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Original scientific paper

AFFORESTATION IN THE REPUBLIC OF SERBIA: SCOPE AND TRENDS FROM 2002 TO 2021

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Abstract: *The issue of the annual volume of afforestation directly affects changes in the degree of forest cover and represents one of the most topical and complex activities of the forestry profession. Therefore the main aim of this research was to determine the current trends in the scope of afforestation and make projections about future courses by monitoring multi-year trends.*

Norway spruce and Austrian pine are coniferous forest species most frequently used in afforestation in Serbia. Oaks are broadleaved species most frequently used in afforestation, although beech forests are the most common forests in Serbia. For that reason, we analysed the trends in the scope of afforestation with these tree species in the period from 2002 to 2021. All species, except for beech, recorded a negative trend in the scope of afforestation.

The analysis of data related to the extent of afforestation, together with the data related to the level of subsidisation provided by the state for afforestation, gives an insight into the dynamics of afforestation, based on which recommendations and guidelines can be given for planning and carrying out work on further afforestation, the establishment of new forests, which would, in turn, increase the degree of forest cover.

Keywords: afforestation trend, annual afforestation rates, state subsidizing.

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POŠUMLJIVANJE U REPUBLICI SRBIJI: OBIM I TRENDOVI U PERIODU OD 2002. DO 2021. GODINE

Izvod: *Pitanje godišnjeg obima pošumljavanja direktno utiče na promene stepena šumovitosti i predstavlja jedan od najaktuelnijih i najkompleksnijih aktivnosti šumarske struke. Zato je osnovni cilj ovih istraživanja utvrđivanje kretanja obima pošumljavanja, ali i predviđanje njihovih daljih tokova na osnovu praćenja višegodišnjih trendova.*

Smrča i crni bor su najzastupljenije i najčešće korišćene četinarske šumske vrste za pošumljavanje u Srbiji. Vrste koje se najviše koriste kod pošumljavanja lišćarima jesu hrastovi, dok su šume bukve najzastupljenije šume u Srbiji. Zato je analizirano i kretanje obima pošumljavanja navedenim vrstama drveća u periodu 2002-2021. Kod svih vrsta, osim bukve, konstatovan je negativan trend obima pošumljavanja.

Analizom podataka o obimu pošumljavanja i analizom podataka o stepenu učešća države u subvencionisanju pošumljavanja dobija se uvid u dinamiku, na osnovu koje se mogu dati preporuke i smernice za planiranje i izvođenje radova na daljem pošumljavanju, sprovođenju radova na podizanju novih šuma, samom tim na povećanje stepena šumovitosti.

Ključne reči: trend pošumljavanja, godišnje stope pošumljavanja, subvencija države.

1. INTRODUCTION

It is a well-known fact that the establishment of new forests and the improvement of existing ones enhance their climatic, protective, erosion control, aesthetic-environmental, tourist-recreational and other roles and increase the yield of other resources of forests and forest areas.

The annual rate of afforestation directly affects the degree of forest cover. The high degree of soil degradation caused by erosion, the lack of water, the increasing need for wood production, recreation, etc., as well as the fact that the forest cover in Serbia used to be as much as 80% (Dražić, 1992), call for the increase of areas under forest in Serbia.

Afforestation is one of the most topical and complex activities of the forestry profession. According to the data of the Statistical Office of the Republic of Serbia, an average of 1,762 ha were reforested annually from 2016 to 2021. Norway spruce and Austrian pine were the most common coniferous species, while broadleaved species used for afforestation mainly included oak species.

Therefore the main aim of this research was to determine the current trends in the scope of afforestation and make projections about future courses by monitoring multi-year trends. Data on the annual scope and trends of afforestation will be analysed in order to develop the trend models related to the total afforested area and the area afforested with the broadleaved and coniferous species most frequently used for afforestation in the specified period. Analysing these data, together with the data related to the subsidization provided by the state for afforestation, gives an insight into the dynamics of afforestation. Based on the results obtained, we can put forward recommendations and guidelines for planning

and conducting work on further afforestation and the establishment of new forests, which would, in turn, increase the degree of forest cover.

2. METHODOLOGY

The basic principle underlying this research was to use the methods of analysis and synthesis, induction and deduction to develop trend models that would study the intensity and scope of afforestation, analyse the existing and projected state of afforestation within forest complexes and ecosystems, and based on the results produce the most satisfactory solutions and proposals related to the extent of afforestation.

