ARTICLE INFO
Review Article

Citation:
Milev M, Petkova K, Iliev N (2017) Afforestation in Bulgaria. Reforesta 3:143-154.
DOI: https://dx.doi.org/10.21750/REFOR.3.12.36

Editor: Vladan Ivetić, Serbia
Received: 2017-06-02
Accepted: 2017-06-29
Published: 2017-06-30

Afforestation in Bulgaria

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Abstract

The historical development of afforestations in Bulgaria was investigated. Some of the more important decisions and events which determine the correct state policy in the field of afforestations are pointed out. The most significant achievements are in: erosion control, incl. water tank protection from silting up; increasing the tree volume and forest growth; protection of agriculture via forest protection belts; landscape improving. The social importance for more employment and improvement of means of livelihood is mentioned. Proved reasons for decreasing the afforested areas since 1980s are given. The main mistakes and problems are mentioned as well as the changes in the afforestation policy and future challenges.

Keywords

History of Afforestation; Forest Plantation; Erosion Control; Forest Facts; Main Challenges

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1 History and results of afforestation in Bulgaria

Afforestations in Bulgaria have over 135 year of history. The first attempts for artificial planting of forest vegetation were performed in 1880, when the Ministry of Finances, to which Forest Service was affiliated at the time, issued orders for establishment of new forests. In 1888–1889 the foresters from North Bulgaria were given seeds of Black locust and instructions for afforestation via sowing on grounds near the settlements. This way started the earliest period of afforestation development lasting nearly 25 years – from 1880 to 1905 (Milev et al. 2015).

First plantings were mainly afforestation – on free and uncultivated lands, as well as for ornamental purposes around settlements. There were only beginnings of reforestation in the forests. Forest plantations were established in the vicinities of many towns but the best ones, even today, remain these around Sofia, Kyustendil, Stara Zagora and Koprivshtitsa (Zahariev 1977).

Substantial part of the first afforestations were unsuccessful but the difficulties did not discourage the public activists who were the main initiators of this noble activity and the enthusiasts' model found many new followers. During the period 1885–1900 total 3,060 ha were afforested in the country, using 29,400 kg seeds and 2.436 million saplings. Although not large in area, the afforestations of this period were first attempts to cultivate forest vegetation (Vachovski and Dimitrov 2003).

The autumn of 1904 is accepted as the beginning of the state-organized afforestations. It was marked by the launching otthe Bureau for reinforcement of torrents and afforestation in Kazanluk. The Bureau itself was officially opened in 1905. Its first chief was the French inspector-forester Félix Louis-Marie Vogéli who arrived with his assistant Jean-Christian Jagerschmidt. Thus the leading French experience for afforestation of torrential slopes was introduced to Bulgaria (Zahariev et al. 1977; Némoz-Rajot et al. 2015). At first seeds and saplings were imported from Central Europe (mainly from Germany and Austria). The saplings arrived in bad conditions and most of them were wasted. This was the reason since 1908 to leave the import and to start local sapling production. Seeds and saplings of the following species were delivered from abroad: Scots pine (*Pinus sylvestris* L.), Austrian pine (*Pinus nigra* Arn.), Norway spruce (*Picea abies* (L.) Karst.), Eastern white pine (*Pinus strobus* L.), Douglas fir (*Pseudotsuga menziesii* (Mirb.) Franco), *Pinus banksiana* Lamb., Grey alder (*Alnus incana* (L.) Moench) and Black alder (*Alnus glutinosa* (L.) Gaetn.), European larch (*Larix decidua* Mill.), oaks (*Quercus* spp., incl. Northern red oak – *Q. borealis* Mich. F.), European beech (*Fagus sylvatica* L.), Large-leaved Lime (*Tilia platyphyllos* Scop.), ashes (*Fraxinus* sp.), Sycamore (*Acer pseudoplatanus* L.), Box elder (*Acer negundo* L.), Silver birch (*Betula pendula* Roth.) (Milev et al. 2015).

