

## PINES IN THE DELIBLATO SANDS: ECOLOGICAL LESSONS

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**Abstract:** In the Deliblato Sands Austrian pine (*Pinus nigra* Arnold) and Scots pine (*P. sylvestris* L.) are present. These species mainly constitute single species plantations which are very endangered by fires. The greatest fires in this area were recorded in 1973, 1990, 1996 and 2007. In this stand type, rapid spread of diseases and pests is also the problem. In the Deliblato Sands such stands should be avoided, especially on large areas. The pines should be mixed with deciduous species, and prime consideration should be given to habitat conditions. Deciduous species that are autochthonous in this area (limes and oaks) should be favoured.

**Key words:** the Deliblato Sands, Austrian pine, Scots pine, forest fires, afforestation

### 1. INTRODUCTION

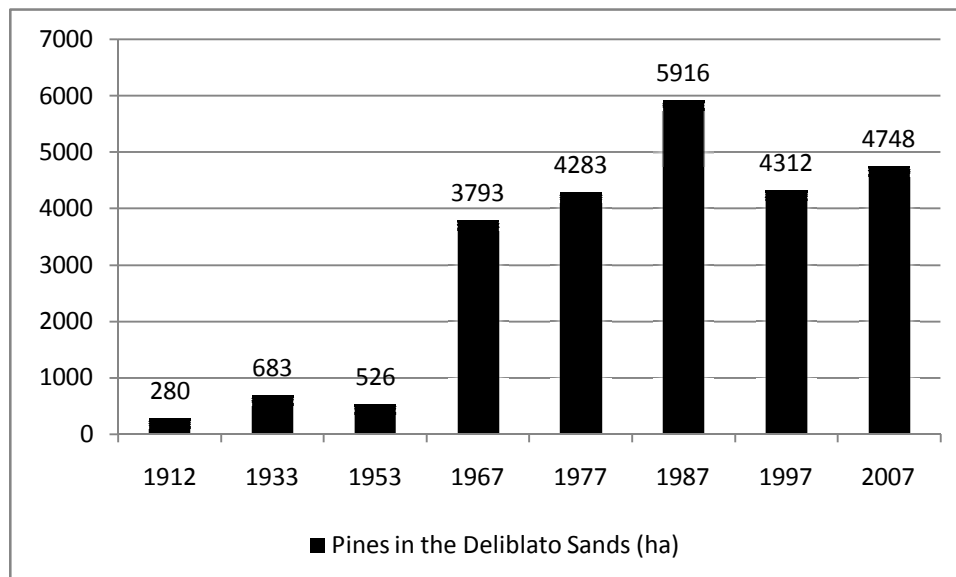
“The Deliblato Sands” Special Nature Reserve is situated in the Southeastern part of the Autonomous province of Vojvodina (Republic of Serbia). The greatest part of forests in this area is included in Management Unit “Deliblatska peščara”, which is a part of Forest Holding “Banat” – Pančevo (Public Company “Vojvodinašume” – Novi Sad). MU “Deliblatska peščara” covers 28,464 ha, and 17,552 ha (61.7%) are under forests. The most present tree species is black locust (*Robinia pseudoacacia* L.) – 11,320 ha (64.5% of the forest area). Other deciduous species cover only 1,483 ha (8.4%), while pines cover 4,748 ha (27.1%).

In the Deliblato Sands, Austrian pine (*Pinus nigra* Arnold) and Scots pine (*P. sylvestris* L.) are present. Eastern white pine (*P. strobus* L.), Jeffrey pine (*P. jeffreyi* Balf.) and ponderosa pine (*P. ponderosa* Douglas ex C. Lawson) are present on very small areas. It is important to note that pines are not autochthonous in the Deliblato Sands and their presence is a consequence of afforestation. The Deliblato Sands has been under strong anthropogenic influence for about two and a half centuries. For complete understanding of ecological problems in this area, it is necessary to comprehend the history of human influence.

