, industry, etc directly linked for development, this paper tries to bring out the links and synergies between the different goals with forests. Therefore, it is important to understand that all the SDGs are inter-related and progress of each goal directly or indirectly depends on the other.

4.2. Importance of Forests

Beyond timber, forests provide various ecosystem services such as biodiversity conservation, climate regulation, water regulation and flood protection, soil protection and nutrient supply, pest control and pollination, etc. Forests provide natural carbon sinks and their products can substitute for emissions-intensive materials, thereby reducing emissions (Nunes et al., 2020).

Services can be grouped into provisioning services, supporting services, regulating services, and cultural services (Figure 2).

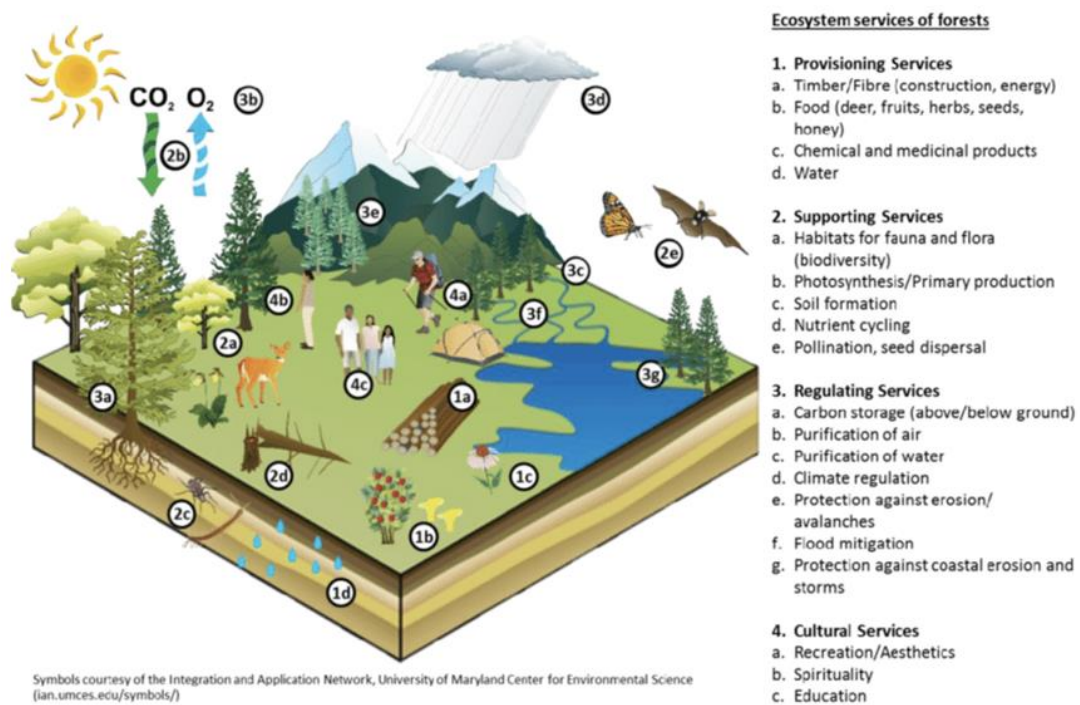


Figure 2. Ecosystem goods and services provided by forests (Holzwarth et al., 2020)

Forests have the primary source for non-food and non-feed renewable biological resources globally, play an important role and should therefore not be set-aside for storing carbon only. Emerging technologies and innovative approach of future functioning of forestry provide possibilities for using wood to produce a new range of biobased and renewable solutions that can replace fossil-intensive and non-renewable products, such as construction, chemicals, textiles or plastics. Therefore, a forest management that ensures a continued, sustainable flow of woody raw material is crucial to mitigate climate change and achieve sustainable development goals.



GOAL 4: ENSURE INCLUSIVE AND EQUITABLE QUALITY EDUCATION

Providing adequately education for teachers, children, youth and student's education about the importance of forests for environment and sustainability through professional development and continuous transfer knowledge.



