# Comparative analysis of artificial and natural plantations in the Kurdjipsky subdivision of Maikop forest area in Republic of Adygea

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**Abstract.** The Republic of Adygea is one of the southern entities located in the northwestern part of the North Caucasus. The northern part of the republic stretches across the Kuban lowlands and the southern part along the slopes of the Greater Caucasus. Climatic conditions are favourable for the growth of heat-loving woody and shrub vegetation. The area covered by forests is 285.7 thousand hectares, including 278.4 thousand hectares covered by forests. The forests of the republic are distributed unevenly; most of the forests are concentrated in the piedmont and mountainous areas. The main forest-forming species are oriental beech and English oak. The forests of the Republic have an important water and soil protection function. The area of forests is insignificant, more widespread are forest shelter belts and boles scattered among the fields, often confined to river valleys, reservoirs, and low-lying places. Plantings include English oak, common ash, Caucasian hornbeam, field maple, poplar, willow, grey alder and black alder. Plantations located in forest shelter belts perform water protection, water protection, sanitary-hygienic, and aesthetic functions [1]. The work provides a comparative analysis of plantations of natural and artificial origin of the same age, growing in the same forest and vegetation conditions.

## 1 Introduction

Forest management development provides for the integrated and rational use of forest resources with an increase in the productivity and quality of forests while preserving the habitat-forming, water-protective, protective, sanitary-hygienic, health-improving and other beneficial functions of forests. Forests in Russia refer to one of the most important renewable natural resources according to article 5 of the Forest Code of the Russian Federation (Federal law from 04.12.2006 No 201-FZ), the concept of forest is defined simultaneously through the ecological system and natural resource [1]. In the first case, the forest is the quartery of trees, shrubs, waters, atmospheric air, and the subsoil of the earth. In the second case, the forest is wood, a place of recreation, the green lungs of the planet.

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The classic of forestry G.F. Morozov, the recognised creator of the doctrine of the forest, was the first to reveal the essence of the forest, defining three concepts. Firstly, he showed that "the forest should be understood as a totality of woody plants, changed both in their external form and in their internal structure under the influence of their influence on each other, on the occupied soil and the atmosphere. Secondly, "the forest is not only a totality of plants, but also, together with them, of animals, i.e. a complex of all life, where all constituent components interact with each other and with the environment, changing continuously". In fact, G.F. Morozov was the first to understand the forest in this way and to call it a biocenosis. Thirdly, continuously and everywhere pointing out that the forest is a geographical phenomenon, and emphasising that we must look at the forest even wider and deeper, namely as a landscape or part of the terrestrial space together with plants and animals, G.F. Morozov says: "The partitioning of the terrestrial surface is followed by the partitioning of the soil cover and the adjacent layers of atmosphere, and all taken together entails a partitioning of the vegetation cover as well". And further: "The forest is a geographical phenomenon whose diverse forms and life cannot be understood outside of the connection of these formations with the external or geographical environment. This connection is so close and profound that by forest, in essence, we must mean not only a single set of woody plants, quartered by a mutual connection, but also the environment, the arena in which the social processes are played out, which we all gather as a focal point in the concept of "forest". The forest is an element and, like the steppes, deserts, and tundras, is a part of the landscape, a part, therefore, of the earth's surface, occupied, due to its certain biological properties, by corresponding forest commquarteries of both artificial and natural origin.

The object of our research are artificial and natural plantations that grow on the territory of Maikop Forest,the KurdzhipskyDistrict Forest of the Republic of Adygeya. Located in the central and southern part of the Republic of Adygea, the territory of three municipalities is covered: Maykop administrative district, Giaginsky administrative district and the city of Maykop. The forestry area belongs to the North Caucasus Mountain Zone, North Caucasus Mountain District [2].

The vegetation cover is represented by a marked combination of Caucasian and Colchic flora (alder forests with typical bog vegetation, on the outskirts grows - oak, beech, hornbeam, lianas) with a significant spread of forest. The area of our research consists of oak forests formed of English oak and Hartvis oak with admixtures of common ash, Caucasian linden, Caucasian hornbeam, elm, field maple. Moreover, a considerable part of the forested area is covered by oak and hornbeam forests [3, 4].

The plantations are pure and mixed in composition. The age of natural stands is 50 years, artificial stands vary from 51 to 53 years. The type offorest is fresh oak-scarred English oak, type of growing conditions $D_2$ (fresh oak forest). In the undergrowth there are hazel, elder, hawthorn, Caucasian hawthorn, blood-red pigweed.

