UDK 630* 231 + 232

Pregledni članci – Reviews
Šumarski list, 9–10 (2016): 503–514

THE PROCESS OF SILVICULTURE PLANNING IN TURKEY: HİSAR CASE STUDY

PRIPREMA PLANA UZGAJANJA ŠUMA U TURSKOJ: SAŽETAK PRIMJERA UPRAVNOG ODJELA HISAR ŠUME

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Summary

Forestry resources are managed by long, middle and short term national, regional and local scale plans, programs and special arrangements to consider international and national purposes. The smallest administrative and planning units of forest area in Turkey are the Forest Administration Chief Offices. Planning units are managed by forest management plans prepared in accordance with Ecosystem-based Multiple Use Forest Management principles. The application steps of forest management plans are the silvicultural plans. Although the preparation of silviculture plans in the last five-year period in Turkey is included in the planning process as a legal challenge, a definite standard cannot be formed in the preparation and application of the silviculture plans. In this article, silvicultural plan of Hisar Administration Chief Office selected as the pilot area in order to find solutions to the specified problems were prepared. The process of preparing silviculture plan has been introduced comprehensively. The process begins after the completion of forest management plans. Silviculture plan preparation process, the measurement and evaluation on the forest land, geographical database design, the preparation of silvicultural treatment prescriptions, the production of output such as table, graph and maps, and application, monitoring and evaluation are composed of stages.

KEY WORDS: Forest management plan, silviculture plan, geographic information systems, *Pinus sylvestris*.

INTRODUCTION
UVOD

The forest areas in the world either decrease or are destructed structurally due to the reasons such as opening fields for agriculture and settlement, the construction of roads and energy lines, illegal cuts and wrong forestry applications. Many plant and animal species living in these areas are disappearing or they face extinction. Human population and demands are increasing and diversifying day by day. According to FAO (2015), forest areas in the world is 3,99 billion hectares and it cover 30,6% of world's land. Since 1990, there has been a decrease nearly as much as six times (129 million ha) of all forest area in Turkey. Due to specified reasons, making use of forest areas are discussed in the international arena and it is evaluated in the global scale with many conventions primarily with Convention on Biodiversity. The sustainable management of the forest resources is shaped according to the criterion and indicators determined by each country in accordance with the forestry philosophy. Every country has formed the required legal legislation, technical and administrative sub-structure (Yolasığmaz, 2013). There are policies supporting the sustainable forest management in 148 countries in the world and there is forestry legislation depending on these laws in 145 countries. 39% of forest areas (2,1 billion ha) is managed with forest management plans (FAO, 2010; FAO, 2015; GDF, 2014a).

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Forest areas in Turkey are managed by the Ministry of Forestry and Water Affairs. Forests are discussed under two headings as protected areas and production and conservation forests. National parks, nature reserve areas, and the areas protected as Nature Parks are managed with long term development plans and administration plans by Nature Conversion and National Parks General Directorate; and production and conservation forests are managed with forest management plans by the General Directorate of Forestry. The smallest administrative units are forest administration chief offices/forest planning units and they are managed by forest management plans in accordance with Ecosystem-based Multiple Use Forest Management principles. The preparation process of forest management plans consist of a) the inventory of forest ecosystems, b) the installation of geographical database by using geographical information systems technology (GIS), c) the preparation of digital baseline maps such as stand type map, forest functions maps, d) the identification of management objectives and conservation targets with the participatory approach, e) the arrangement of utilization (the determination of how much allowable cut will be taken from which part in the forest, when and with which silvicultural treatments), f) the presentation in plan format; the preparation of cutting map that is the final output and the arrangement of the relevant tables (GDF, 2014b; Asan, 1999; Yolasığmaz, 2013; Başkent et al, 2008a, 2008b; Başkent et al, 2005).

In the last five-year period, the preparation of silviculture plans that are the application step of forest management plans has been included in the planning process as a legal obligation. However, a definite standard could not be formed in the preparation and application process of the silviculture plans. In forest management plan, there are two different tables related to regeneration, reforestation and tending fields, the shape of silvicultural treatments, determined functional/decided allowable cut and their locations are stated. Silvicultural treatment times applied to these areas cover ten or twenty-year periods due to the implementation time of the plan. However, it is not clearly stated that where it is going to be treated year to year, and which regeneration and tending techniques will be applied (GDF, 2014b; 2014c).

Silviculture plans are prepared with a series of studies performed in the land and offices. Silviculture plans are prepared by forest administration chief officer (forest engineer) who will apply forest treatment plan and with the technical support of other administrators; and the monitoring and controls are made by classical methods. According to the notification related to the preparation of silviculture plans, three additional tables are arranged. In the first one of these tables, the field studies to be made in the preparation of silviculture plans are given, the treatment techniques to be implemented in regeneration and tending fields are given in the second one; and the years of treatments and information about allowable cuts to be taken are given in the third one (GDF, 2014c).

Spatial databases prepared by using GIS have been designed to prepare forest management plans and maps, and it is not for preparing silviculture plans and maps. It is not convenient for following the structural changes in the forest, monitoring and control the silvicultural treatments (Yolasığmaz and Keleş, 2009). For this reason, geographical database has been redesigned to prepare silviculture plan and treatment in the research.

BASIC CONCEPTS
OSNOVNI POJMOVI

To comprehend the matter better, the forestry philosophy in Turkey, the planning approach, and the basic concepts must be explained briefly. While forest management plans are being prepared, the sampling plots that are 300 meters to 300 meters are distributed systematically and randomly to the planning unit. Main objective of the sampling is to prepare the stand map that is the baseline map. There are compartments and sub-compartments on this map. The compartments are the fields, the borders which do not change and are divided by the natural lines and artificial lines such as streams, roads etc. The sub-compartments are the parts remained within the division of the stands. The stand is a patch of forest that is separated from the forest areas just besides it with some features such as tree species, mixtures, crown closers and development stages that are bigger than one hectare. The main objective in forest inventory is to decide on the stand symbols and to identify the borders and stand parameters. There are some information such as the tree species, mixtures, stand development stage and crown cover in stand symbol. Tree species are described with symbols. Of the species included in the research area, it is described like this; Çs; *Pinus sylvesteris*, M; *Quercus* spp, Kv; *Populus* ssp., Ar; *Juniperus* spp. In the determination of the mixture of tree species, tree numbers in the stands and stand volume are considered together and the species exceeding 10% of the stand is included in the stand symbol. The species having the most tree numbers proportionally or volume is written on the front in the symbol. The stand development stages* are expressed as a, b, c, d, e text characters and are named according to the measurement values in dbh (diameter based height). The term „crown closer**/forest canopy" is defined as the shelte-

* **Development Stages: a;** young stands: < 8 cm dbh, **b;** pole pine stands: 8 -19,9 cm dbh, **c;** pre-mature stands: 20-35,9 cm dbh, **d;** mature stands: 36-51,9 cm dbh, **e;** old stands: > 52 cm dbh.