The result of the activities of Bureau for reinforcement of torrents and afforestation of Vogeli from 1905 to 1911 was 5 established nurseries with an area of 6.1 ha and annual production of 1 million saplings, afforested nearly 500 ha, constructed 18 barrages and many other reinforcement equipment, and the most important effect – many torrents in the region of Kazanluk were turned into calm water streams. Since 1911, following the model of Kazanluk, other sections on torrent reinforcement and afforestation were opened in the country and their number reached 38 to 1944. Significant work on inventory and précising of torrent catchments named protection perimeters was done. The activity of the sections lasted until 1951, when that they were closed and their functions taken by the state forest services (Milev et al. 2015).

In 1904, after a competition, 5 Bulgarian youngsters were selected to go to study in France on state's expenses and they successfully graduated in French National School of Forestry in Nancy. This school played an important role for the reinforcement of afforestations and development of forestry science in Bulgaria (Vachovski and Dimitrov 2003).

Noticeable impact on the development of forestry and in particular the afforestation activities were given after the opening of a Forestry Department at the Faculty of Agronomy and Forestry of Sofia University "St. Kliment Ohridski" in 1925 and the Forest Service in 1928. Special contribution to this progress had the Minister of agriculture at the time Dimiter Hristov. At the beginning of his stay in the Office – 1926–27 – 4,101.3 ha were afforested. He provided better finance and supported the afforestation in a number of torrential catchments. Only in 1927 he organised 3 meetings dedicated to afforestations and insisted on their acceleration. The years of

D. Hristov as a Minister were the peak in the annual afforestations for the period, the maximum being in 1928 – 9,262.1 ha. The momentum of the intelligent management of this notable statesman lasted no longer and in 1934 the afforested area decreased 4 times to 2,246.4 ha. During the next years 1935–1936 there was a new increase of the afforestations and in 1943 they reached 8,996.3 ha (Milev et al. 2015).

After Second World War all branches in Bulgaria, incl. forestry and afforestation developed on systematic base. It started with 2-year plan from 1947 and during its implementation 41,400 ha bare and erosion terrains were afforested, 5,737 ha rare forests were completed, 34,721 ha sparsely forests were rejuvenated and 100 km forest protection belts were established in the region of Dobrudzha. Main part of the activities were realised with voluntary work (Vachovski and Dimitrov 2003).

The management was implemented with a number of governmental decisions and decrees. The Governmental Decree (GD) N1171 in 1951 framed and developed the first 10-year plan for afforestation (Vachovski and Dimitrov 2003). To the established Management of Forestry to the Government were set 10 tasks in the field of afforestation and erosion control. Among them were: afforestation of total 99,000 ha; production of 37,000 Mg seeds and 3.76 billion saplings; opening of new nurseries on an area of 654 ha; organizing of preliminary soil cultivation and attention for the plantations up to their 3rd year; establishment of two forest seed control stations – in Sofia and Plovdiv; development of forestry regions; preparing instruction for afforestation; educating annually 100–120 engineers in forestry and 200 specialists with special secondary education in the forestry schools, etc. (Milev et al. 2015).

With Decrees from 1951, 1953 and 1954 work stared on the so called technical projects for erosion control in the catchments of the building large dams. Within the framework of such projects 153,000 ha new forests with anti-erosion purpose were established. In order to synchronise the anti-erosion activities in forest and agriculture territories, National programme for erosion control was developed in 1975. It was found that 54,200 ha (15 %) of forest territories were affected or endangered by erosion. For the agricultural grounds the percent was over 80, having in mind the wind erosion problem. Total of 2,294 torrents for technical and biological reinforcement were detected (Milev et al. 2015).

Significant achievement of afforestation activity was the establishment of protection belts system in North-east Bulgaria. During the period from 1951 to 1958 belts with a total length 800 km and an area of 22,000 ha had been established (Vachovski and Dimitrov 2003). Successfully were used the local oaks – Pedunculate oak (*Quercus robur* L.), Sessile oak (*Q. petraea* (Matt.) Liebl.), Turkey oak (*Q. cerris* L.), European ash (*Fraxinus excelsior* L.), Honey locust (*Gleditsia triacanthos* L.), Black locust (*Robinia pseudoacacia* L.), English walnut (*Juglans regia* L.), poplars (*Populus* sp.), etc. To 1980 the belts reached 15 m height and accumulated volume of about 390,000 m^3, playing as well an anti-erosion role, mitigating the microclimatic conditions and favouring the agriculture production. Due to the belts agricultural crops' production increased by 15–35 %, especially in dry years (Milev et al. 2015; Petkova et al. 2002).

