



**INVESTIGATION OF THE DENSITY AND
VOLUME REDUCTION OF THE WOOD FROM
SOME INTRODUCED SPECIES IN MACEDONIA**

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Introduction

- ▶ Complex function of the forests in the ecosystem, as well as their present situation, the obligation of the society and forestry sector is to conduct energetic and urgent measures to improve their condition. One of the most efficient ways to fulfil this task is to introduce tree species with high growing potential and other positive characteristics that can help cultivate them out of their natural areals. In the framework of the world process of introduction of outlandish tree species, Republic of Macedonia started with introduction after the WWII, when first forestry institutions were established.
- ▶ Although there were no scientific conception for the methodology of introduction, meaning right experimental placement and installation, several exotic tree species were introduced.
 - In the semiarid stands near Vardar River, on the *Carpinetum orientalis macedonicum* stand the following species were introduced: *Pinus halepensis*, *Pinus brutia*, *Pinus eldarica*, *Pinus pinea*, *Cupressus arizonica*, *Cupressus sempervirens*, *Cedrus atlantica*, *Cedrus deodara*, *Morus alba*, *Fraxinus Americana*, *Acer negundo*, *Ailantus glandulosa*, *Juglans nigra*, *Populus euroamericana* (different clones), *Eucaliptus* (several species), *Robinia pseudoacacia*, *Sophora japonica*, etc.
 - On the higher altitudes, in the oak and beech region, the number of introduced species was lesser: *Pinus strobus*, *Chamaecyparis lawsoniana*, *Larix europea*, *Sequoiadendron giganteum*, *Abies grandis*, *Abies concolor*, *Abies pungens* etc.

