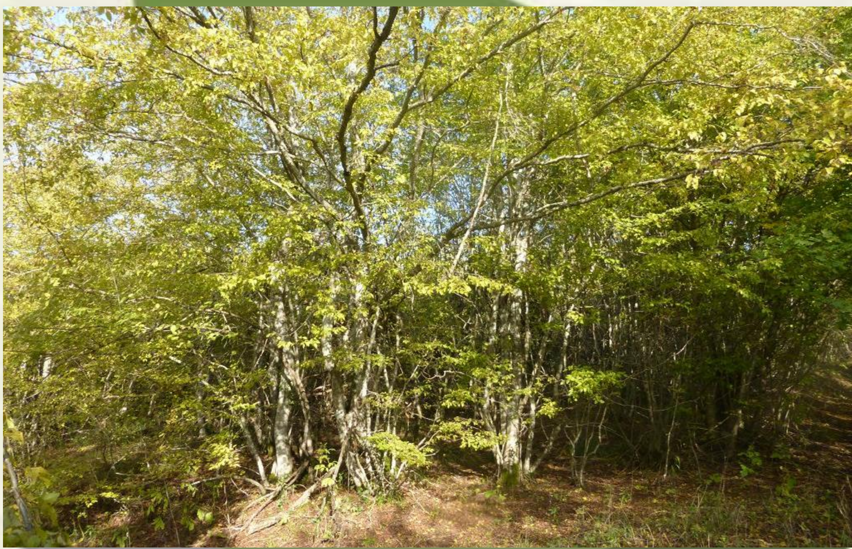
Integrated Biodiversity Management, South Caucasus

Forest inventory results and socio-economic forest management concept for the NFA District "Dedoplistskaro"



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Executive summary

The present report illustrates the forest inventory results of the NFA state forest of Dedoplistskaro and presents a future forest management option as discussion basis for all further planning measures. All underlying activities originate from a NFA-GIZ cooperation.

Generally, *Carpinus species* dominate the forest, representing 65 % of all tree species. *Fraxinus excelsior* (14%), *Quercus iberica* (7 %) and *Crataegus microphylla* (5 %) are further species which occur considerably often. In total, 16 species have been identified of which 6 are bush species. 70% of all trees show a diameter at breast height (DBH) smaller than 12 cm, and 95% of all trees are below 20 cm DBH. In general, the inventory results reveal that the Dedoplistskaro state forest is in a severe ecological situation consisting in a majority of highly degraded coppice forests. More than 25% of the forest area has already been transformed into non-forest. Open and dissolving forests represent about 65% of the area and respectively show strong to severe signs of degradation. Only about 10% of the forest area can be considered dense forest with a mean volume stock of about 41 m³/ha.

In order to be able to deviate comparable entities within the forest, the following subdivision of comparable strata has been applied. The table presents the mean volume of standing stock per strata and the corresponding standard error.

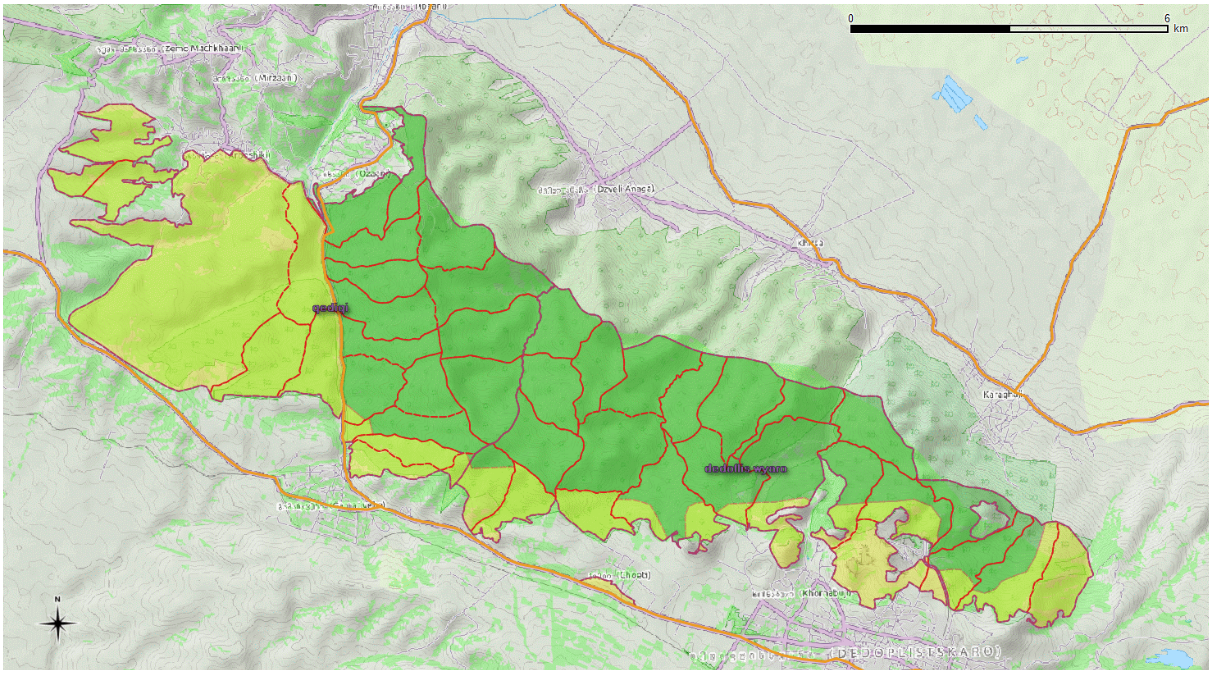
Table 1: Volume of standing stock per strata divided into volume of trees >8cm and trees <8cm DBH