** **Crown closer: B (degraded);** %1-10 crown cover, **1;** %11-40 crown cover, **2;** %41-70 crown cover, **3;** %71-100 crown cover

ring or shadowing of the soil by the crown cover (GDF, 2014b; Eraslan, 1982).

Sub-compartments are the application areas of the silvicultural treatments. Silvicultural treatments are gathered under four headings as *reforestation*, *tending*, *regeneration* and *rehabilitation* (Saatçioğlu, 1971; Nyland, 2007; Genç, 2001; GDF, 2014b; GDF 2014c). It is decided on silvicultural treatment type, techniques and allowable cuts to be applied depending on the ecological conditions of forest areas, biological demands of tree species, road network, transportation-marketing opportunities, technical capacities of the forest administrations, conservation targets, management objectives, forest forms, stand parameters. While the silvicultural treatment to be applied to a sub-compartment was being applied to the whole of the sub-compartment area, the sub-compartment area only in the areas to be forested can be/is divided (Eraslan, 1982).

Reforestation areas are open areas within the forest regime and they are the fields to be forested with plantation within the plan period. Regeneration areas are the areas to be regenerated or have begun to be regenerated in the previous period that have completed the rotation period or have been completing. Tending areas are the forest areas out of the reforestation and regeneration areas, these areas are exposed to the silvicultural tending treatments due to being crown closer, development stage, pure or mixed of the stands especially biological demands of tree species in accordance with the management objectives and conservation targets. The tending treatments such as weeding the young stands, release cutting at pole pine stands and pre-mature stands and thinning and release cutting at old or mature stands are applicate. The silvicultural methods used in thinning are named as low thinning and high thinning; and according to the amount or dose of treatments they are described as weak and heavy thinning. Rehabilitation fields are generally crown closer degree 1, and they are degraded forest areas. While taking the final harvest allowable cut in the regeneration fields, the intermediate yield allowable cut in the tending areas is taken. In the cutting maps that are the final output of forest management plans, the fields subjected to reforestation, regeneration, tending and rehabilitation are indicated in different colors (Saatçioğlu, 1971; Genç, 2001; GDF, 2014b; GDF, 2014c).

MATERIAL AND METHODS
MATERIJAL I METODE

Research Area – *Područje istraživanja*

Hisar Forest Administration Chief Office is attached to Oltu Forest Enterprise of Erzurum Forest Regional Directorate. It is 70 km away from the province of Erzurum. The elevation from the sea level ranges from 710 m to 2892 m. The research area coordinates are ED 50 datum 37th zone 735000-770000 eastern longitudes and 4495000-4520000 northern latitudes according to UTM coordinate system (Figure 1). The total

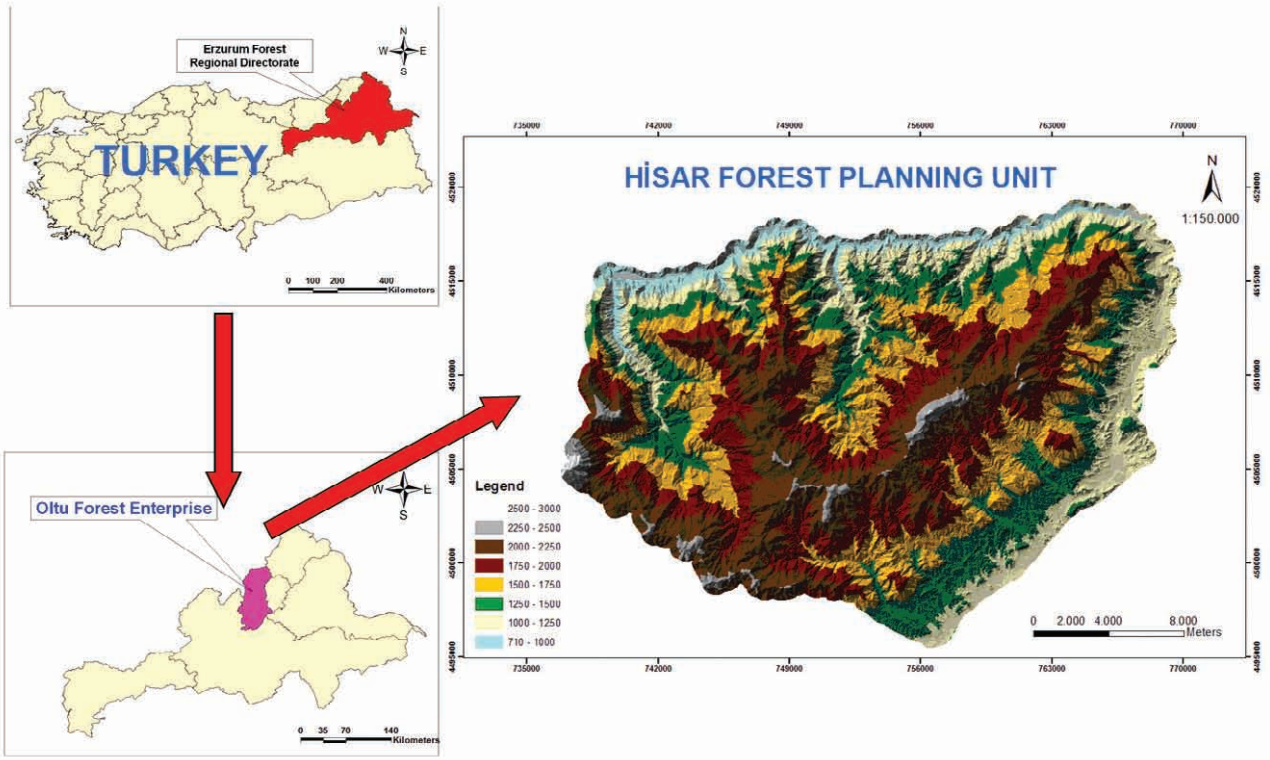

Figure 1. Location of the study area
Silika 1. Područje istraživanja Upravnog odjela Hisar šume

Table 1. Area distribution of the forest management unit in Hisar Forest Planning Unit
Tablica 1. Tabela sa rasporedom jedinica koji pripadaju upravnom odjelu Hisar šuma

Forest Management Unit – *Upravna jedinica*	Area – *Prostor* (hectares)	%
A – Wood production – *Proizvodnja drva u najvećoj količini* (*Pinus sylvesteris*)	15417,05	30,93
B – Nature Conservation – *Zaštita prirode* (*Juniperus communis*)	20653,85	41,43
C – Ecological Conditions are very poor areas – *Jako loši prostori za uzgoj šume* (*Juniperus communis*)	3842,64	7,71
D – High Mountain Forest Ecosystem – *Visokogorski šumski ekosustav* (*Pinus sylvesteris*)	1358,19	2,72
E – Forest Ecosystem Monitoring Areas – *Područja za monitoirng* (*Pinus sylvesteris*)	76,58	0,15
F – Erosion Control – Soil conservation – *Sprječivanje erozije – Zaštita tla* (*Pinus sylvesteris*)	758,89	1,52
G – Conservation of Water Sources – *Zaštita vodnih resursa* (*Juniperus communis*)	7585,52	15,22
H – Recreation – *Rekreacija* (*Pinus sylvesteris*)	155,30	0,31
General Sum- *Sveukupni zbroj*	49848,02	100,00

area of the planning unit is 49848,02 hectares; 32757 hectares of this area consist of forest; and 17091 hectares of it consist of non-forest area. In planning unit consisting of 2813 sub-compartments, 771 compartments, 21 different stand types were determined for forest areas. It is foreseen that 30,93% of the study area is planned to be made use of for economic purposes, 53,54% is planned to be used for ecologic purposes, and the remaining 15,53% is planned to be used for socio-cultural purposes (Table 1).