An achievement of the foresters in Bulgaria is the system of sources of quality reproductive materials and establishment of intensive forest plantations of fast growing forest species, incl. development of poplar breeding. As a result of the started in 1947 selection work in our country, more than 5,300 objects were established with a total area of 52 thousand ha for the most valuable plantations of the main tree

species. About 6,000 plus trees and candidate-elite trees were selected and registered. For the species used about 390 ha generative and 135 ha clonal seed orchards were established. A collection of about 120 poplar cultivars was established and maintained. It could be stated that Bulgaria has well-developed seed production base but with a view to rich genetic diversity and differences of afforestation objects it should be further developed and maintained. During the second half of 20th century many provenance tests and short-rotation plantations were established using both local and exotic species – Douglas fir (*Ps. menziesii* ssp. *menziesii*), cedars (*Cedrus* sp.), European larch (L. *decidua*), Eastern white pine (*P. strobus*), Willows (*Salix* sp.), Northern red oak (*Quercus rubra* L.), Black locust (*R. pseudoacacia*), and some others. The results concerning main conifers – Scots pine (*P. sylvestris*), Austrian pine (*P. nigra*) and Norway spruce (*P. abies*) showed that 50 % higher productivity was achieved by using seeds from the best sources. Only poplar plantations reached an area 34 250 ha, but during the last years there is retreat and the poplar breeding was implemented only in about 20 thousand ha, of the available appropriate sites, which are about 35,000 ha (Milev et al. 2015).

Since 1958 reconstruction management system was introduced, consisting of replacement of the so-called low-value, rare coppice forests. Programmes for establishment of plantations of fast growing (local and exotic) and fruit trees species were set – English walnut (*J. regia*), Sweet chestnut (*Castanea sativa* Mill.). Since 1966 afforestations aiming at two-storeyed stands have been introduced, and since 1977 for establishment of intensive (industrial) plantations. There was some bias to quantitative indicators (forested area) instead of precise evaluation and identification of appropriate sites. In many reconstructions conifers were settled on significantly dry sites and in regions with critically low air humidity. The unrealistic goal for increasing the timber production on such places led to drying and became a reason to cease the action in 2007. Of the forest fruit plantations established from 1951 to 1970 only about 1/3 are in good status (Milev et al. 2015).

Interesting experiments were set in order to recover the alpine tree line in the high mountains – Rila, Pirin, Stara planina (Balkan range) and Osogovo. Nine tree species and hybrids were examined as well as technological variants for afforestation. These experiments are a source of useful information in case of anti-avalanche and other melioration afforestations in high mountain zone (Dakov et al. 1980).

The most important question in case of afforestations is the choice of the species. It is related to the sustainability and longevity of the plantations as well as the economic and ecological results. Answer to this question is especially difficult in the variable natural conditions and diverse floristic composition of Bulgaria. For years the species choice was done based on observations, visual determination of environmental conditions, imitating the nature and older successful plantations. A task was set in 1951 to identify and prepare a classification of the main forest vegetation regions in Bulgaria. Five teams of scientists and experts worked on this task starting from 1974 and developed methods for identification and classification of forest sites regarding their optimal species composition (Zahariev 1977; Zahariev et al. 1977). In 1978 'Instruction for identification and mapping of forest sites and optimizing the trees composition' was published and it was a base for the 'Classification scheme of forest site types', which was implemented in the forestry practice and served for determining of the proper afforestation composition.

Afforestations reached the highest rate during 1960s and 1970s – an average of 50,000–60,000 ha year^{-1} (Fig. 1). At that time the annual afforestation areas were larger than those in France, Italy, Great Britain, for example. For afforested area *per capita* Bulgaria was at the leading places in the world (Milev et al. 2015). The establishment of suburban forest parks was activated during this period and many terrains destroyed by industrial activity were recultivated by afforestation (Vachovski and Dimitrov 2003).