Strata	Volume of trees > 8cm DBH in m³ per hectare	Standard Error in m³/ha	Volume of trees < 8cm DBH in m³ per hectare	Standard Error in m³/ha	Sum of volume in m³ per hectare
Dense forest	39.4	2.9	1.9	0.5	41.3
Open forest	8.0	0.6	4.6	0.7	12.6
Dissolving forest	0.6	0.1	6.3	1.1	6.9
Non forest	0.0	0.0	0.9	0.1	0.9
All area	**6.5**	**0.7**	**4.1**	**0.4**	**10.6**

Calculations on the basis of collected “future tree status” data reveals a possible harvest volume of about 15 m³/ha in dense forest and about 2.5 m³/ha in open forest without calculating yearly increment rates.

The proposed vision concerning this forest is rehabilitating the forest ecosystem within the next 50 years. The social demand for firewood and grazing, however, implies a socio-economic management concept which allows a sustainable use of the forest resources. Thus, on the basis of inventory data, about 4,000 ha have been proposed as future fire-wood production forest, about 9,400 ha as forest rehabilitation area, and about 1,000 ha as grazing-land. Within each zone, specific technical management rules and principles are proposed. The figure below visualizes the proposed zoning for Dedoplistskaro and Qediqi district. The proposed zoning for Qedi can be found in chapter 3.3.1.

Figure 1: Proposed zoning for Dedoplistskaro and Qediqi district, state forest



The presented concept should not be regarded as a blue print approach, but as a discussion basis for processes of participatory planning and management. In the upcoming planning phase, the future management concept must be based on participatory decisions and active participation of all stakeholders in order to guarantee a successful implementation. First concrete steps are recommended such as distributing the final report, especially the inventory results and concept ideas to all relevant public or private stakeholder, communicating inventory results and the concept ideas via radio at local level, and starting a public discussion and decision forum at the municipality in Dedoplistskaro concerning the management concept.

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1. Introduction

The present report summarizes the results of a forest management inventory in the NFA state forest area within the municipality of Dedoplistskaro. On the basis of the inventory results, a forest management concept was developed, which is presented in the second part of the report. The forest management inventory for Dedoplistskaro was the first of its kind in Georgia and must be regarded as a test to future FMI of coppice and non-coppice forests. The implemented methodology followed a design that was developed for forest management inventories (FMIs). The present report does not refer to methodological aspects; these aspects are summarized in a previous report “FMI Test Dedoplistskaro”.

The present report is the last of a series of reports developed in for a GIZ funded project aiming at “improving the implementation of concepts concerning the sustainable management of biodiversity by state, private and civil society actors in the South Caucasus”. Project activities started in December 2015 and ended in November 2016. During this period the following main documents have been elaborated:

1. FMI Test Dedoplistskaro, including
    a. Methodology for forest management inventories in Georgia
    b. Forest Management Inventory Field Manual for Dedoplitskaro
    c. Field inventory supervision and quality control report
    d. Summary of short comings and lessons learnt concerning the FMI test
2. Inventory results and management concept for Dedoplistskaro (present report)
3. Inventory data table set (excel sheets with all collected data and analysis calculation)

Furthermore, many additional information has been provided and documented in the following reports:

- Review of resolution 179
- General silvicutural options for Dedoplistskaro forest
- FMI field manual for Dedoplistskaro (English and Georgian version)
- Species code list for Dedoplistskaro
- FMI field form bilingual
- TOR for providing inventory services
- Inventory Field Team Training and Supervision report
- Overview maps of the Dedoplistskaro forest and inventory results – online gis platform
- Annex to methodology concerning regeneration classes

Figure 2: NFA area Dedoplistskaro. Brown: NFA administration area, blue forest area. Rose dots: Plots of field inventory

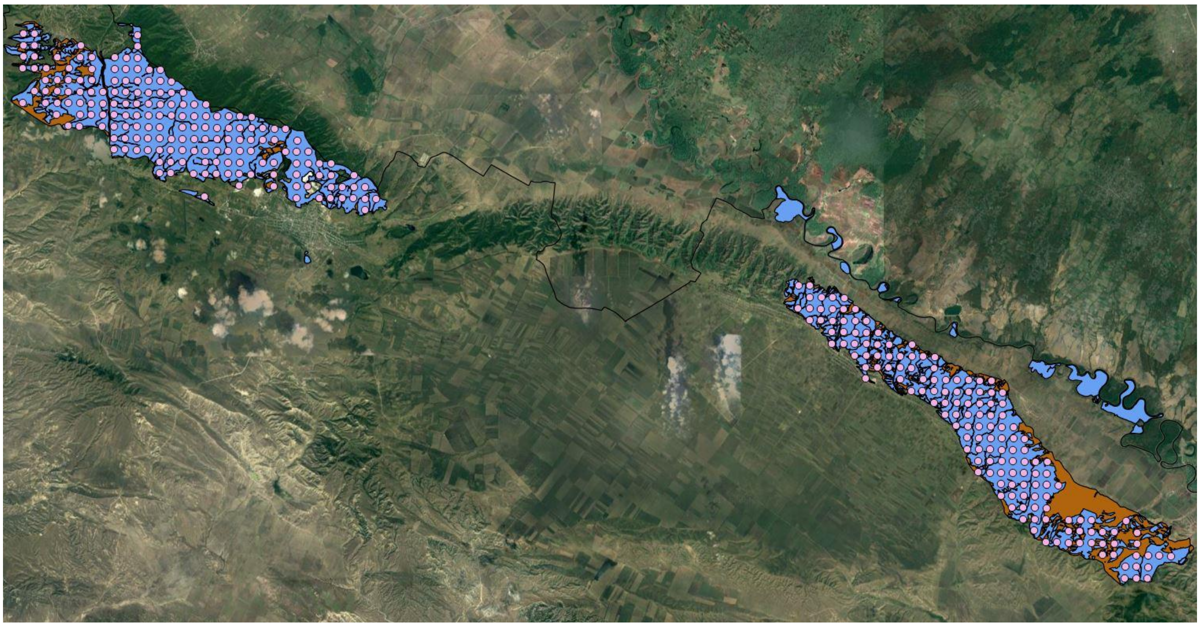


Figure 3: Satyeo Qediqi & Dedoplistskaro. Brown: NFA administration area, blue forest area. Rose: Plots of field inventory