According to meteorological data, the average temperature is 9,8°C and the annual rainfall is 393,3 mm. 21 settlement units (districts) within planning unit and there are 4919 people in the region (TSIE, 2015). There is Oltu in the south of the plan unit and Olur district centers in the north. Due to the topography with high slope and hard winter conditions, in the region where life conditions are hard, the migration from the village to the city has been continuing (GDF, 2015).

In the fields subjected to the industrial wood production, *Pinus sylvestris* are dominant. In the degraded forests, the dominant tree species is again *Pinus sylvestris*. While *Juniperus communis* and *Quercus pedinculata* are included in the mixture in these areas, there are also pure degraded *Juniperus communis* stands. Although there is no comprehensive plant sociology study in the study area, 9 plant species including 4 different tree species such as *Platanus orientalis*, *Acer sp.*, that do not constitute stands on its own and that join in the mixture separately or as groups, and 4 different shrubs and bush species besides the original tree species were included in the forest management plans.

The endemic species recorded in the region are: *Allium incisum, Allium oltense, Astragalus acmophylloides, Astragalus nigrocalycinus, Astragalus oltensis, Bupleurum schistosum, Campanula sorgerae, Centaure ataochia, Delphinium munzianum, Draba narmanensis, Elymus sosnowskyi, Hieracium caloprasinum, Hieracium hypopityforme, Hieracium onosmaceum, Hieracium variegatisquamum* (Eken et al., 2006). Among these species, the endangered ones with narrow spread are the following 3 species: *Astragalus nigrocalycinus* (CR***), *Centaurea antiochia* (EN) and *Delphinium munzianum* (CR). In addition, the medical and aromatic use of 241 vascular plant taxons belonging to 66 families and 170 species have been defined (Önal, 2012). 35 different bird species have been observed in the study area, and it is expressed that the area is one of the important habitats of *Capra aegagrus* and *Ursus arctos* (Okutucu, 2007). In addition, there are thirteen different fish species living in the existing streams (Kuru, 1971, 1975; Aras, 1974 and Solak, 1977, GDF, 2015).

MATERIAL
MATERIJAL

The forest management plan data of 2015, the geographical database, and the soil analyses in the area and the evaluations made during the inventory and observations have been used in the study. The forest management plan was prepared according to the forest inventory that was made during summer season of the year 2014. In order to prepare silviculture plan, the measurements and examinations were made in the area both in 2014 and in 2015 summer seasons. These examinations were intended to determine the ecological conditions in the areas where reforestation and regeneration areas would be made, to define the actual stand structures, and record the abundant seed year. ARC/GIS 10.0 (Arc/Info license level) software and modules were made use of in the design of the geographical database by handling again, data entry, data analysis and the derivation of the new data and maps; and MS Office 2010 was made use of in the prepared processes of data analysis, table and graphs.

METHODS
METODE

Database design – ***Baza podataka***; in silviculture plan database prepared using GIS, forest management plan database has been used. The data about compartment, sub-com-

*** IUCN Category: CR: Critical; EN: Endangered

partments, the information about the stand type, age class and site index were made use of in the preparation of silviculture plan. In addition to the data of forest management plan database, growing stock (m^3/ha), annual growing stock increment (m^3/ha/year), silvicultural treatment types as in the forest management plan and the decided functional allowable cuts/tending allowable cuts (m^3) data were entered. Besides, silvicultural treatment methods, which is the basis for the silviculture plan, five different silvicultural treatment process types, five different treatment times, the allowable cuts to be taken for five different treatments, total treatment number and the total number of performed allowable cuts data groups were added to the database. For the measurements and evaluations in the regeneration fields, the data such as slope, aspect, altitude, seed tree sufficiency and actual stand type were also added.

Silvicultural prescriptions – ***Načini intervencija u pogledu uzgoja šuma***; while making forest management plan, primarily the stand map that is a baseline was prepared, and then the forest function maps were prepared. In the preparation of the forest function map, the inventory datum, requests and demands of the society, special ecosystem or species having sensitive, rare or critical importance according to the report prepared by plant and wildlife specialists were made use of. According to these maps, each functional area is defined as a management unit and when there are more than one forest functions, the main purpose or function becomes the management unit name. For each management unit, the main and secondary purposes are defined clearly. The silvicultural purposes are defined in the light of these purposes; and the purposes of the (re)establishment of the stand are determined, and the silvicultural treatment prescriptions that will be applied to each forest area (sub-compartment) are prepared in accordance with these purposes. The silvicultural treatments that will be applied to the stands (sub-compartments) in Hisar Forest Planning Unit are the reforestation, regeneration, tending and the areas that are other than treatment. In the silvicultural treatments to be applied to these areas, especially the biological features of the tree species and the stand parameters such as mixture, crown closer etc. and ecological condition such as elevation, slope, soil features (soil type, soil depth, etc.) and aspect besides the technical capacity of the forest administration chief office, the potential labor force in forest villages located in forest planning unit, seedling supply and the situation of the roads have also been considered. Due to the unavailability of the roads, technical insufficiency of the forest enterprise and labor force capacity, some areas were excluded from the plan.

Reforestation areas – ***Područja za pošumljavanje;*** are the gaps and degraded forest areas that are suitable for reforestation in the forest. Silvicultural recipe to be applied to the gaps and degraded forest areas (Table 2, 3);

Table 2. Silvicultural prescriptions to the gaps
Tablica 2. Šumskouzgojni postupci na otvorenom prostoru

Silvicultural Treatment Numbers *Broj šumskouzgojnog postupka*	Silvicultural Recipe *Vrsta zahvata*
Silvicultural Treatment_1 *Šumskouzgojni postupak*	Planting – *Sadnja*
Silvicultural Treatment_2 *Šumskouzgojni postupak*	Weeding (1 years after planting) – *Održavanje kulture (1 godinu nakon sjetve)*
Silvicultural Treatment_3 *Šumskouzgojni postupak*	Weeding (2 years after planting) – *Održavanje kulture (2 godine nakon sjetve)*
Silvicultural Treatment_4 *Šumskouzgojni postupak*	Release cutting (10 years after the second weeding) – *Čestoća održavanja (10 godina nakon održavanja druge kulture)*