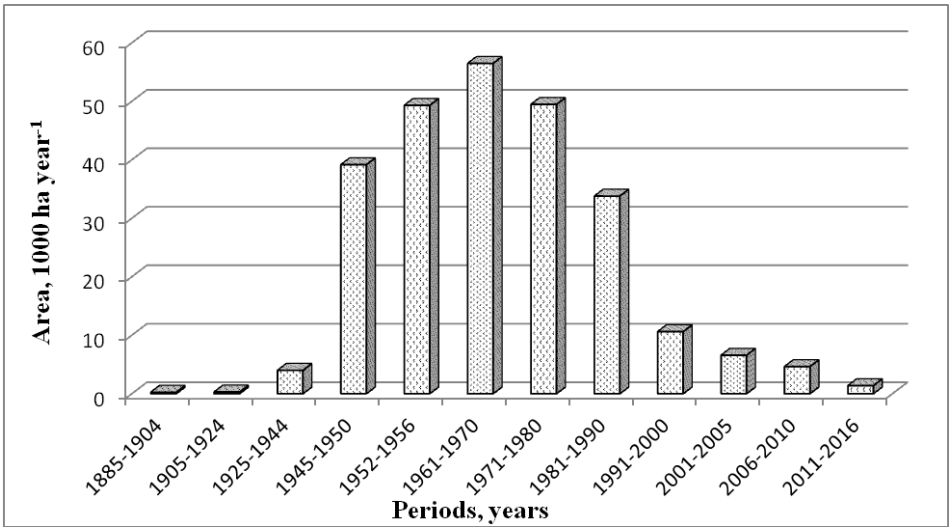

Figure 1. Annual afforestation dynamics in Bulgaria.

During the second half of XX century the afforestations done in Bulgaria can be classified as follows: new ones – 680,000 ha (25 %), reconstruction of low-value and low-production forests – 630 000 ha (37 %), in mature non-renewed plantations – 370,000 ha (26 %), filling rare forests – 350,000 ha (11 %), for two-storeyed stands – 32,700 ha (1 %), or total 2,060,000 ha. According to the character of the afforested objects and the aims of the plantations established, their composition was 70 % conifers and 30 % deciduous species. The mentioned large total area included several times afforestation of the same objects, where the felling was short as it is in poplar plantations and fillings, re-afforestations, etc. (Milev et al. 2015). The afforestations performed required sufficient seed supply and nursery production that were developed at rather good level but they will not be commented here.

With decreasing of bare areas and detecting some discrepancies and problems related to the species chosen for afforestation, a decrease of conifer species share in favour of deciduous ones happened during the 1980s.

Critiques to afforestation increased in the last decade of 20th century. It was due mostly to misunderstanding and with the motive of conserving the autochthonous vegetation and if afforestation should be done at all, it should be using the local deciduous species. The expert opinions were based on the sites' conditions and where these conditions were secondary worsen, mainly by erosion, using of valuable oak and other sensitive deciduous species is groundless (Milev et al. 2015).

During the long term of afforestation practice there were some mistakes and aberrations. Many of them were corrected with time and with experience gathered. The treatment of some species as Pubescent oak (*Quercus pubescens* Willd.), Oriental hornbeam (*Carpinus orientalis* Mill.), Manna ash (*Fraxinus ornus* L.), was changed;

these species, although slow growing, are now not considered 'low-value'. They perform satisfactory their protective functions on very poor and dry sites and there is no reason to be changed with economically more valuable ones (Milev et al. 2015).

For about 55 years the participation of coniferous species increased from 11.8 to 32 %. This fact is the base for increasing our forests' production, to assure better quality and demanded timber, the social functions were improved. Similar policy in the afforestations have many countries. Coniferous species dominate in Belgium (89 %), Spain (98 %), Greece (91 %), and France (89 %). Gradually, with mastering the torrents and changes in the afforestation policy, the balance between conifers and deciduous changed. The view for priority usage of deciduous species was supported by the specialists yet in 1980s and since the 1990s it has become in practice (Fig. 2). The percentage showed on Figure 2 is not due to the significant increase of afforestations with deciduous but to the significant decrease of coniferous plantations establishment (Milev et al. 2015).