Plantation characteristics are given in Tables 1, 2.

**Table 1.** Natural stands of Kurdjipskiy subdivision forestry

| no. | q. | stand | Composition | Age, years | Height, m | Diameter, cm | TGC | Completeness | Reserve, $m^3$ per ha |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 5 | 31 | 6HB3FE1HO+EFM+AS | | | | $D_2$ | 0.7 | 210 |
| | | | HB | 50 | 19 | 20 | | | |
| | | | FE | | 20 | 22 | | | |
| | | | HO | | 21 | 24 | | | |

| no. | q. | stand | Composition | Age, years | Height, m | Diameter, cm | TGC | Completeness | Reserve, $m^3$ per ha |
|---|---|---|---|---|---|---|---|---|---|
| 2 | 8 | 4 | 8FE2HB+EC+HO | | | | $D_2$ | 0.7 | 140 |
| | | | FE | 50 | 18 | 20 | | | |
| | | | HB | | 18 | 18 | | | |
| 3 | 8 | 23 | 6HB2EO2FE | | | | $D_2$ | 0.8 | 240 |
| | | | HB | 50 | 20 | 26 | | | |
| | | | EO | | 19 | 26 | | | |
| | | | FE | | 21 | 28 | | | |
| 4 | 11 | 12 | 5HB3EOS2FE | | | | $D_2$ | 0.8 | 210 |
| | | | HB | 50 | 18 | 22 | | | |
| | | | EOS | | 19 | 24 | | | |
| | | | FE | | 19 | 22 | | | |
| 5 | 11 | 16 | 4EOS3FE3HB | | | | $D_2$ | 0.5 | 110 |
| | | | EOS | 50 | 17 | 22 | | | |
| | | | FE | | 18 | 22 | | | |
| | | | HB | | 16 | 20 | | | |
| 6 | 15 | 38 | 4EOS3FE3HB | | | | $D_2$ | 0.7 | 160 |
| | | | EOS | 50 | 18 | 22 | | | |
| | | | FE | | 17 | 18 | | | |
| | | | HB | | 16 | 16 | | | |

Note*:EOS – English oak short-stemmed, EO – Englishoak, HO - Hartwiss oak, FE – Fraxinus excelsior, HB – hornbeam, EFM – English field maple, AS – aspen, EC – European chestnut

**Table 2.** Artificial plantations in Kurdjipsky district forestry

| no. | q. | stand | Composition | Age, years | Height, m | Diameter, cm | TGC | Completeness | Reserve, $m^3$ per ha |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 15 | 40 | 3EO6FE1HB+PT | | | | $D_2$ | 0.9 | 140 |
| | | | EO | 52 | 14 | 14 | | | |
| | | | FE | | 14 | 14 | | | |
| | | | HB | | 13 | 12 | | | |
| 2 | 15 | 33 | 3EO6FE1HB+PT | | | | $D_2$ | 0.9 | 140 |
| | | | EO | 52 | 14 | 14 | | | |
| | | | FE | | 14 | 14 | | | |
| | | | HB | | 13 | 12 | | | |
| 3 | 18 | 7 | 3EO1EOS3FE3HB | | | | $D_2$ | 0.8 | 200 |
| | | | EO | 52 | 19 | 24 | | | |
| | | | EOS | | 19 | 24 | | | |
| | | | FE | | 18 | 20 | | | |
| | | | HB | | 17 | 18 | | | |
| 4 | 32 | 18 | 4EO4HB2AS | | | | $D_2$ | 0.7 | 170 |
| | | | EO | 52 | 19 | 24 | | | |
| | | | HB | | 18 | 20 | | | |
| | | | AS | | 23 | 28 | | | |
| 5 | 34 | 20 | 3EO4HB1FE2AS | | | | $D_2$ | 0.8 | 200 |
| | | | EO | 53 | 19 | 22 | | | |
| | | | HB | | 18 | 20 | | | |
| | | | FE | | 18 | 20 | | | |
| | | | AS | | 20 | 28 | | | |
| 6 | 39 | 47 | 3EC3HB2OB2HO | | | | $D_2$ | 0.7 | 190 |
| | | | EC | 51 | 18 | 24 | | | |
| | | | HB | | 17 | 20 | | | |
| | | | OB | | 18 | 24 | | | |
| | | | HO | | 18 | 24 | | | |

Note*: EO – English oak, HO - Hartwiss oak, FE – Fraxinus excelsior, HB – hornbeam, PT – pear tree, EFM – English field maple, AS – aspen, EC – European chestnut, OB – Oriental beech

Analysing the data in Table 1 in Table 2, we see that natural and artificial plantations, growing under the same $D_2$ conditions, have different indicators of fullness and productivity. Natural stands at the age of 50 years are represented by low- and medium-flowered stands. The fullness varies from 0.5 to 0.8. The productivityof the plantations ranges from 110 $m^3$ to 240 $m^3$ per ha. Artificial plantations are characterised by higher fullness values (0.7 - 0.9), which allows us to classify them as medium- and high-fullness plantations. At the plantation same time, the stock is 140 - 200 $m^3$ per hectare.