Table 3. Silvicultural prescriptions to degraded forest areas
Tablica 3. Šumskouzgojni postupci u degradiranim šumama

Silvicultural Treatment Numbers *Broj šumskouzgojnog postupka*	Silvicultural Recipe *Vrsta zahvata*
Silvicultural Treatment_1 *Šumskouzgojni postupak*	Clear cutting + Planting – *Čista sječa na velikom prostoru + sadnja*
Silvicultural Treatment_2 *Šumskouzgojni postupak*	Weeding (1 years after planting) – *Održavanje kulture (1 godinu nakon sadnje)*
Silvicultural Treatment_3 *Šumskouzgojni postupak*	Weeding (2 years after planting) – *Održavanje kulture (2 godine nakon sadnje)*
Silvicultural Treatment_4 *Šumskouzgojni postupak*	Release cutting (10 years after the second weeding) – *Učestalosta održavanja (10 godina nakon održavanja druge kulture)*

Table 4. Silvicultural prescriptions to the stands (Çsd1/Çsd0) in which regeneration has been continuing
Tablica 4. Recept uzgoja šume koji će se primjenjivati kod sastojina kod kojih je pomlađivanje u toku

Silvicultural Treatment Numbers *Broj šumskouzgojnog postupka*	Silvicultural Recipe *Vrsta zahvata*
Silvicultural Treatment_1 *Šumskouzgojni postupak*	Removal Cutting (In 2015 or 2016 years) – *Dovršni sijek (2015 ili 2016 godine)*
Silvicultural Treatment_2 *Šumskouzgojni postupak*	Weeding (1 years after the removal cutting) – *Čišćenje (Godinu dana nakon sječe)*
Silvicultural Treatment_3 *Šumskouzgojni postupak*	Release cutting (10 years after the weeding) – *Prorjeda (10 godina nakon održavanja pomlatka)*

Table 5. Silvicultural prescriptions to be applied to stands in which crown closer degree is 1 (Çsd1)
Tablica 5. Recept za uzgoj šume koji će se primjenjivati kod Prve zatvorene sastojine običnog bora

Silvicultural Treatment Numbers *Šumskouzgojni zahvat*	Silvicultural Recipe *Vrsta zahvata*
Silvicultural Treatment_1 *Čišćenje*	Clear cutting or planting under the forest canopy – *čiste sječe + sjetva ili sadnja pod sklopom*
Silvicultural Treatment_2 *Čišćenje*	Removal cutting (Three years after the planting) – *Sječa (3 godine nakon sadnje)*
Silvicultural Treatment_3 *Čišćenje*	Weeding (one year after the removal cutting) – *Čišćenje (godinu dana nakon sječe)*
Silvicultural Treatment_4 *Čišćenje*	Release cutting (10 years after the weeding) – *Prorjeda (10 godina nakon održavanja kulture)*

Regeneration areas – *Područja za podmlađivanje*; have been discussed as three different groups as „the fields in which regeneration has been continuing", „crown closer degree 1" and „crown closer degree 2 and 3" (Table 4, 5, 6).

Pinus sylvestris stands in which crown closer degree is 1; it has been decided to make artificial regeneration since there is not sufficient amount of seed trees. Of these stands, in the areas having no erosion danger and little slope, it was decided to make clear cutting. In high sloping areas having erosion danger, it has been decided to make planting under the forest canopy.

Pinus sylvestris stands in which crown closer degree are 2 and 3; it was decided to make natural regeneration and to use shelterwood method since there is sufficient amount of seed trees.

Calculation of *allowable cut (allowable cut taken from the regeneration fields) – Izračunavanje dopustivosti sječe;* in these areas, generally shelterwood method, clear cutting method, planting under the forest canopy will be used. All growing stocks or the volume in the regeneration fields will be taken only in different years in twenty-year planning period. After the youth is brought healthily, the trees above will be removed with removal cutting. Within the time that passes from seed cutting to removal cutting, the remaining trees will make increment. For this reason, while calculating the allowable cut in the regeneration areas, half of the growing stock increment is added to the available growing stock. Depending on the silvicultural treatment method and cutting technique, the allowable cut amounts to be taken from these areas have been calculated as follows;

Table 6. Silvicultural prescriptions to be applied to stands in which crown closer degrees are 2 and 3 (Çsd2 and Çsd3);
Tablica 6. Recept za uzgoj šume koji će se primjenjivati kod Druge i Treće zatvorene sastojine običnog bora

Silvicultural Treatment Numbers *Broj šumskouzgojnog postupka*	Silvicultural Recipe *Vrsta zahvata*
Silvicultural Treatment_1 Weeding	Seed cutting (abundant seed year) – *Naplodni sijek (u godini obilnog sjemena)*
Silvicultural Treatment_2 Weeding	Light cutting (3 years after seed cutting) – *Naknadni sijek (3 godine nakon djela osjemenjivanja u godini obilnog sjemena)*
Silvicultural Treatment_3 Weeding	Removal cutting (2 or 3 years after light cutting) – *Dovršni sijek (Nakon naknadnog sijeka ili 2–3 godine nakon)*
Silvicultural Treatment_4 Weeding	Weeding (1 years after the removal cutting) – *Održavanje pomlatka (godina dana nakon zadnje sječe)*
Silvicultural Treatment_5 Weeding	Release cutting (10 years after weeding) – *Učestalost održavanja (10 godina nakon održavanja pomlatka)*

- In degraded stands, it has been foreseen that all of the growing stock will be cut by clear cutting and planting will be made instead of it.
- *Pinus sylvestris stands* in which crown closer is 1, if planting under the forest canopy is made, the available growing stock for the first treatment will be taken of 20%, and light cutting for the second treatment are foreseen. It was foreseen to cut 50% of the remaining growing stock, and 97% of the remaining growing stock in the removal cutting that is the following treatment.

  if clear cutting is made, 97% of the growing stock will be cut clearly in the first treatment, and planting will be made instead of it.
- *Pinus sylvestris stands* in which crown closer is 2, if shelterwood method is made in 20% of the available growing stock in the seed cutting that is the first treatment. It was foreseen to take 50% of the remaining growing stock in the light cutting that is the second treatment and 96% of the remaining growing stock in the removal cutting.

  If clear cutting is made, 97% of the growing stock will be cut clearly in the first treatment and planting will be made instead of it.