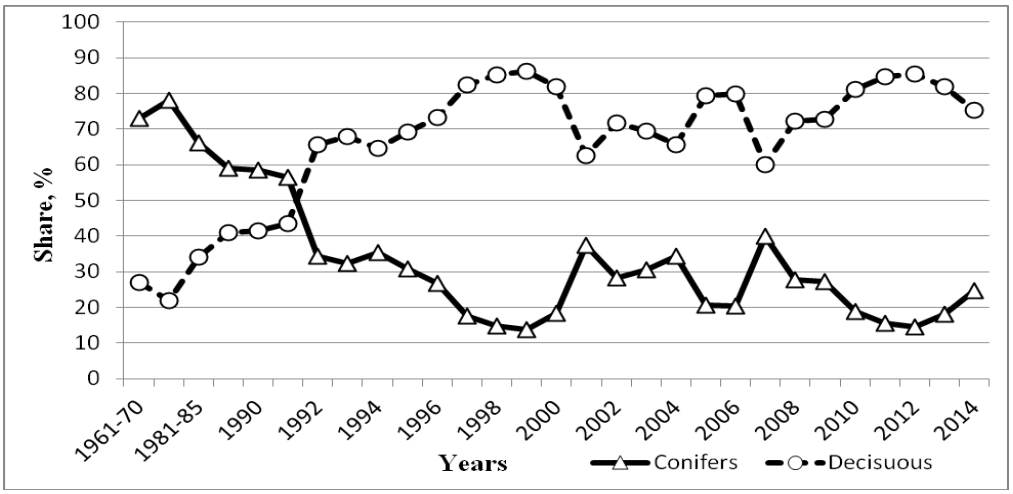

Figure 2. Relationship between areas of afforestation with conifers and deciduous species.

2 Importance and effectiveness of afforestation

Bulgaria has doubtless success which show significant possibilities of afforestation for establishment of new multifunctional forests as well as to assure fast and quality artificial restoration of forests. As to current value the established 1.2 million ha forest plantations are an investment for about 2.5 billion euro – for the afforestation only. Due to the implemented forest economy policy the share of forest plantations reached about 1/3 of the total forest territory. Bulgaria got new image with the newly established forests. The forest vegetation of the country at the beginning of XXI century reached reasonable level – 33.4 %. To a high rate the territory has been protected from erosion, the torrent risk has decreased and the adjoined agricultural areas, reservoirs and transport infrastructure were better protected. The established plantation had a significant is the contribution of the plantations created to increasing the timber volume within 60 years with 3.3 times (from 193 to 645 million m^3), and of the annual growth – with 2.3 times (from 6 to 13.97 million m^3).

If the effect of afforestation is graded, it is at first place ecological, having in mind that most of the plantations have erosion controlling functions, and with the

scale it has significant environment formation function. On the next place is providing raw material. Considering the multifunctional character of afforestations, it is important to mention that they influenced positively many branches – agriculture and water industry, tourism, transport, power production and the entire life style of the population. The results of torrent control, protection of reservoirs from silting, field protection role of agricultural areas, increased productivity of forest and the landscape of Bulgaria was refined beyond recognition. The best examples showing the positive effect of afforestation are the parallel photos from the past and after the plantations have grown (Fig. 3). This is the reason why the foresters feel proud of the activities realized, which were of the most significant country achievements of 20th century. In order to realize completely the timber production potential and to follow the realization of their ecological functions, silvicultural activities are needed for management of the plantations established – a responsible task for contemporary foresters.