The species composition of natural plantations is represented by three main forest-forming species: English oak, Caucasian hornbeam and common ash. Aspen, Europeanchestnut, and Hartwiss oak are secondary tree species. The underbrush species is the field maple.

The species composition of artificial plantations consists of the following species: English oak, low mountain oak, Gartvis oak, common ash, Caucasian hornbeam, aspen, edible chestnut, oriental beech, pear.

Comparing the tree species of natural and artificial origin in terms of height and diameter, the following data was obtained.

The low-stem oak at the age of 50 years (stand 11, stand 12) had the maximum height (19 m) and diameter (24 cm), and the minimum height and diameter were observed in stand 11, stand 16, at 17 m and 22 cm.

In the artificial plantation, low-stem oak at 50 years of age is found only in quarter 18, stand 7, with a height of 19 m and diameter of 24 cm.

The English oak in the natural stand in quarter 8, stand 23 has maximum height and diameter (19 m and 26 cm), while the minimum values are absent. The 52 summer stands of English oak present maximum values in Stand 18, quarter 32, with a height of 19 m and a diameter of 24 cm. The minimum value is observed in quarter 15, stand 33, 40 with values of 14 m and 14 cm.

Caucasian hornbeam is found in both natural and artificial stands. The maximum values are typical for artificial plantations in quarter 32, stand 18 and quarter 34, stand 20 - height 18 m, and diameter 20 cm. The minimum height and diameter values are observed in artificial plantations in stand 15, stand 40, and stand 15, stand 33 - crop age 52 years with a height of 13 m, and 12 cm diameter.

Regarding the 50-year-old natural stands, the maximum height and diameter values are presented in the stand 8, stand 23 and are 20 m, and 26 cm. The minimum value of the height and diameter of the natural stands is 16 m, 16 cm (stand 15, field 38).

Ash in natural stands is characterised by higher values for both height and diameter. At the age of 50 years, the height is 21 m, and diameter is 28 cm, in the neighbourhood 8, excavation 23. The minimum values for height and diameter can be traced in quarter 15, stand 38 - 17 m, and 18 cm.

Artificial stands of ash with maximum values of height and diameter can be observed in stand 18, sample selection 7 and stand 34, sample 20, cultures at the age of 52 and 53 years with the following values 18 m - height, 20 cm - diameter. Minimum values of heights and diameters of 14 m and 14 cm (quarter 15, stand 40 and quarter 15, stand 33), cultures 52 years old.

Hartwiss oak, one of the species that occurs in both natural and artificial plantations. Very rarely capable of forming pure stands, it mainly occurs in combination with Caucasian hornbeam and oriental beech, a beautiful woody species growing on loams. In both natural and artificial stands there is little variation in height and diameter. At the age of 50 years (stand 5, quarter 31) the height is 21 m, diameter 24 cm, at the age of 51 years (stand 39, field selection 47) the height is 18 m, diameter 24 cm.

Oriental beech, European chestnut, aspen trees in the stands we studied grow only in artificial plantations in quarter 32, stand 18, quarter 34, stand 20 and quarter 39, stand 47. The age of cultures is 51-53 years, height 18-23 m, diameter 24-28 cm [5,6].

Based on the results of this analysis, the following conclusions can be drawn:

1. Natural and artificial forests of Kurdjipsky area forestry are characterized by high productivity, at the age of 50 years, the maximum value of completeness of 0.8 (reserve 240 $m^3$/ha) and 0.9 (reserve 200 $m^3$/ha).
2. The main forest forming species in the forestdivision are English oak, common ash, Caucasian hornbeam, which are used in artificial plantations with the admixture of European chestnut, Hartwiss oak. In addition to the above-mentioned species, aspen and field maple self-seeding can be found in crops.
3. The main trees to be used in creation of new artificial plantations are English oak and common ash.
4. In plantations with an admixture of low-value tree species, it is necessary to carry out reconstruction with replacement by more valuable, stable, durable species.

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