  If planting under the forest canopy is made as 20% of the available growing stock in the first treatment, it is foreseen to take 50% of the remaining growing stock in the light cutting that is the second treatment, and 97% of the remaining growing stock in the removal cutting.
- *Pinus sylvestris stands* in which crown closer is 3, shelterwood method will be applied as 40% of the available growing stock in the seed cutting that is the first treatment and it was foreseen to take 50% of the remaining growing stock in the light cutting that is the second treatment and 96% of the remaining growing stock in the removal cutting.
- The 3-4% of the growing stock left in the regeneration areas was left as a value tree for ecological and biological balance.

c) Tending areas – *Njega šuma*; it was foreseen to make tending to all fields except for reforestation and regeneration fields in accordance with the plan technique. During the preparation of the spatial patterns of tending areas, primarily the spatial distribution of the tending areas and the size of annual tending areas are taken into consideration. The study area is divided into ten different tending blocks, cutting map and tables are organized. In the research, ten different tending blocks have been formed and each tending block was divided into ten sub-blocks within itself and numbered. The treatment years have been defined as the first treatments and will be completed from 2015 to 2024; and the second treatments from 2025 to 2034 according to the sub-blocks within each tending block hierarchically. Since the cutting transitions within the planning unit have to be given to the local people living in the nearest settlement place in accordance with the legislation, the spatial distribution of tending areas have been made. Depending on the development stages of the stands, the silvicultural treatment method changes and low thinning method is applied in *Pinus sylvestris* basically (Table 7).

The tending allowable cuts are calculated after the forest inventory. The trees in the sample areas taken in the field are evaluated one by one in the forest inventory, and the intermediate yield allowable cut based on the silvicultural treatments technique is determined. The tending allowable cuts identified on the basis of the stands are reassessed in the office. At this point, some factors such as the forest function presented by the forest area, management purpose and conservation targets, social pressure factor, the stand parameters, ecological conditions, road conditions and the technical capacity of the forest enterprise are effective.

RESULTS AND DISCUSSION
REZULTATI I RASPRAVA

As a result, in the forest management plan of Hisar Forest Planning Unit, 244,293 ha of area has been decided to be forested, and to make tending cutting in the 8946,83 ha of

Table 7. Silvicultural treatment methods to be applied to tending areas
Tablica 7. Metode intervencije u uzgoju šume, koje će biti primjenjene na područja koja su namjenjena za njegu

Stand Symbol *Oznaka*	Silvicultural Treatment – 1 *Šumskouzgojni postupak – 1*	Silvicultural Treatment – 2 *Šumskouzgojni postupak – 2*
Çsa0	Release cutting – *Čišćenje*	Release cutting – *Učestalost održavanja*
ÇsMbc3	Heavy low thinning – *Jako nisko prorjeđivanje*	Moderate low thinning – *Umjereno nisko prorjeđivanje*
Çsb3	Heavy low thinning – *Jako nisko prorjeđivanje*	Moderate low thinning – *Umjereno nisko prorjeđivanje*
Çsbc1	Weak low thinning – *Slabo nisko prorjeđivanje*	Weak low thinning – *Slabo nisko prorjeđivanje*
Çsbc2	Moderate low thinning – *Umjereno nisko prorjeđivanje*	Moderate low thinning – *Umjereno nisko prorjeđivanje*
Çsbc3	Heavy low thinning – *Jako nisko prorjeđivanje*	Moderate low thinning – *Umjereno nisko prorjeđivanje*
Çsc3	Moderate low thinning – *Umjereno nisko prorjeđivanje*	Moderate low thinning – *Umjereno nisko prorjeđivanje*
Çscd1	Weak low thinning – *Slabo nisko prorjeđivanje*	Weak low thinning – *Slabo nisko prorjeđivanje*
Çscd2	Moderate low thinning – *Umjereno nisko prorjeđivanje*	Moderate low thinning – *Umjereno nisko prorjeđivanje*
Çscd3	Moderate low thinning – *Umjereno nisko prorjeđivanje*	Moderate low thinning – *Umjereno nisko prorjeđivanje*
Çsd1/Çsa0	Weak low thinning – *Slabo nisko prorjeđivanje*	Weak low thinning – *Slabo nisko prorjeđivanje*
KvÇsbc3	Heavy low cutting – *Jako nisko prorjeđivanje*	Moderate low thinning – *Umjereno nisko prorjeđivanje*

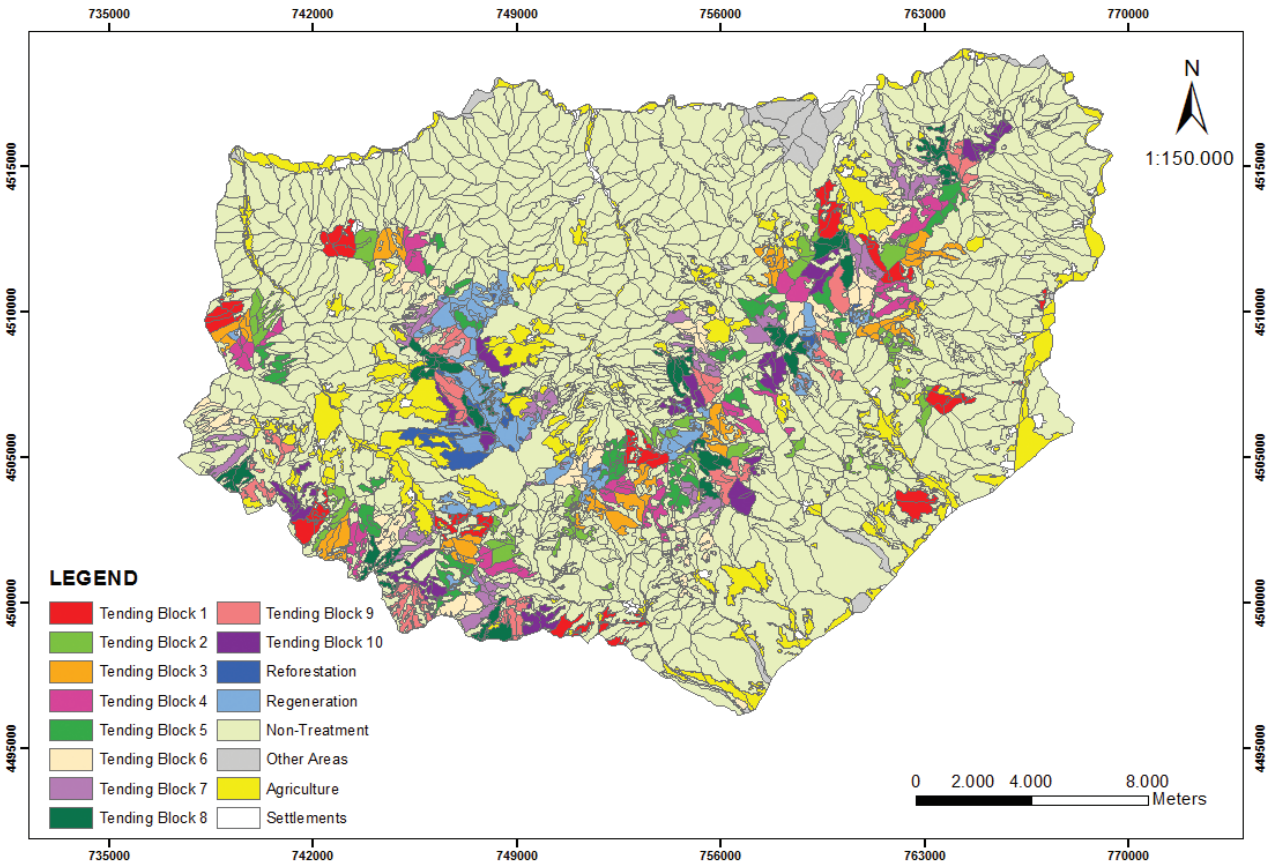

Figure 2. Silviculture treatment map according to Hisar Silvicultural Plan.
Slika 2. Karta šumskouzgojnih postupaka Upravne jedinice šume Hisa

the area and to regenerate 1167,22 ha of the area. There are no rehabilitation areas in the planning unit. According to the cutting map in the forest management plan, the total growing stock is 1619719,536 m^3, annual growing stock increment is 31755,689 m^3/year, and the decided total allowable cut amount is 345196,424 m^3.