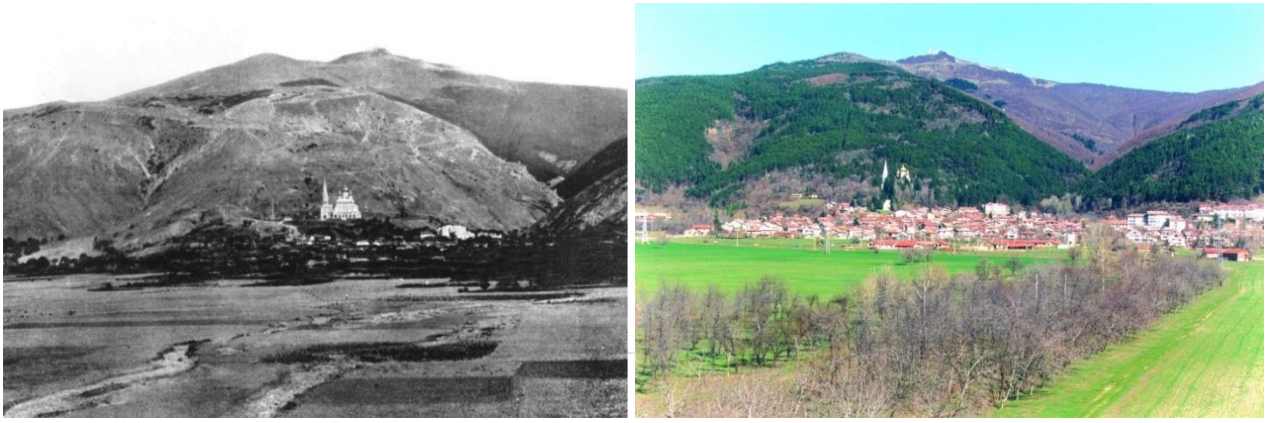

Figure 3. Views from Stara planina slope above Shipka town from 1905 (left) and 2005 (right), (Archive Gora Journal).

Special attention was paid to the in time dam protection. Nowadays all large dams in Bulgaria are surrounded by protective 'green belts, which protect them from silting and increase the exploitation terms to centuries (Fig. 4).

Figure 4. Views from dams Iskar (left) and Kamchiya (right).

3 Afforestation in recent times

Since the 1980 the afforestations in Bulgaria have decreased. This is expected having in mind the large mastered areas for afforestation. There were additional factors as well: development of silvicultural systems with natural regeneration priority; chronic economic crises and lack of resources, etc. Similar processes are typical for other countries in East Europe (Weber 2000). During 1990s the afforested areas per year decreased under 10,000 ha year^{-1}, and after 2009 – under 5,000 ha year^{-1} (Fig. 1). At the same time the possibilities for afforestations according the project calculations reflecting the forest territories condition are about 15 to 18 thousand ha annually. Obviously the afforestation dynamics is under the power of social and economic environment and the forest policy realized, and for the last 20–25 years more significantly influenced the market relations in the forest sector.

Looking at the afforestations from a multifunctional point of view, we could state that they are not only a solid ecological and raw material investment, but have a social importance as well. They are a carrier of a potential for work loan security and stabilizing the population occupation. Good work loan has a reflection on the decreasing the offenders in the forests. The afforestation marginalization hides a significant risk to break the connection in the transmitting the rich experience in the activity of seed production, nursery production, afforestation and plantation care.

The correct direction of afforestation policy needs analysis of the condition and dynamics of forest territories. According to data from Executive Forest Agency (EFA 2016) to 31.12.2016 forest territories in Republic of Bulgaria cover 4,230,825 ha (increased toward 2015 with 7,951 ha) or 38 % of the country area. Of these, 91 % are forests so they reach 34.7 %. The area of forest territories without forest vegetation is 365,860 ha. The average age of forests increased and reached 57 years. The total growing stock is 680.5 million m^3 and it increased with 4.2 % only after 2005. About 42 % of this stock is concentrated in the protected and recreational forests, and protected territories. The average growing stock is 178 m^3 ha^{-1}. It is higher than that in Europe (105 m^3 ha^{-1}) and higher than that for forests in the world (130 m^3 ha^{-1}). For the first time decrease of the mean increment is reported, from 14.4 (2010) to 13.97 million m^3 year^{-1}. Use of the timber is about 8 million m^3 year^{-1}, which is 55 % of the annual increment. The detected tendency for increasing the timber stock is better expressed in coniferous forests. The average stock in these forests is 260 m^3 ha^{-1}. On the other hand, significant decrease was registered in the average growing stock of coppice forests to be turned into seed ones – only 114 m^3/ha. Coniferous forests demonstrate the highest annual increment – 6.2 m^3 ha^{-1} year^{-1}, followed by deciduous high forests – 3.7 m^3 ha^{-1} year^{-1}, and for coppice forest it is about 2.3 m^3 ha^{-1} year^{-1}. For the distribution of forest territory according types of forests there is a trend to decrease coniferous forests area (towards 2013 they are 1,145,781 ha or 21.6 %) and coniferous plantations. The total area of established forest plantations during the last three years is small but increases from 3862.4 ha (2013) to 5,694.2 ha (2015). As a results, the total share of coniferous decreases to 20.9 %, mainly due to abiotic and biotic damages. The deciduous forests cover 68.4 % of the total area of forest territories and their share gradually increases. An important fact is that Bulgarian forests are a reservoir of 229 million Mg carbon.