Data on the state and privately-owned forested and barren areas and the scope of afforestation were obtained from the Statistical Office of the Republic of Serbia, the Forest Directorate of the Ministry of Agriculture, Forestry and Water Management, SE “Srbijašume”, SE “Vojvodinašume”, as well as relevant scientific papers, studies, projects and monographs on this topic.

Data were obtained and regression models of the trends were developed and verified (using the coefficient of determination R^2) using the Statistica 7 software and the Microsoft Office package.

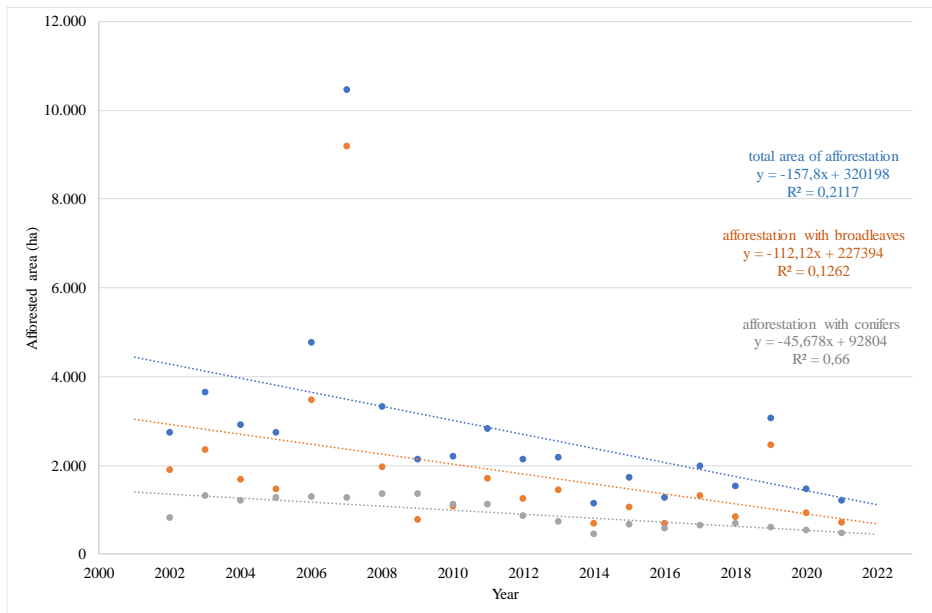
3. RESULTS AND DISCUSSION

The relationship between economic growth and environmental deterioration was first placed on the international agenda in 1972, at the UN Conference on the Human Environment, held in Stockholm. After the Conference, Governments set up the United Nations Environment Programme (UNEP¹), which today continues to act as the core of the action in the fight against climate change. Increasing the area of forest cover by encouraging the activities and by providing assistance for the afforestation of the land on which it is economically and ecologically feasible to raise forests (degraded soil, abandoned agricultural land, barren forest land, etc.) regardless of the ownership is one of the main goals for population (Nevenić et al., 2007).

Afforestation can transform vulnerable forests into diverse, productive, and climate-resilient forests (Bolte et al., 2009; Reyer et al., 2015). Afforestation also entails the active involvement of actors from forestry, conservation, and nursery business (Hazarika et al., 2021). Furthermore, forest services are changed from an industrial one, focusing on timber production, to a postindustrial one, in which forest services become more important to timber production.

A linear regression function was used to develop a model of the afforestation trend in the Republic of Serbia from 2002 to 2021, both taking all species into account and separately for broadleaved and coniferous species (Graph 1).