In the silviculture plan, it has been decided not to make silvicultural treatment in 28,24 hectares of the reforestation

Table 8. The distribution of the area and the allowable cutting according to the silvicultural treatment method in silviculture plan.
Tablica 8. Distribucija prostora i dopustivosti sječe prema metodama intervencije u pogledu uzgoja šuma

Silvicultural Treatment Method *Metoda šumskouzgojnih postupaka*	Area *Površina* (ha)	%	Allowable cut *Sječa* (m^3)	%
Reforestation Areas – *Pošumljivanje*	244,29	100	–	–
Planting – *Sadnja*	216,05	88,44	–	–
No Treatments – *Neplanirano*	28,24	11,56	–	–
Tending Areas – *Njega*	8946,83	100	136870	100
Thinning – *Prorjeđivanje*	8320,75	93,00	136870	100
Release cutting – *Čišćenje*	626,07	7,00	–	–
Regeneration Areas – *Obnova*	1167,22	100	193046,28	100
Natural Regeneration – Shelterwood *Prirodno pomlađivanje na velikom prostoru pod zaštitom krošanja*	721,36	61,80	143403,199	74,28
Artificial Regeneration – Clear Cutting *Umjetno pomlađivanje – Veliki prostor čista sječa*	273,06	23,39	33556,239	17,38
Artificial Regeneration – Planting under The Forest Canopy *Umjetno pomlađivanje – Sadnja pod zaštitom*	94,91	8,13	16086,841	8,33
Non-treatments – *Neplanirano*	77,89	6,67	–	–
General Total – *Sveukupni zbroj*	10358,34	–	329916,279	–

areas and 77,89 hectares of the regeneration areas due to the technical reasons. In the twenty-year plan period in the research area, a total of 329916,279 m^3 allowable cut will be taken 136870 m^3 of which is the intermediate yield, and of which 193046,279 m^3 is the final yield (Figure 2, Table 8). The non-treated fields due to the technical reasons and the value trees planned to be remained in the field for the continuance of the wildlife; it was waived 15280,147 m^3 of allowable cut taking. While annual growing stock increment was being 31755,689 m^3/year, nearly 51,95% of the annual increment will be taken each year. The annual increment rate is around 50% throughout the country and it is similar to the research area values (GDF, 2014a).

While making treatment for two times each field with 10 year return time in 20-year plan period in the tending fields, it is foreseen to be made five treatments at most depending on the year in which the first treatment has been made. In the fields subjected to the tending, thinning and

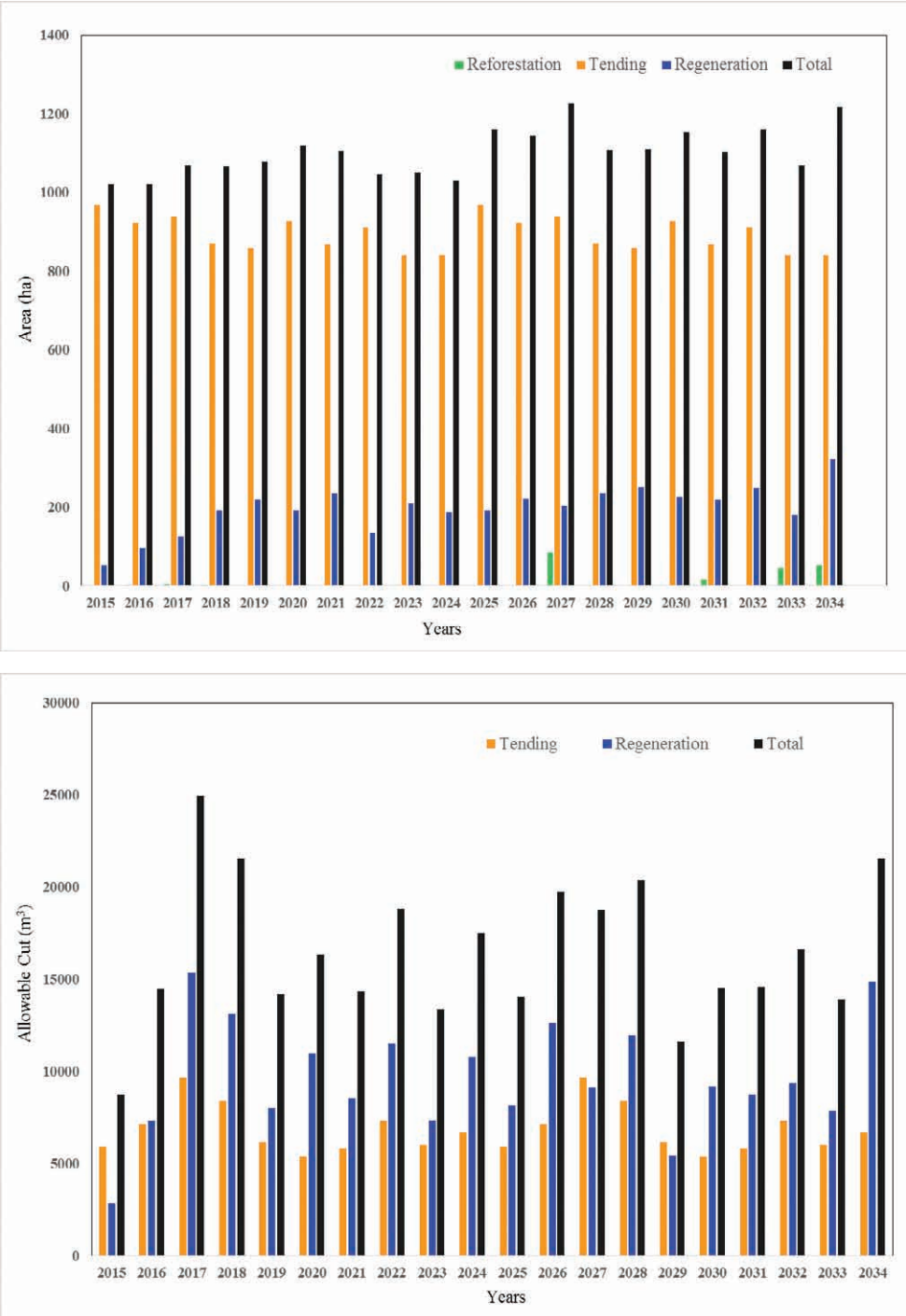

Figure 3. The distributions of the area and the allowable cut according to the treatment years in reforestation, tending and regeneration areas.
Slika 3. Distribucija prostora intervencija u uzgoju šume i određena dopustivost sječe prema godinama intervencije

Table 9. The distributions of the area and allowable cut according to silvicultural treatment methods in the reforestation, tending and regeneration areas.