Significant influence on decreasing the afforestations has the active processes of auto-afforestation of free forest territories and abandoned uncultivated areas out

of forest territories. During the last years afforestation is done mainly in post-fire areas, drying stands and plantations, cutting areas and only on small part of the rest are bare non-forested territories. The decrease in afforestation is due to various reasons. First, large part of the areas that need afforestation were used by the programmes for wide scale establishment of forest plantations in the near past. Second, the influence the social and economic factors as insufficient funding, low labor cost, lack of workers., Also, along with the decreased funding of afforestation activities, another important factor was the priority of the natural regeneration, regulated in the Forest Act.

4 Contemporary problems and prospects for afforestation

Bulgarian forests are characterised by extremely rich diversity of coniferous and deciduous tree species. Forest territories included in the European Ecological Network NATURA 2000 are 58 % of the total forest area. An essential fact is that 2/5 of the forest stock is concentrated in protected and recreational forests and in protected areas. This is related to increasing of use in other forests. As the mentioned above increase of forest resources is mainly extensive so the establishment of intensive plantations, where possible, turns to be an important reserve for providing the necessary quantity of wood. In other words, the development of plantation silviculture could contribute to close-to-nature management in predominant part of our forest territories. There are recommendations for establishment of plantations aiming mainly at timber production on 20,000 ha (10–12 % from forest territories), which should be managed following the principles of plantation silviculture (Vachovski 2009).

Despite of significant achievements in the erosion control not everything is completed. Still 15 % ofrom the forest territories are endangered by torrents, and 80 % of the agricultural areas are threatened by erosion. The inclined terrains are particularly susceptible. Even if cultivated, annually soil layer of up to 5 mm is removed. About 250 thousand ha are desolated and unsuitable for agriculture. Their afforestation is implemented in the National Action Plan on Climate Change and should be realised within Bulgarian duties on UN Frame Convention. That is why in the National strategy for development of forest sector 2013–2020 (MoAF 2013), as well as in the Strategic plan for development of forest sector 2014–2023 (MoAF 2014) is foreseen increasing of the forest area via afforestation of abandoned former agricultural lands, bare, deforested, eroded and endangered by erosion territories. Favourable opportunity for afforestation of neglected non-agriculture lands is provided by the Programme for development of rural areas. Other important factors are described In the mentioned strategic documents s as well: significant fire risk; necessity of adapting the afforestations to climate changes; potential for carbon accumulation and disturbances in the forests. In this connection actions for recovering from forest fires, natural disasters and illegal action are foreseen (Milev et al. 2015).

Currently, we are facing the challenge of frequent forest fires. The annually burnt area in 20th century upto 1980s ranged between 800 and 3,000 ha. During the subsequent years the fires as a number became 6 times more and caused 35 times larger damages measured as area. Total 133,700 ha were burnt from 1991 to 2001 which was about 3 % from the forest area of the country. Only 1200 ha were afforested of about 78,000 ha burnt in 2000-2001. According to the statistical data the

forest fires during the period 2003–2013 affected 91,127 ha forest territories, with an average for the country 8,284 ha. Total 584 forest fires were registered in 2016, and 6,320 ha were affected, of which 5,331 ha in forests and 989 ha in unforested areas (Batalov 2017). Burnt areas were about 40,000 ha.