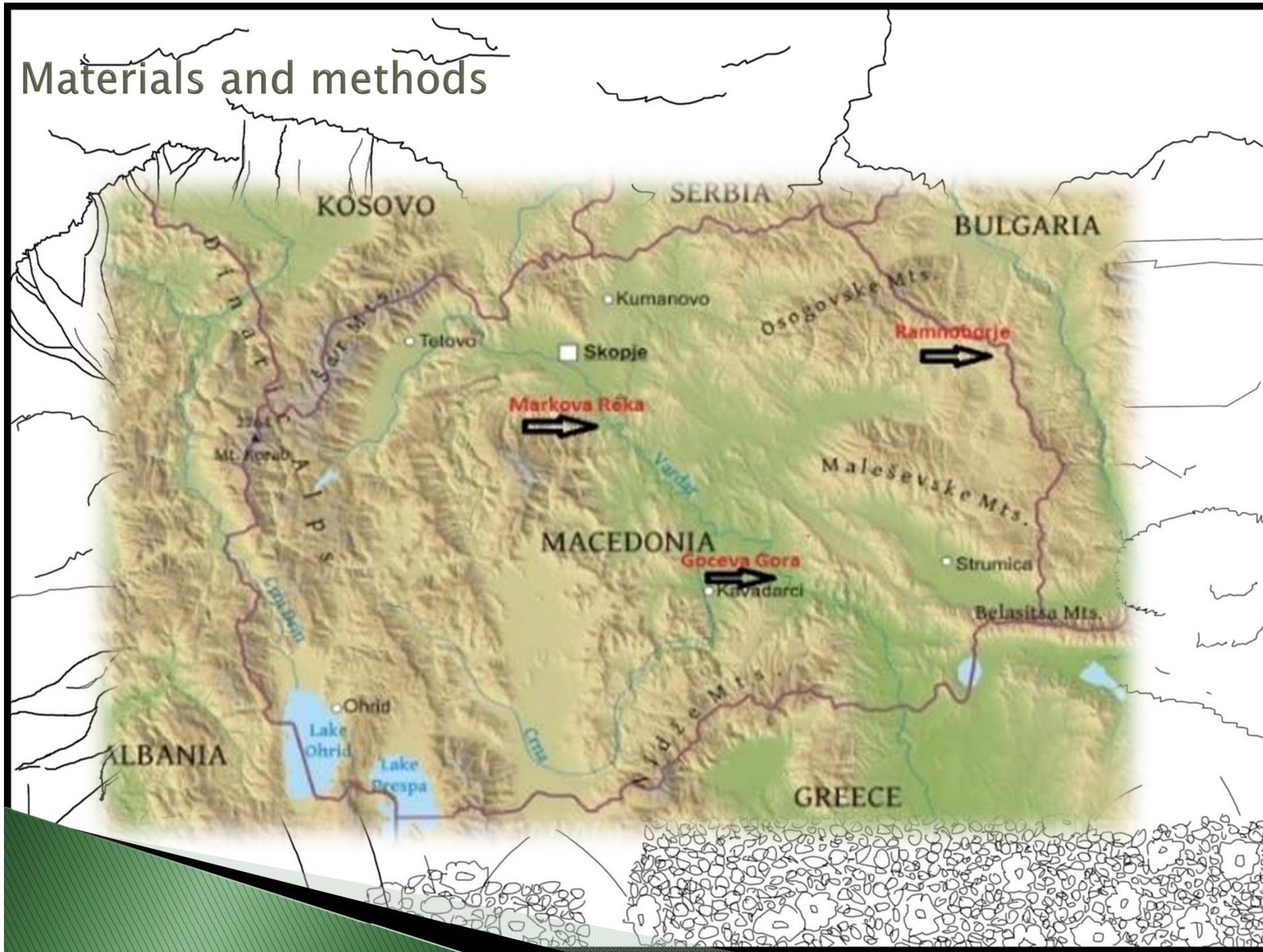
Introduction

- ▶ Some of the mentioned species, in the past period of adaptation **showed encouraging results** according to Andonovski [1978] and Lazarevski, [1978]. The newest investigations of the adaptive capacity of some species, **confirm previous conclusions**, [Andonovski 1995].
- ▶ The acquaintance of the properties of introduced tree species as a factor for success of the introduction is stressed through the segment of wood technical properties. There are very few previous investigations of those characteristics due to the age of the stands (juvenile wood) done by Nacevski et al [2001, 2002]. In accordance with determined quantity and quality of produced wood at the age of 30 years, the authors ascertain that **Pseudotsuga menziesii should maintain the epithet of perspective species** for introduction in Republic of Macedonia in the *Quercus sessilis* ecological conditions.
- ▶ In the same direction, this paper is an extension of the previous investigations, with primary goal to establish the wood density in standard dry (absolute dry) condition. The possibility for rational usage of the material, is a factor for usage of the same samples, although their dimensions deviate from standards, for volume reduction determination of **Sequiadendron giganteum, Pinus strobus and Larix decidua**.

Materials and methods

- ▶ Material for the investigation of the properties of Cupressus arizonica is gathered from Crveni bregovi locality, in the region of Demir Kapija, known as Goceva Gora. The area of the stand is **620 ha, at the altitude of 13 to 246 m**, with north to north-east exposure. Geological underlay are sediment rocks, sand stones and clay, and the soil is alluvial and **vertisol**
- ▶ Sequoiadendron giganteum material was gathered from Rasadnik locality in Skopje region, in the FMU "Markova Reka", department 12. The area of the stand is **1 ha, on the altitude of 900 m**, with north-west exposure. Geological underlay is silicate with eutric cambisol. The stand is monoculture with around 100 trees, in scarce covered sessile oak trees. The stand is in the fructification phase and there are no offspring. The trunks are straight, healthy with average stem cylindricity. (Andonovski, 1995).
- ▶ Material for Pinus strobus was collected from Ramnaborje locality, in Pehcevo region, from FMU Bukovik-Bajaz Tepe, department 26-a. The area of the stand is **103 ha, on altitude of 1050 m** and flat terrain. Geological underlay are lake sediments that arose on the surface in the form of small rocks. The soil is dark brown forest soil without humus and leaves