Tablica 9. Distribucija prostora i dopustivost sječe u pogledu metoda pošumljavanja, njege i pomlađivanja.

Silvicultural Treatment *Intervencije Uzgoja Šume*	Reforestation *Pošumljivanje*	Tending – *Održavanje*		Regeneration *Pomlađivanje*		Total Allowable Cut *Sveukupna dopustivost sječe* (m^3)	Total Area *Sveukupni prostor* (ha)
	Area *Prostor* (ha)	Allowable Cut *Dopustivost sječe* (m^3)	Area *Prostor* (ha)	Allowable Cut *Dopustivost sječe* (m^3)	Area *Prostor* (ha)		
Weeding – *Održavanje kulture*	280,25	–	0,00	–	535,95	–	816,20
Youth tending – *Održavanje pomlatka*	–	–	0,00	–	605,86	–	605,86
Weak low thinning – *Slabo nisko prorjeđivanje*	–	–	2495,28	–	–	–	2495,28
Moderate low cutting – *Umjereno nisko prorjeđivanje*	–	123871	12616,31	–	–	123871,000	12616,31
Heavy low cutting – *Jako nisko prorjeđivanje*	–	12999	1529,92	–	–	12999,000	1529,92
Thinning – *Učestalost održavanja*	–	–	626,07	–	373,60	–	999,67
Release cutting – *Prorjeđivanje*	–	–	626,07	–	–	–	626,07
Planting – *Sjetva*	216,05	–	–	3291,179	94,91	3291,179	310,96
Clear cutting+Planting *Čista sječa + sadnja*	–	–	–	33556,239	273,06	33556,239	273,06
Seed cutting – *Sječa kod je osjemenjavanje bogato*	–	–	–	27390,318	607,61	27390,318	607,61
Light cutting – *Prorjeđivanje*	–	–	–	57096,565	706,09	57096,565	706,09
Removal cutting – *Zadnja sječa*	–	–	–	71711,979	816,27	71711,979	816,27
Non-treatment – *Neplanirano*	28,24	–	–	–	77,89	–	106,13
General Total – *Sveukupni zbroj*	524,54	136870	17893,65	193046,279	4091,24	329916,279	22509,44

release cutting were foreseen in the treatments to be made for the first time. The second and third treatments were foreseen as weeding and release cutting. Shelterwood method was given weight due to the large part of the regeneration fields being high slope. Since 273,06 ha area constituting 23,39% of the area has not sufficient and quality seed tree, it has been decided to be regenerated with clear cutting method and planting. 94,91 ha area consisting of 8,13% of the regeneration fields, it was foreseen to regenerate with planting under the forest canopy due to being high sloped (Table 8).

It was aimed to complete the regeneration works continuing in 2015 that is the first application year in the planning unit. For this reason, it was observed that the regeneration allowable cut and the total allowable cut in the years of 2015 and 2016 are relatively less when compared with the other years. Silvicultural treatment area occurred at most in 2027 and the least in 2016; and the highest allowable cut taking in 2017 and the least allowable cut occurred in 2015 (Figure 3).

The fields subjected to the tending treatment was being tried to be distributed to be equal each year and the mean treatment area is 894,683 ha/year, the average tending allowable cut was calculated to be 6843,5 m3/year. The total of tending allowable cuts 136870 m3 and its share in the total allowable cut is 41,49%. The allowable cut to be obtained in the regeneration areas constitutes 58,51% of the total allowable cut. In the treatments to be made to the regeneration areas, it is aimed to be equal of the annual treatment area and the allowable cut and annual average treatment area is 197,164 ha/year and the allowable cut to be taken from the regeneration fields has been planned to be nearly 9652,314 m3/year (Figure 3). When the allowable cut and treatment area amounts were examined according to the years and the tending and regeneration are evaluated together, average annual treatment rate is 1102,649 ha and the average annual allowable cut is 16495,814 m3/year.

It was foreseen to make silvicultural treatment once at least and five times at most during planning application time in the areas subjected to the silvicultural treatments in the research field. During the planning time, the treatment to 22509,44 ha of an area with the repetitions was planned. The silvicultural treatment methods to be made to these areas, area sizes and the allowable cuts to be obtained in these applications are given in Table 9. Accordingly, the biggest allowable cut in the tending cuttings is obtained

from the moderate low cutting and heavy low cutting; it is taken from the removal cutting and light cutting in the regeneration areas.

CONCLUSION
ZAKLJUČAK

Silviculture plan is the application step of the forest management plan and it is a part of it. After forest management plans were prepared in Turkey, forest inventory is made again for the preparation of the silviculture plans, and the silviculture plans are prepared by being adhered to the reforestation, regeneration and tending fields given allowable cut amount in the forest management plan in general sense. The practitioners of these plans, in other words the forest administration chief officer must prepare the silviculture plan in accordance with the relevant legislation. In the preparation of the silviculture plans, classical database structure has been used up to now, digital geographical baselines have not been prepared and used. They have been prepared by the common viewpoint of the Hisar Planning Unit silviculture plan, forest management and silviculture disciplines. In the silviculture plan, spatial database has been designed again with additional arrangements based on the treatment areas included in the forest management plan and the relevant geographical database. For each silvicultural treatment area (sub-compartment), silvicultural treatment recipes have been prepared according to the silvicultural treatment. By producing the cutting plan map that is the final output or in other words, the silviculture plan map, it has been submitted to the service of the users.

By using analysis, interrogation and presentation features presented by the geographical information systems, the general evaluations such as silvicultural treatment methods to be applied in the research area, the distributions of them due to years and treatment times have been presented as the outputs of this research. In addition to these outputs, many analyses depending on the stand parameters such as detailed silviculture plan tables, development stage, age, bonitet classes and the other outputs such as the treatment areas for five different treatments and the maps of the application years are produced and presented.

Silviculture plan has been prepared for the forests in the vicinity of Oltu consisting of pure *Pinus sylvestris* stands where only one species is dominant and especially for Hisar Forest Planning Unit. Due to the geographical structure of Turkey, there are different tree species, different species compositions and different forestry problems in different geographical areas. In these areas, the number of the silvicultural treatments, the years and the allowable cuts to be taken will vary. Therefore, by making similar studies in other forest areas in our country, it is required to prepare silviculture plans and to design the database for each forest planning unit.