¹ <https://www.unep.org/>

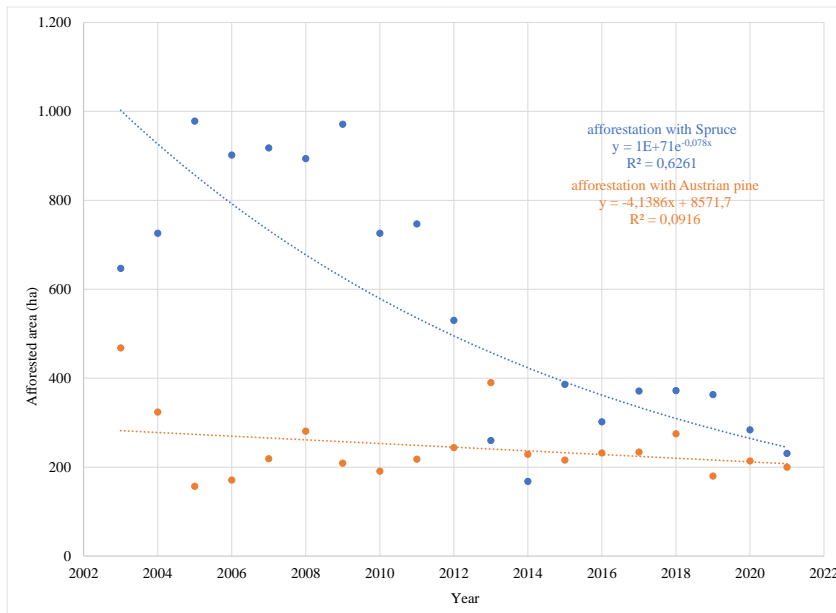


Graph 1. Trends in the total afforested area and the areas afforested with broadleaves and conifers in the Republic of Serbia from 2002 to 2021

A decreasing linear trend, i.e., a decreasing trend in afforested areas in Serbia, can be noticed throughout the study period. The scope of afforestation, i.e., the afforested area decreased in this period by an average of 157.8 ha (5.39%) per year. A decreasing trend could be noted in afforestation with both broadleaved and conifer species. It was more evident in broadleaved species, whose annual scope of afforestation decreased on average by 5.71%. The scope of conifer afforestation decreased by an average of 4.70% per year.

Data on afforestation for 2003-2016 in the Republic of Serbia (Ćirković-Mitrović et al., 2018) also revealed a negative trend, with a larger annual average decrease in the scope of afforestation, amounting to 203.73 ha. The research by Ranković (2009) states that the scope of afforestation in Serbia in the period from 2000 to 2007 was characterised by exponential growth, with an annual increase in the afforested area of 804 ha (average annual growth rate of 17.4%). This difference in the research results was caused by the high degree of afforestation performed in 2007 when the afforestation was several times above the average for the last twenty years (Ćirković-Mitrović et al., 2018).

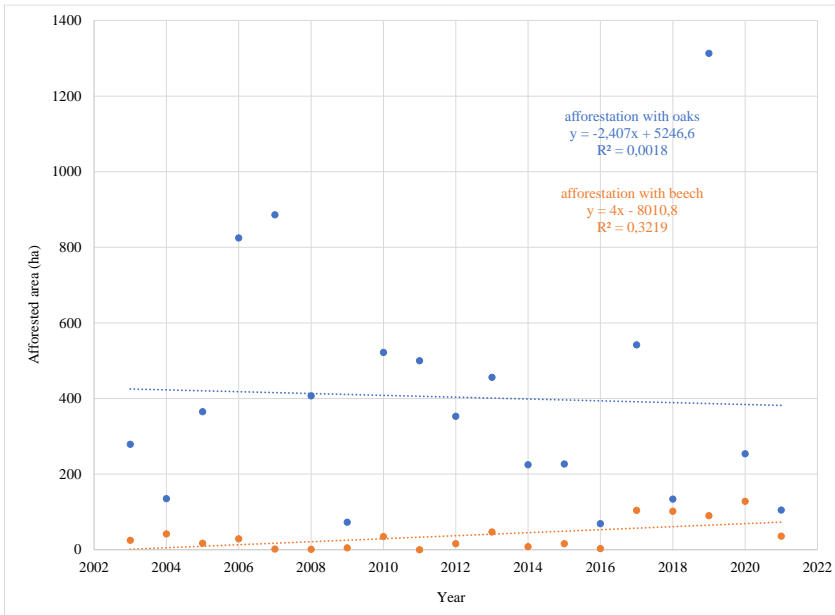
Norway spruce and Austrian pine were the most common and most frequently used coniferous forest species for afforestation in Serbia. Therefore, we studied the trend in the scope of afforestation with these species in the period from 2002 to 2021 (Graph 2).