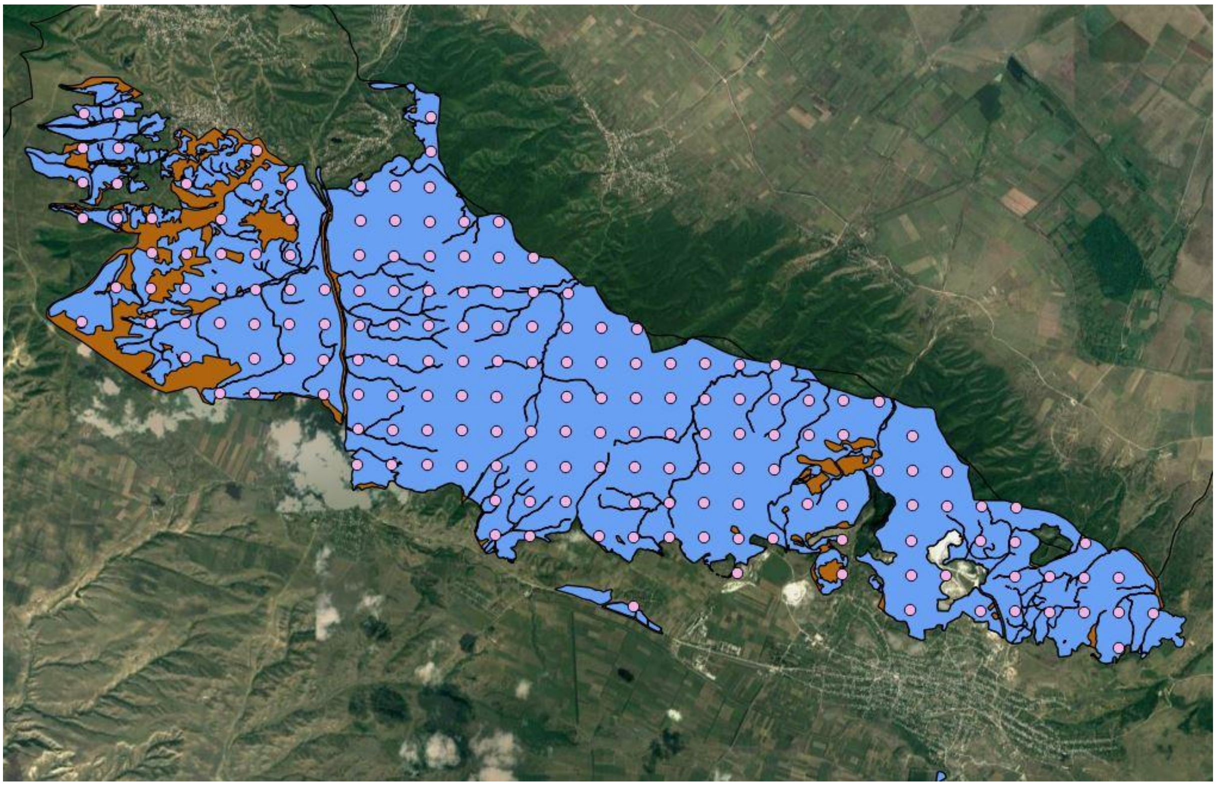
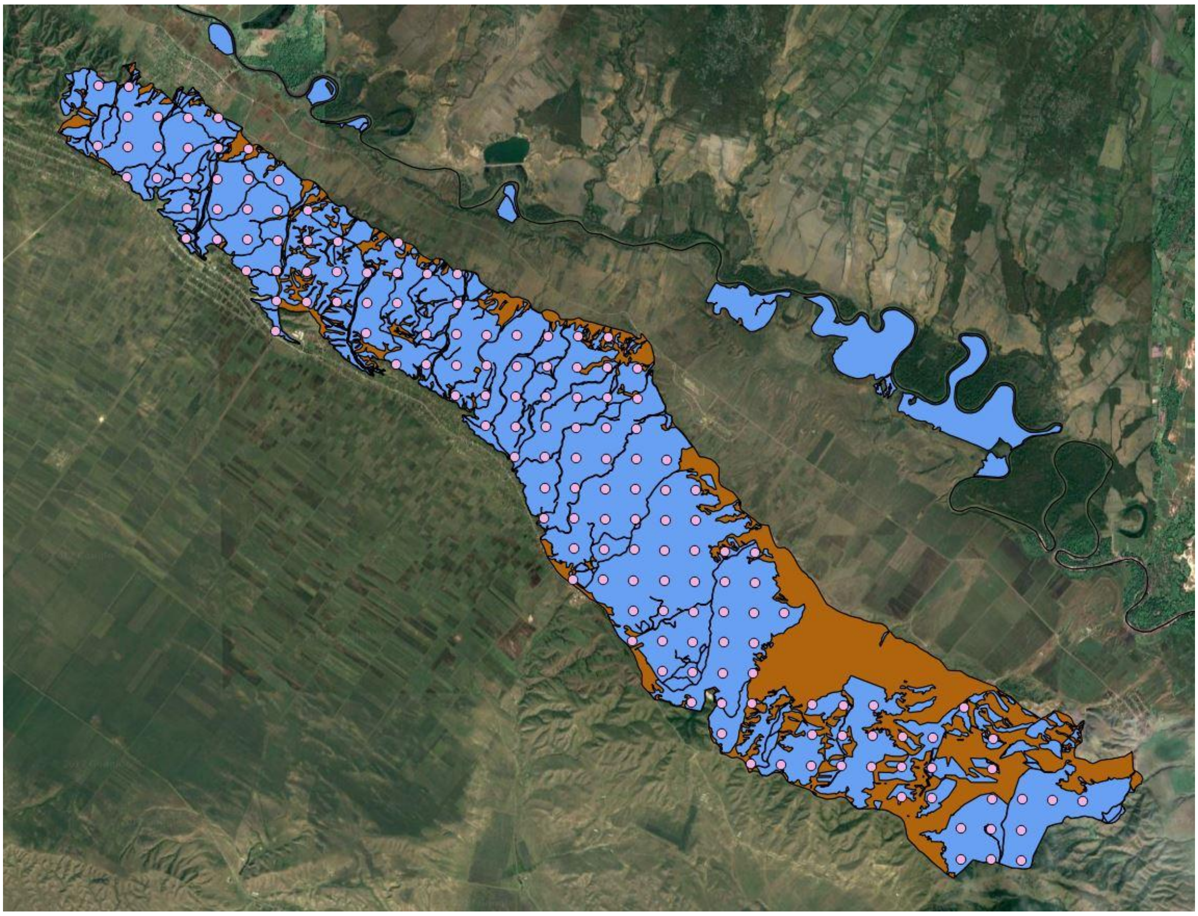