ACKNOWLEDGEMENT
ZAHVALE

We thank to ANÇEO, Anatolian Environment Forestry Cartography INC. CO., General Directorate of Forestry and Artvin Çoruh University, Faculty of Forestry that have given all kinds of support in the preparation of both the silviculture plan and the forest management plan and obtaining the data.

REFERENCES
LITERATURA

- Aras, M. S., 1974: Bio-ecological Researches on the Trouts in Çoruh and Aras Basin, Phd. Thesis, Atatürk University Institute of Science and Technology, Erzurum, Turkey, p. 275
- Asan, Ü., 1999: Multiple Use of Forest Resources and Planning Systems. In Proceeding of Meeting on the Multiple Use Forest Management Planning, Bolu, Turkey, 5–6 May, 33–40.
- Başkent E. Z., S. Köse, S. Keles, 2005: Forest management planning system of Turkey: constructive criticism towards the sustainable management of forest ecosystems, International Forestry Review, 7 (3) 208–217.
- Başkent, E.Z.; Ş. Başkaya,; S. Terzioğlu, 2008a: Developing and implementing participatory and ecosystem based multiple use forest management planning approach: Yalnızçam case study. Forest Ecology and Management, Volume 256, Issue 4, 798-807.
- Başkent, E.Z.; S. Terzioğlu, Ş. Başkaya, 2008b: Developing and Implementing Multiple-Use Forest Management Planning in Turkey. Environmental Management, 42, 37-48.
- Eken, G., M. Bozdoğan, S. İsfendiyaroğlu, D.T. Kılıç, Y. Lise, 2006: Important Natural Areas in Turkey (2 volumes). Association of Nature, Ankara.
- Eraslan, İ., 1982: Forest Management, Istanbul University, Forth Press, İstanbul, p. 582.
- FAO, 2010: Global Forest Resources Assessment 2010 Main Report, FAO Forestry Paper 163, Food and Agriculture Organization of the United Nations, Rome, p. 371.
- FAO, 2015: Global Forest Resources Assessment 2015 How are the world's forest changing?, Foof and Agriculture Organization of The United Nations, Rome, p. 56.
- GDF, 2014a: Forest Inventory Results. Republic of Turkey Ministry of Forestry and Water Affairs General Directorate of Forestry, Forest Management and Planning Department, Ankara, p. 28
- GDF, 2014b: Preparation of Technical Principal of Forest Management Plan in Turkey. Notification Num: 299, Republic of Turkey Ministry of Forestry and Water Affairs General Directorate of Forestry Directorate of Silviculture, Ankara, p. 210.
- GDF, 2014c: Technical Principal of Silviculture Applications. Republic of Turkey Ministry of Forestry and Water Affairs General Directorate of Forestry Directorate of Silviculture, Notification Nu: 298, January, Ankara, p. 144.
- GDF, 2015: Hisar Forest Management Plan. General Directorate of Forestry, Ankara, Turkey, p. 262.
- Genç, M. 2001: Forest Tending. Süleyman Demirel Univ. Isparta, Turkey, Pub. Num: 14, p. 244.
- Kuru, M. 1971: The fresh – water fish fauna of eastern Anatolia, İstanbul Univ., Serial: B, 36, 137–147.

- Kuru, M. 1975: Systematic Assessment of Zoogeographical on fishes (Pisces) in the Dicle-Fırat, Kura-Aras, Lake Van and the Black Sea Basin. Assoc. Thesis, Atatürk University, Erzurum, Turkey, p. 180.
- Nyland, R. D., 2007: Silviculture Concepts and Applications, Second Edition, State Univ. of NewYork, Collage of Environmental Science and Forestry, Long Grove Illinois, p. 682.
- Odabaşı, T., A. Çalışkan, F. Bozkuş, 2004: Forest Tending Book. İstanbul University, Serial Nu: 4458, Volume: 474, İstanbul, Turkey, p. 235.
- Okutucu, M. A. 2007: Population Studies on Capra aegagrus in Oltu Wildlife Development Area. Phd Thesis, Kafkas Univ., İnstitute of Science and Technology, Artvin, Turkey, p. 178.
- Önal, M., 2012: Medicinal and Aromatic Plants in Olur, Oltu and Şenkaya Villages. Phd. Thesis, Artvin Çoruh University, Instiute of Science and Technology, p. 215.
- Saatçioğlu, F. 1971: Silvicultural Methods, İstanbul Univ, 1648/172, İstanbul, Turkey, p. 562.
- Solak, K., 1977: Population Dynamics on Barbus Species in Çoruh-Aras River Basin, Ege Univ., Journal of Science Faculty., Serial Nu: B, 4, 361- 374.
- TSIE, 2015: Population Statistics, Turkish Statistical Institute, http://www.nufusu.com/ilce/oltu_erzurum-nufusu, 26.11.2015.
- Yolasığmaz, H. A., 2013: Forestry in Turkey from the Forest Management Perspective. In Proceedings of the International Caucasian Forestry Symposium, Artvin, Turkey, 24-26 October, 299-301.
- Yolasığmaz, H. A., S. Keleş, 2009: Data Base Design with GIS in Ecosystem Based Multiple Use Forest Management in Artvin, Turkey: A Case Study in Balcı Forest Management Planning Unit. Sensors, 9, 1644-1661.
- Yolasığmaz, H.A., N. Tüylü, E. Süner, B. Çavdar, 2013: The Evaluation of Forest Management Plans Prepared by Private and Public Institutions: Artvin-Şavşat and Yusufeli Samples. In Proceedings of the International Symposium for the 50TH Anniversary of the Forestry Sector Planning in Turkey, Antalya, Turkey, 26-28 October, 377-383.

Sažetak

Šumskim resursima se upravlja dugoročnim, srednjoročnim i kratkoročnim nacionalnim, regionalnim i lokalnim planom, programom i posebnim uredbama, imajući u vidu međunarodne i nacionalne ciljeve.. U Turskoj je najmanja jedinica gospodarenja šumom šumski upravni odjel. Šumski upravnim odjelom se upravljaju na osnovi planova eksploatacije šuma koji se pripremaju prema načelima **V**išestrukog **p**laniranja **z**asnovanog na **E**kosustavu. Uprkos tome, što je u Turskoj u zadnjih pet godina proces pripreme planiranja šumskouzgojnih radova uvršten kao zakonska obveza, ipak u pogledu pripreme planova i njihove primjene nije se uspostavio jedan određeni standard. U ovom članku, s ciljem da se se iznađe rješenje za navedene probleme, sačinjen je plan šumskouzgojnih radova gdje je odabran šumski upravni odjel Hisar šume. Proces počinje nakon upotpunjavanja planova u vezi eksploatacije šume. Sastoji se iz sljedećih faza primjene i nadzora: radovi na terenu, izrada geografske baze podataka, priprema rješenja u pogledu intervencija kada se radi o uzgoju šuma, izrada tabela, grafikona i karata.

KLJUČNE RIJEČI: Plan šumskog upravljanja, plan uzgajanja šuma, geografski informacijski sustav, obični bor