Graph 2. *Trend of the total scope of afforestation with Norway spruce and Austrian pine in the Republic of Serbia from 2002 to 2021*

The model of the trend in the afforestation with Norway spruce used the exponential function and the model developed for Austrian pine used the linear function. A negative trend of afforestation with Norway spruce could be observed from the beginning of the study period, with the scope of afforestation decreasing exponentially. Norway spruce was more frequently used in afforestation than Austrian pine in the first ten years of the study period. The area afforested annually with Norway spruce decreased by an average of 7.32% (by 6.90% per year in the first ten years and by 8.11% per year in the next ten years). Regarding the afforestation with Austrian pine, a uniform decrease in the scope of afforestation by about 4.14 ha per year was observed from the beginning of the study period. The area reforested annually with Austrian pine decreased by an average of 1.60% (1.39% per year in the first ten years and 1.83% per year in the next ten years). In the last ten years, the trendlines got closer to each other because the spruce trendline showed a more significant decline than the Austrian pine trend line.

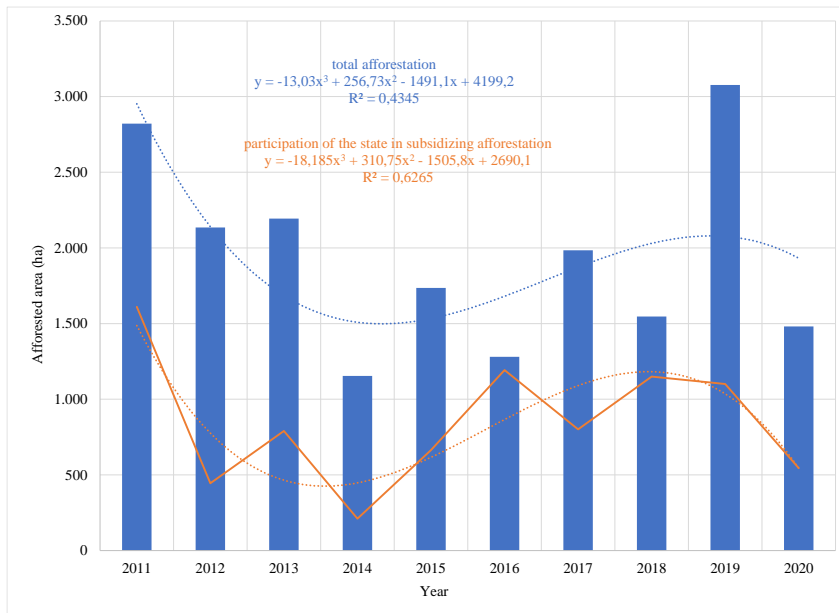
Oaks were the broadleaved species most frequently used in afforestation, although beech forests are the most common forests in Serbia. Therefore, we analysed the trends in the scope of afforestation with oak and beech trees from 2002 to 2021 (Graph 3).



Graph 3. *Trend of the total volume of afforestation with oaks and beech in the Republic of Serbia from 2002 to 2021*

The linear function was used to model the trend of afforestation with oaks and beech. While the volume of afforestation with oaks decreased, the volume of afforestation with beech increased, thus decreasing the difference between their afforested areas. The same pattern can be noticed in the trends of the share of afforestation with oak and beech. On average, the area afforested with oaks annually decreased by 0.56%, and the area afforested with beech increased by 10.19%. Tomaz et al. (2013) in their research on changes in forest cover and afforestation in Portugal stated that the multi-year trend of afforestation with the most common autochthonous oak species did not show a significant increase in the area afforested by these species.

The absolute values and the trend of afforestation in the ten-year period (2011-2022), including the share of incentives provided by the state (subsidies from the Forest Directorate of the Ministry of Agriculture, Forestry and Water Management) are shown in Graph 4.



Graph 4. *Trend of the total volume of afforestation and afforestation with state subsidies in the Republic of Serbia from 2011 to 2020*

The polynomial regression function of the third degree was selected for the model. A decrease in the scope of afforestation could be noted until the middle of the study period when more intensive afforestation began and lasted until 2019. A significant decrease occurred in 2020, which can be explained by aggravating circumstances and the state of emergency in the country due to the COVID pandemic. The trend of the volume of afforestation with state subsidies follows the total volume of afforestation trend, and the average volume of afforestation with subsidies from the Forest Directorate was about 45% of the total afforested area.

Afforestation in Serbia can be increased by afforesting unutilised agricultural land and arable land categorised as class VI, VII and VIII, changing regulations, facilitating the conversion of agricultural land into forests, and enabling subsidised or free afforestation of these categories of agricultural land.