Materials and methods

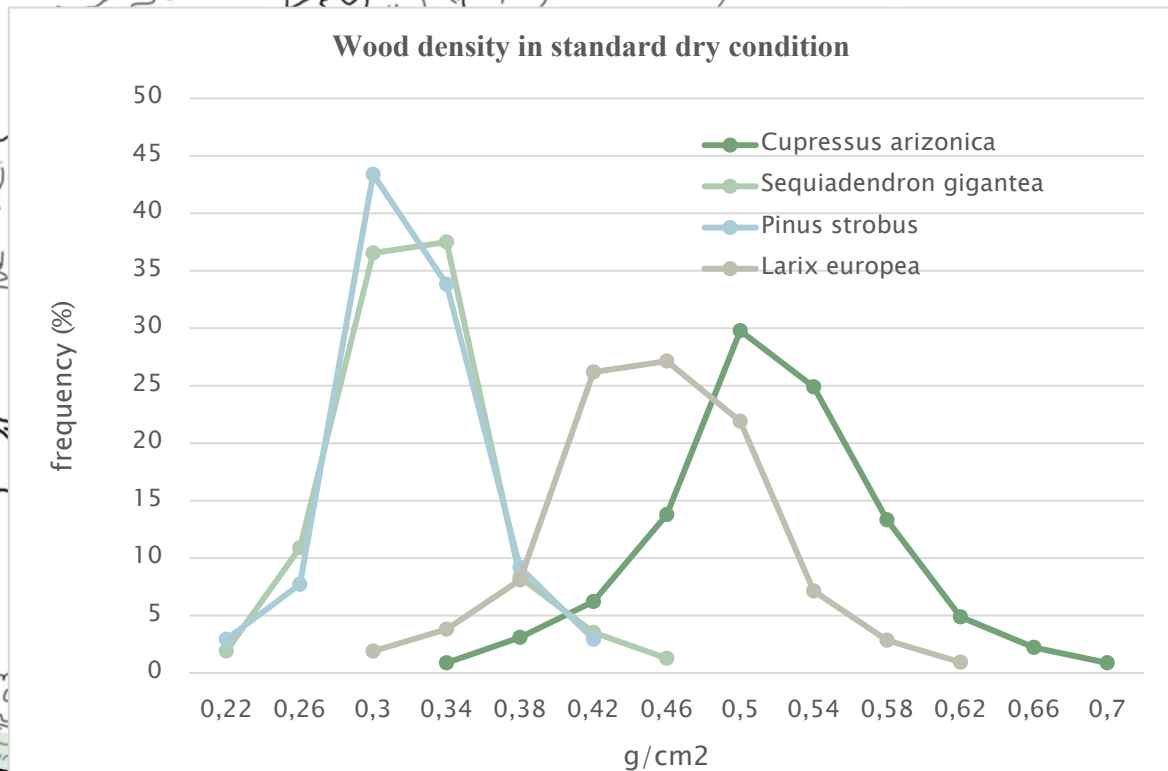


Materials and methods

- ▶ From every species, **3–4 trees that structurally represents** the stand, were cut. The basic dendrometric characteristics of the model trees are shown in Table 1. Every model tree was **cut on 0,3, 1,3, 3,3, 5,3 and 7,3 m and piece's 1m long** from them were taken to the laboratory.
- ▶ **Radial boards** were cut from every log, that were used to prepare profiles with dimensions **23 X 23 X 100 mm**, and they were transformed into the samples for investigation. The boards were cut from every log, that were used to prepare profiles with dimensions **23X23X100 mm**, and they were transformed into the samples for investigation of the physical and mechanical properties of the species. Samples that were used to determine the wood density (20X20X30 mm) **were also used for determination of the wood volume reduction**. The sample number was 225 for *Cupressus arizonica*, 312 for *Sequoiadendron giganteum*, 272 for *Pinus strobus* and 210 for *Larix decidua*.
- ▶ The wood density of ***Cupressus arizonica*** in standard dry condition varied from 0,356 to 0,656 g/cm³, **averaging $0,516 \pm 0,0042$ g/cm³**, with standard deviation of $0,063 \pm 0,0030$ g/cm³, and **coefficient of variation of $12,2 \pm 0,584\%$** .
- ▶ The wood density of ***Sequoiadendron giganteum*** in standard dry condition was in the neighborhood from **0,228 to 442 g/cm³**, averaging $0,322 \pm 0,0024$ g/cm³, with standard deviation of $0,042 \pm 0,0017$ g/cm³, and **coefficient of variation of $13,0 \pm 0,529\%$** .