GOAL 6: ENSURE ACCESS TO CLEAN WATER FOR ALL

Supporting (financial and capacity building) best forest management practices relating to water quality, and promotion of projects that help evaluate water quality and quantity in sustainable certified forest ecosystems.



GOAL 12: ENSURE SUSTAINABLE CONSUMPTION AND PRODUCTION PATTERNS

Supporting sustainable management of natural resources and the supply of ecosystem goods and services. Appropriate evaluation and emphasis on the added value of bio-based products and circular bioeconomy concept.



GOAL 13: TAKE URGENT ACTION TO COMBAT CLIMATE CHANGE AND ITS IMPACTS

Supporting research and grant making for improving forest management measures to identify best practices in well-managed forests to increase carbon storage and resiliency to climate change.



GOAL 15: SUSTAINABLE MANAGED FORESTS, REDUCING DESERTIFICATION, REVERSING LAND DEGRADATION, PREVENTION BIODIVERSITY LOSS

Supporting sustainable forests through community engagement and education to reduce deforestation and by promoting ecosystem health and protection of at-risk species.



GOAL 17: STRENGTHEN MEANS OF IMPLEMENTATION AND REVITALIZE THE GLOBAL PARTNERSHIP FOR SUSTAINABLE DEVELOPMENT

More successful and productive collaboration of different stakeholders (government, public enterprises from forest sector, academic and research institutions, landowners, local communities, NGO) to promote shared goal of sustainable forests.

Figure 3. Importance of forests and forestry-based sector in the pursuit of goals important for sustainable development

4.3. Climate-Smart Forestry Concept

Climate-Smart Forestry (CSF) is an integral approach of sustainable forest management that focuses on forest management in response to climate change (Bowditch et al., 2020). The fundamental focus of the CSF concept is on adaptation, mitigation and social dimensions. CSF is being interpreted in a number of ways, which mostly focus on adaptive forest management, the decrease of GHG emissions, and effective carbon sequestration (Yousefpour et al., 2019).

Nabuurs et al. (2018) presented the following three pillars of the CSF approach:

- active forest management aiming to sustainably increase productivity and provide all benefits that forests can provide
- adapting forest management to build resilient forests
- reducing and/or removing GHG emissions to mitigate climate change.

According to Verkerk et al. (2020), the concept of CSF goes beyond forest management measures, including GHG mitigation opportunities of wood use, carbon storage and substitution in its targets:

- increasing carbon storage in forests and wood products, in conjunction with the provisioning of other ecosystem services;
- using wood resources sustainably to substitute non-renewable, carbon-intensive materials;
- enhancing health and resilience through adaptive forest management.

Achieving the goals of the Paris Climate Agreement requires a significant reduction in carbon dioxide emissions and increased removal through carbon sinks. In this context, Climate-Smart Forestry is a necessary, but still missing component in national strategies for implementing actions under the Paris Agreement. Successful Climate-Smart Forestry has important policy implications on finding the right balance between short and long-term goals, as well as between the need for wood production, the protection of biodiversity and the provision of other important ecosystem services. CSF thus can provide important co-benefits that are increasingly being recognized as essential for sustainable well-being. According to Roe et al. (2019, 2020), improved forest management measures can contribute to climate change mitigation and determine the composition of new forests in terms of tree species and provenances, and their rate of removing carbon from the atmosphere.

Climate-Smart Forestry measures can vary greatly from region to region due to the very different regional conditions in Europe. A “*one size fits all*” solution across Europe will not work. However, the use of locally adapted CSF measures, as indicated by several case studies conducted across Europe, can result in overall long-term emissions benefits or more stable forest conditions, better adapted to climate change (Nabuurs et al., 2018).

4.4. Circular Bioeconomy Concept

Very important role of forests is in a storage carbon and circular bioeconomy by being renewable, recyclable and energy efficient. In addition, forests provide raw materials for innovative bioproducts such as bioplastics, biofuels and biochemicals that replace fossil materials (Hetemäki et al., 2017).