### 2. HISTORY

By the second half of the 18th century, wider area of the Deliblato Sands was very sparsely populated. Dominant type of vegetation was forest-steppe, and forest was composed mainly of oaks (*Quercus* spp.) and limes (*Tilia* spp.). In the second half of the 18th century, the population in the vicinity of the Deliblato Sands started to grow gradually. Therefore, the need for pastures and arable lands increased, and the consumption of wood was on the rise, too. In 1777, the Ottoman Empire conquered the area, but their army withdrew the following year, leaving destroyed forests behind. Return of refugees has brought back excessive logging and grazing. Surfaces without vegetation in the Deliblato Sands have increased over time, and southeast wind (košava) blew the sand on the surrounding agricultural areas and villages. At that time the Deliblato Sands was named “European Sahara”. Therefore, in 1810, the Austrian authorities began to survey the area. It was found that the total area was 40,660 ha, while 16,800 ha were under sand and without vegetation. In 1815, the plan for the sand afforestation was created. It was implemented for the first time in 1818, which is therefore considered as the year of the beginning of the organized work on sand fixing and stabilisation. In the period 1818–1843, a total of 5,131.60 ha were afforested, while the best results were obtained by using poplars and pines (Austrian pine and Scots pine). Later, black locust was more used, but afforestation with previously mentioned species was also continued. The work was followed by numerous problems, above all excessive logging and grazing. In the late 19th and early 20th centuries, as the afforestation was ending, pines were rarely used, and deciduous species (black locust, American ash, eastern black walnut, pedunculate oak and bird cherry) were frequently used. It was believed that in 1907 the process of the sand fixing and stabilisation was over. At the same time, the state property area of 25,054 ha was named “the Deliblato Sands”. In 1912, there were 12,189 ha of forest and 12,865 ha of other lands. Black locust was

present on 7,040 ha, poplars and other hardwood on 4,869 ha and pines on 280 ha. That same year, the area was divided into compartments measuring 57.54 ha. They were separated by breaks whose function was, among others, to prevent fire spreading. The division into compartments and breaks is still in the use today. In the period after World War I, black locust was still used in the afforestation, while the pines were rarely used. However, this period is characterized by reduction of the forest tree biomass, substantially due to fires. In the first years after the World War II, excessive exploitation of black locust and pines started [1, 2].



**Figure 1:** The area under pines in the Deliblato Sands (1912–2007) [3]

The main reasons for the excessive use of Austrian pine and Scots pine in the afforestation are their hardiness, modest request for habitat conditions, simple production of seedlings and wide possibilities of the use of their wood. The main pine protection problem in the Deliblato Sands is forest fires. Pines are extremely endangered by fires, and in the conducted research special attention is paid to this problem.

### 3. FOREST FIRES

In pine plantations and forests, the biomass represents excellent fuel. On the forest floor, there is a layer from fallen needles, cones and branches. This material is flammable and its decomposition is slow. Pines contain resin so they burn fast. Younger pine trees have lower branches close to the forest ground. These branches are mainly dry, so fires quickly grab the whole crown. Fires are quickly transferred from lower to higher trees and this is very important for the fire spread.

On the basis of the surveyed documentation of FH “Banat” – Pančevo (Public Company “Vojvodinašume” – Novi Sad) it was determined that there were 267 forest fires in the area of MU “Deliblatska peščara” in the period 1948–2015. The total burned area is 11,943.2 ha, and 6,138.6 ha of forests. The greatest fires, which represented ecological catastrophes, were recorded in 1973, 1990, 1996 and 2007 (Table 1).

**Table 1:** The greatest forest fires in the recent history of the Deliblato Sands – the burned areas (on the basis of the documentation of FH “Banat” – Pančevo) [4]

Fire	Burned area (ha)				
	Deciduous	Conifers	Forests total	Other	Total
March 27–29 1973	270.33	478.05	748.38	258.31	1,006.69
August 30 – September 5 1990	69.05	636.11	705.16	176.44	881.6
August 10–16. 1996	677.38	1,557.63	2,235.01	1,580.39	3,815.4
July 24–31 2007	81.08	333.5	414.58	132.21	546.79
Total	1,097.84	3,005.29	4,103.13	2,147.35	6,250.48

The total burned area in all four fires was 6,250.48 ha, which represents 52.34% of the total burned area in the period 1948–2015. The total burned forest area in these four fires was 4,103.13 ha (66.84% of the total burned forest area in the same period).

In the Deliblato Sands, the afforestation was done in single species plantations on large areas. In addition, these areas were connected and therefore the conditions for rapid spread of fires are made. The solution for this problem could be mixture of pines and some deciduous species which are less endangered by fires. Efficient measure could also be growing biological fire prevention belts made of deciduous trees. This measure has been planned several times so far, but it has never been realised. The application of these measures could create conditions for the decrease of the fire spread speed.

It should also be kept in mind that the newest research showed that forest fires are caused by highly energetic solar wind particles. According to the hypothesis, these particles in some cases pass through geomagnetic field and could reach the Earth's surface causing vegetation fires [5, 6]. The July 2007 fire in the Deliblato Sands was analysed in the framework of the hypothesis and it has been determined that its source of energy was coronal hole CH279. The penetration of the particles happened in the area of Atlantic geomagnetic anomaly, and after that they were aimed towards south Europe [7]. During the last decade of July numerous fires were recorded in the south Italy, Montenegro, Greece, Albania, Serbia and Bulgaria. There are some indications that the other three catastrophic fires in the Deliblato Sands were also caused by solar wind particles [8]. Common characteristics of the catastrophic fires in the Deliblato Sands were rapid fire spread, simultaneous fires, strong winds that change direction, difficult and disabled firefighting, etc. [9]. The newest research confirmed hypothesis on solar wind as a cause of fires in the case of the USA, whereby the analysis covered all fires during several fire seasons [10].