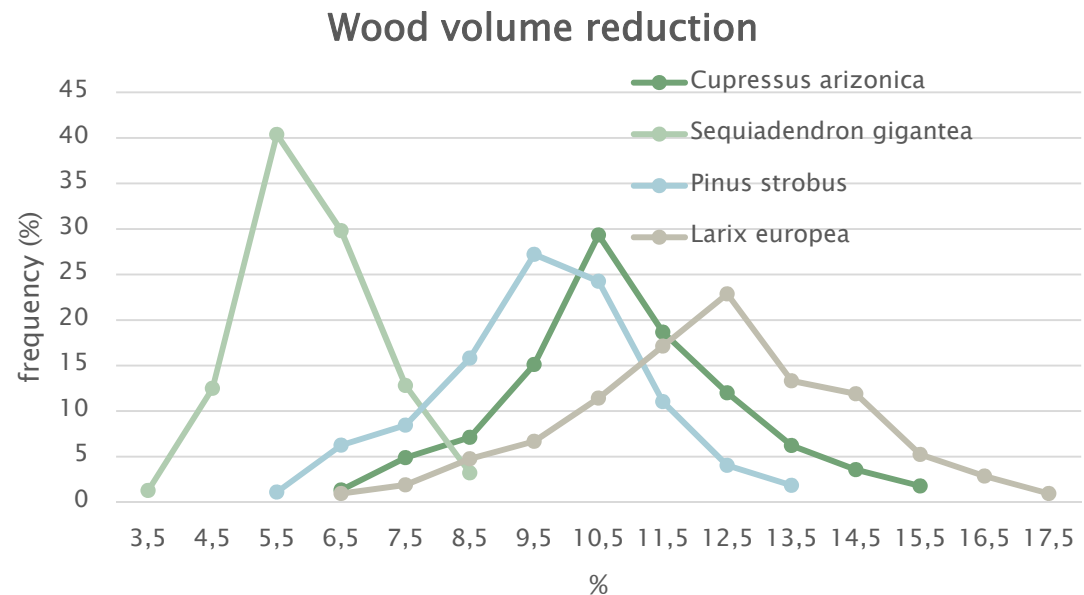
Results

- ▶ The wood density of **Pinus strobus** in standard dry condition was in the neighborhood from 0,235 to 0,410 g/cm³, **averaging 0,319±0,0040 g/cm³**, with standard deviation of 0,039±0,0017 g/cm³, and **coefficient of variation of 12,2±0,531%**.
- ▶ The wood density of **Larix decidua** in standard dry condition was in the neighborhood from 0,312 to 0,605 g/cm³, **averaging 0,455±0,0040 g/cm³**, with standard deviation of 0,058±0,0028 g/cm³, and **coefficient of variation of 12,7±0,630%**.



Results

- ▶ The average wood volume reduction of **Cupressus arizonica** was estimated on $10,9 \pm 0,1193$ %, with standard deviation of $1,790 \pm 0,0844$ %, and **coefficient of variation of $16,4 \pm 0,794$ %**.
- ▶ The average wood volume reduction of **Sequoiadendron giganteum** was estimated on $6,0 \pm 0,0573$ %, with standard deviation of $1,012 \pm 0,0405$ %, and **coefficient of variation of $16,9 \pm 0,696$ %**.
- ▶ The average wood volume reduction of **Pinus strobus** was estimated on $9,6 \pm 0,0971$ %, with standard deviation of $1,602 \pm 0,0687$ %, and **coefficient of variation of $16,7 \pm 0,736$ %**.
- ▶ The average wood volume reduction of **Larix decidua** was estimated on $12,2 \pm 0,1463$ %, with standard deviation of $2,120 \pm 0,1034$ %, and **coefficient of variation of $17,4 \pm 0,874$ %**.