The circular bioeconomy is a complex and dynamic system and thus decision-makers need new strategies and tools to steer and govern this complex system towards the desired outcomes. The literature review concludes that the key principle of the circular bioeconomy is the 4Rs framework (Reduce, Reuse, Recycle, Recover), in which the hierarchy between the Rs is a fundamental aspect. The first R (Reduce) is considered to take precedence over the second R (Reuse) and so on. This hierarchical relationship is closely linked to the “cascade” principle”,

which envisages the use of raw materials according to a priority based on potential added value (Ciccarese et al., 2014; Proskurina et al., 2016; Paletto et al., 2019).

The circular bioeconomy is seeking new ways of producing and consuming resources while respecting our planetary boundaries and moving away from a linear economy, based on extensive use of fossil and mineral resources.

The importance of a circular bioeconomy in the context of the sustainable development goals lies in its potential to contribute to climate change mitigation, socio-economic development and environmental protection over time by maintaining the value of bio-based products, materials and resources in the economy for as long as possible (Figure 3).



Figure 4. Impact of Circular Bioeconomy on UN Sustainable Development Goals (Startus-insights, 2021)

Bio-based products offer recyclable and biodegradable alternatives with applications in materials, engineering, agriculture, forestry and other sectors. By moving away from the take-make-dispose approach to coupling industrial growth with ecosystem preservation, circular bioeconomy adds societal value as well. Moreover, by restoring natural ecosystems and promoting decarbonization, it drives progress towards carbon-negative goals.

4.5. GIS and Remote Sensing

Geographic Information Systems (GIS) play a significant role in the field of forestry and sustainable development, enabling efficient management of forest resources through accurate inventory, monitoring, and analysis (Zápotocký & Koreň, 2022). Thanks to its ability to link data from different locations, GIS enables adequate mapping of vegetation, identification of endangered species, and updating information in real-time (Puziene, 2024). Forestry experts use it to monitor changes in ecosystems over time, which is particularly important in the context of climate change and biodiversity conservation (Tariq et al., 2023; Wang et al., 2024). By combining satellite images and other geospatial data, GIS allows monitoring of large and difficult-to-reach areas with minimal effort (Liu et al., 2024). In addition, through complex analyses of different factors such as climate extremes, vegetation status, or CO₂ emissions, GIS allows a better understanding of the mutual influences within forest ecosystems (Durlević et al., 2025). This will enable experts to simulate different scenarios and make decisions based on spatial and temporal data, thus encouraging long-term planning and sustainable use of natural resources (Mishkin & Navarrete Pacheco, 2022).

5. CONCLUSION

The forests and forestry-based sector has a fundamental role in the pursuit of the following choices and objectives important for several sustainable development goals:

- ✓ the sustainable management of natural resources and the supply of ecosystem goods and services useful for human well-being;
- ✓ preservation of biodiversity;
- ✓ the sustainable patterns of production and consumption;
- ✓ improving the efficient use of resources– circular bioeconomy concept;
- ✓ reducing waste production and promote secondary raw material market;
- ✓ boosting sustainable forestry throughout the production and supply chain;
- ✓ applying the results of research, development, innovation and technology;
- ✓ supporting the competitive business environment;
- ✓ enabling and improves education, skills and awareness.

The management of carbon flows between reservoirs in the Earth's system forms the basis for climate change mitigation. Applying climate-smart forestry concept is needed to increase the total forest area and avoid deforestation, connect mitigation with adaptation measures to enhance the resilience of global forest resources, and use wood for products that store carbon and substitute emission-intensive fossil and non-renewable products and materials.

The implementation of the innovative approaches and methods presented, such as GIS and remote sensing, climate-smart forestry and the concept of circular bioeconomy in forest management, will contribute to this:

Strengthening cooperation - Better coordination in research, innovation and policy development.

Attracting investments and financing - Joint performance increases the chances of obtaining support from funds.

Knowledge sharing and capacity building – Connecting participants leads to more efficiency.

Adapting to global trends - Aligning with European and international initiatives.

Continuous transfer of know-how methods, capacity building and implementation of the innovative approaches and methods in the field of forest management is a possible way to improve the current situation in forestry and achieve some of the sustainable development goals.



Figure 5: Forest support to the SDG (Sustainable Forestry Initiative, 2025)

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