Regardless of the cause of fire, the presence of a single species pine plantations and forests on large, mutually connected areas represents an extreme risk factor.

#### 4. THE OTHER FACTORS

The detrimental factors that affect forest ecosystems are divided into abiotic, biotic and anthropogenic. The other abiotic factors that affect Austrian pine and Scots pine in the researched area are drought, extreme high and low temperatures and the damages made by snow and storm. These factors represent much greater problem in the single species stands in comparison with mixed (two or more species). The advantages of the several species presence are evident in the case of combining conifers and deciduous trees. These stands are characterized by stability and better space utilization and the damages caused by abiotic factors are much rarer.

As for biotic factors, diseases and pests are the most important. The causes of diseases are mostly fungi, and insects are the most important and numerous pests.

The most important fungi in the plantations of Austrian pine in the Deliblato Sands are: *Mycosphaerella pini* Rostrup apud Münk. (n.f. *Dothistroma septospora*), *Sphaeropsis sapinea* (Fr.) Dyko & Sutton and *Armillariella mellea* (Vahl. ex Fr.) Karst.. These fungi develop as parasites and in the case of perennial infections they can cause tree dieback. Within Scots pine plantations, the most important species are: *Heterobasidion annosum* (Fr.) Bref. and *Lophodermium seditiosum* Minter, Staley & Millar [11].

The greatest damage in pine plantations and forests in the Deliblato Sands is caused by following insects: pine bark beetles (fam. *Scolytidae*), pine shoot moth (*Rhyacionia buoliana* Den. Schiff.) and red pine sawfly (*Neodiprion sertifer* Geoffr.). There are several species of pine bark beetles and in the Deliblato Sands, the most important is six-toothed bark beetle (*Ips sexdentatus* Boern.) [11].

Diseases and pests make the greatest problems in single species stands, not only on pines, but also on other tree species. In this stand type, the conditions for rapid spread of harmful organisms are more favourable.

The particular problem is a phenomenon known as “the chain of detrimental factors”. The detrimental factors are divided according to the order of their action: primary, secondary and tertiary. Primary factors damage healthy trees and thus create conditions for further tree decline. They are mostly fires, snow and storm damage, but also they can be fungi and insects. Secondary factors affect physiologically damaged trees and they are primarily parasites of weakened trees and secondary insects. After them, tertiary factors (rot fungi and some xylophagous insects) appear.

Apart from the above mentioned problems, it is also important to notice that the presence of pines in the Deliblato Sands has some negative consequences. Above all, it is low quality of soil in pine stands. In comparison to deciduous leaves, decomposition of pine needles is slower and the soils under pines are acid. Besides, pines are present in the Deliblato Sands on many sites where they should not be. As pioneer species [12], pines should be present primarily on the sites which are not appropriate for other tree species.

After the catastrophic fires, especially after the 1996 fire, the prevalent opinion was that the use of pines in the afforestation of the Deliblato Sands should be stopped. The opinion is extreme and without environmental grounds. It is clear that there were some serious mistakes made in the past and the society is now faced with their consequences. For example, almost half a century ago, it was stated that in this area 15,000 ha should be under pines [13], which accounts for more than half of MU “Deliblatska peščara”.

Finally, it should be emphasized that pines are important for tourism development. Forest communities have particular importance for tourism flows, which is reflected through their recreational (health) and esthetical attributes. Although pines are not autochthonous in the Deliblato Sands, they represent integral part of its landscape. Thanks to pines, the landscape becomes more attractive for tourists. The Deliblato Sands has been a pine habitat for more than two centuries, and most of the visitors could not imagine this area without them. Favourable geographic and tourism position, i.e. the vicinity of Banat towns Bela Crkva, Vršac, Pančevo, and the major tourism dispersive zone, Belgrade, allowed the development of the excursion and weekend tourism. The most important excursion sites are Devojački Bunar and Čardak. Besides, the youth recreational tourism is also developed, thanks to the existence of school-recreational centre Čardak, which has been built in this site due to beneficial effect that vegetation has on children and youth health.

## 5. CONCLUSION

The main ecological lessons related to the Deliblato Sands are:

- Using pines in the afforestation should be limited primarily to the sites that are not appropriate for most other species;
- Outside these sites, pines could be present in the combination with deciduous species;
- Larger areas under pines should be divided by deciduous species belts;
- In the pine plantations and forests, preventive protection measures should be primarily used (these measures are aimed to create resistant pine trees).

In future more attention should be paid to the autochthonous forest vegetation (oaks and limes). It has been determined that lime in the Deliblato Sands has a satisfactory growth, similarly lime on Fruška Gora [14, 15].

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