Discussion and conclusion

- ▶ Average values of the investigated properties from introduced species in Republic of Macedonia are from **juvenile wood from around 30 years**, artificially planted in different regions. Data used from other authors are **mostly treating mature wood**, so the significant differences of the average values from the same species were expected.
- ▶ The fact that **Cupressus arizonica** in and out of its natural boundaries, is mostly appreciated as horticultural species is a factor of limitation for wider comparative analysis. Horvat [1987], and Teissier du Crus et al., 1999, presented same values for the density and wood reduction - $0,560 \text{ g/cm}^3$ and 10,2%. Our investigations determine wood density on $0,516 \text{ g/cm}^3$ and 10,9% volume reduction. **Those differences favors mature stands in Italy**. The putrid in the central part in some trees from domestic stands, arise anxiousness about its phenotypic expression and wood quality.
- ▶ Investigation of these wood properties for **Sequoiadendron giganteum** in California [Pirto 1985], show average values of wood density for juvenile and mature wood in standard dry condition $0,35 \text{ g/cm}^3$ and $0,30 \text{ g/cm}^3$, respectively, that is **totally opposite of from global agreement that aging actually increase the wood density from same species**. In Germany and Belgium, Knige [1994], ascertain average value of $0,345 \text{ g/cm}^3$ wood density in standard dry condition. Badjun [1987] presented average values of $0,340 \text{ g/cm}^3$ wood density and 7,4% volume wood reduction. Our investigation established average value for wood density of $0,322 \text{ g/cm}^3$ and **average volume reduction of 6,0%**.

Discussion and conclusion

- ▶ Eastern white pine (*Pinus strobus*) from the stand in Republic of Macedonia has **0,319 g/cm³** wood density in standard dry condition and **9,6%** total volume reduction. Kurt [1964], for the same physical properties present **0,320 g/cm³** and **10,1%**, for stands in **Switzerland**, while Horvat [1987], same properties puts in the neighborhood of **0,370 g/cm³** and **8,3%**, form the natural stands in **USA**.
- ▶ Comparative analysis of the basic physical properties of the *Larix decidua* wood is reduced to the analysis of the average values from Macedonia stand and stands in autochthonous regions in Poland, Check Republic and Sweden, [Jelonek et al. 2009; Gryc et al. 2011 and Karlman et al. 2005]. Average value of wood density from larch stand in Republic of Macedonia is **0,455 g/cm³** and is lower than average value in Poland – **0,476 g/cm³** [Jelonek et al. 2009], Check Republic – **0,543 g/cm³** [Gryc et al. 2011] and Sweden – **0,536 g/cm³** (Karlman et al. 2011). In 1987, Horvat for the same property present value of **0,450 g/cm³** and **11,8%** of volume reduction. In our investigation, the value for volume reduction was **12,2%**.
- ▶ Presented comparative analysis of the investigated physical properties of introduced tree species in Republic of Macedonia, impose the need of its amplifying to the rest of their technical properties, with final goal– establishing the picture for the wood quality produced from those species and its induction into the programs for introduction and protection from the very high potential risks.

A black and white line drawing of a landscape. On the left, a large, detailed tree trunk with many roots extends from the bottom left towards the center. In the background, there are several other trees of varying sizes and shapes. The foreground is a field of flowers, with a large, dense cluster of small flowers on the right and a smaller cluster on the left. The bottom left corner of the image is filled with a green, hatched pattern, suggesting a grassy slope. The entire scene is enclosed in a thick black border.

Thank you for the attention