4. CONCLUSIONS

Recent research and analysis show the differences and potential changes in the extent of afforestation and trends in different time intervals from 2002 to 2021.

By analysing the changing trends, we can notice that both the total afforested area and the area of individual species decreased. Beech forests were the exception, which can be explained by the choice of sites suitable for afforestation with this species. Another reason was the reduced afforestation of extreme sites or the ones with unfavourable production characteristics where Austrian pine was planted.

The obtained data and projections related to the afforestation trend behaviour in the following period are very important for the management and

implementation of measures to establish new forests. They also have an important role in planning and increasing the forest cover in the future. The application of modern technologies in future afforestation makes it easier to collect, process, present, and apply data needed for logistics in hardly accessible areas. Information can be used to improve the planning workflow efficiency (by cutting costs and saving time). There is great potential in monitoring the entire workflow and the qualitative and quantitative measurements of the performed work (Šurjanac, 2019).

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Summary

The main goal of this research was to determine the course and project trends in the scope of afforestation for 2002-2021 in order to gain insight into their dynamics. Based on the obtained trends and dynamics, we can provide recommendations and guidelines for planning and implementing future afforestation.

By analysing the trend of change both in the total afforested area and the area afforested with individual species, a decrease can be observed. Beech was the exception, which could be explained by the choice of sites suitable for afforestation with this species, and reduced afforestation of extreme sites or the ones with unfavourable production characteristics where Austrian pine was planted.

The absolute values and trends of afforestation in the ten-year period (2011-2022), including the participation of including the share of incentives provided by the state (subsidies from the Forest Directorate of the Ministry of Agriculture, Forestry and Water Management), indicate a decline in the scope of afforestation until the middle of the study period when more intensive afforestation began and lasted until 2019. A significant decrease occurred in 2020, which can be explained by aggravating circumstances and the state of emergency in the country due to the COVID pandemic. The trend of the volume of afforestation with state subsidies follows the total volume of afforestation trend, and the average volume of afforestation with subsidies from the Forest Directorate was about 45% of the total afforested area.

The economic, social and political situation reduced the funding and incentive measures, which would have had a positive effect in terms of increasing the scope of afforestation and the forest cover of the Republic of Serbia. That is why it is necessary to plan adequate means and measures so that these negative trends in the scope of afforestation change their direction.

POŠUMLJIVANJE U REPUBLICI SRBIJI: OBIM I TRENDOVI U PERIODU OD 2002. DO 2021. GODINE

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Rezime

Osnovni cilj ovih istraživanja bio je da se utvrde tokovi i predvide trendovi kretanja obim pošumljavanja u periodu 2002-2021. godina, kako bi se stekao uvid u njihovu dinamiku. Na osnovu trendova i dinamike mogu se dati preporuke i smernice za planiranje i sprovođenje radova na budućem pošumljavanju.

Analizom trenda promene, kako ukupne pošumljene površine, tako i po pojedinim vrstama, može se konstatovati smanjenje ove površine, izuzev kod bukve, što se može objasniti izborom staništa pogodnih za pošumljavanje ovom vrstom, ali i smanjenjem pošumljavanja ekstremnih staništa, odnosno staništa lošijih proizvodnih karakteristika, na kojima se sadi beli bor.

Apsolutne vrednosti i trend pošumljavanja u desetogodišnjem periodu (2011-2022), uključujući učešće podsticajnih sredstava koje daje država (subvencije Uprave za šume Ministarstva poljoprivrede, šumarstva i vodoprivrede), ukazuju na pad obima pošumljavanja do sredine posmatranog perioda, kada počinju intenzivnija pošumljavanja do 2019. godine, sa značajnim padom u 2020. godini, što se može objasniti otežavajućim okolnostima i vanrednim stanjem u državi usled COVID pandemije. Trend obima pošumljavanja uz subvencije države prati ukupan obim pošumljavanja, a prosečni obim pošumljavanja uz subvencije Uprave za šume bio je na oko 45% ukupne pošumljene površine

Ekonomska, socijalna i politička situacija uticala je na smanjenje finansiranja i podsticajnih mera, koje bi dale pozitivan efekat u pogledu povećanja obima pošumljavanja, samim tim i šumovitosti Republike Srbije. Zato je neophodno isplanirati adekvatna sredstva i mere kako bi ovi negativni trendovi obima pošumljavanja promenili svoj smer.