Violations of rules and illegal activities in the forests in the initial period of the development of Bulgarian forest economy as well as today are described as the main problem of the system. There are users and offenders, and even owners, possessed by rude commercialism, who during cutting harvest the valuable individuals, without ensuring sufficient and quality renovation. Thus during the last 20 years when the conceptions of close-to-nature management of the forests and biodiversity conservation were implied, the expected good results are difficult to achieve in the practice. The quality of many stands is destroyed. Their natural restoration, even if achieved, will be a step back in the genetic sense. A clear example is one of the most valuable local deciduous species – the Pedunculate oak. There are practically no valuable populations left. So it could be certainly said that there is groundless underestimation of one very positive part of the afforestations – the possibility to maintain and improve the quality of forest stands in genetic and breeding sense. This is especially valid for valuable local deciduous species to which the policy of afforestation pays attention. Stopping the reconstructions should not limit the use of good quality reproductive materials to help or totally restore in case of worsen breeding structure. The highest potential in this direction is in turning the coppice stands into seed ones, because along with their low quantity indicators, also negative phenotypic selection took part many times there. The transition to seed origin is important but it is only one and smaller step to improving the deciduous forests. Promoting the restoration with use of appropriate seed origin could increase the quality and value of the stands with 40–50 %. The negative changes should be also taken into account due to the soil erosion. In such stands it is logical to look for different species composition, which will correspond to the conditions available. The balance shows that at least 15 % (410–460 thousand ha) of the stands in forest territories need improvement – species composition, origin and quality.

Other important tasks are related to the recultivations of destroyed terrains by means of afforestation, finishing the establishment and reconstruction of the forest shelter belts system, and protecting the transport infrastructure by road protection belts. Specific task related to the afforestations is how to manage the areas of forest plantations damaged by biotic and abiotic factors. The cases are diverse and need special differentiated measures. Bulgarian researchers work on this task and one promising directions is the idea of ecosystem correspondence (Kostov 2014). The evaluation should be based on the environmental conditions status evaluated via site system (Raykov et al. 2011). It is important to evaluate to potential for natural restoration and foresee which ecosystems would be stable and worth economically.

Significant challenge for the correct choice of species composition is the problem of climate change. The afforestation policy should consider the direction and speed of these changes. At this stage in Bulgaria and in the world dominates the expectation of global warming. Different scenarios for local climate changes which differ by the level of warming and drough were developed t (Raev and Alexandrov 2011; Raev et al. 2015). However, there are also other opinions and some of them predict cooling rather than warming. There are even assumptions that according the global cycles the world goes to next ice age (Yankov 2010; Hansen et al. 2013; Snyder

2016; Viterito 2016; Nikolov and Zeller 2017). At this stage it is preferable not to relay on a determined direction but run investigations on the adaptive possibilities of tree species and their ecotypes.

There are real risks for the sustainability of forest plantations and these risk are related to their health conditions. Most frequent damages by abiotic causes are snow breaks and snowfalls, windbreaks and wind throws, ice glass (ice breaks), fires and other natural disasters. Droughts expressed in the low air humidity lead to physiological weakness and occurrence of calamities. During the last years the strongest attacks were on coniferous species, especially *P. sylvestris*, attacked by Engraver beetle (*Ips acuminatus* Gyllenhal, 1827). Another important problem is caused by the fungus Sphaeropsis blight (*Sphaeropsis sapinea* (Fr.) Dyko & B. Sutton.), which attacks Austrian pine plantations.

Bulgarian foresters and researchers are in a complex situation due to the high diversity of environmental conditions and rich floristic composition. On the other hand this provides wide spectrum of opportunities to choose from. The total number of indigenous and introduced forest tree species used in Bulgaria (without shrubs) is about 160, of which 120 are broadleaved and 40 coniferous. We are aware that with the rich experience in the afforestations and scientifically based problem solving, forest plantations will contribute to the sustainable development of forest resources and better economic results in the forest sector in the country.

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