Figure 4: Satyeo Qedi. Brown: NFA administration area, blue forest area. Rose dots: Plots of field inventory. Areas alongside Alazani river not part of inventory, therefore without plots.



The area under NFA administration[1] within the municipality of Dedoplistskaro covers roughly 14.400 ha of land divided into 3 districts, Qediqi, Dedoplistskaro and Qedi – see map above – which are divided in two big blocks. Part of the area is not classified as forest by NFA. This part is neither regarded within inventory nor here in description.

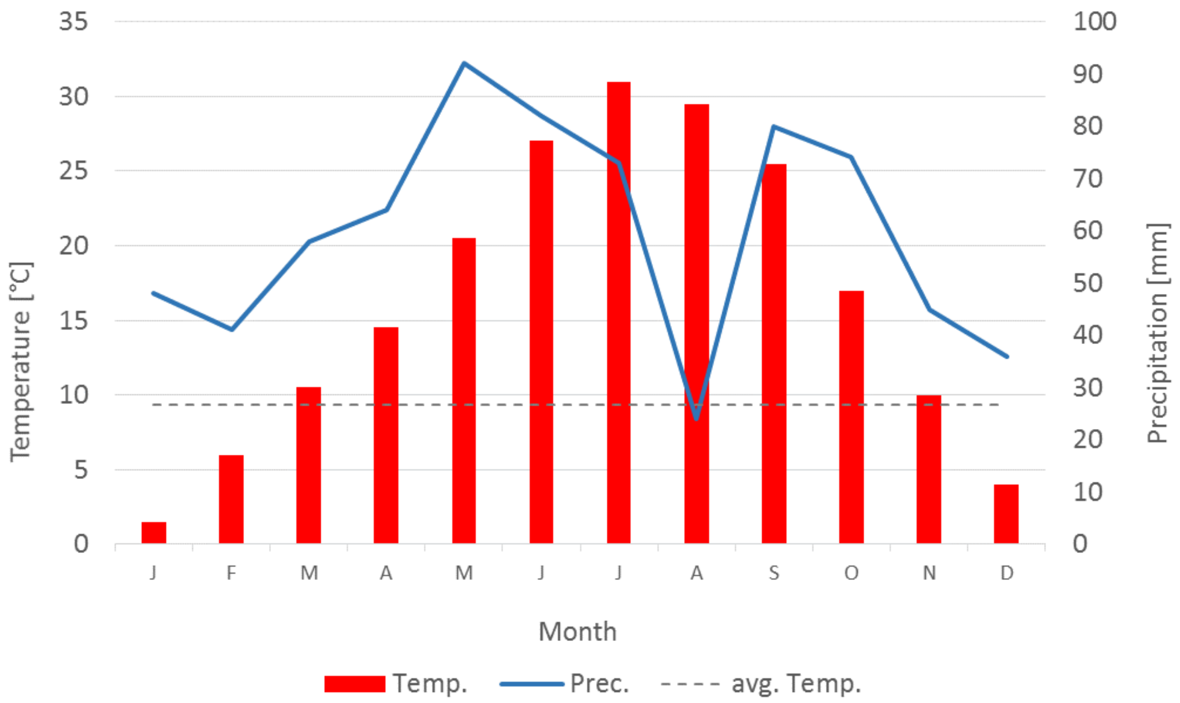
The remaining forest area[2] forest is situated on the moderate to steep slopes of Gomboris Kedi mountain range. About 800 ha are riverine forests next to Alasani River which, however, have been excluded from the inventory and management planning. This leaves an inventory area of 11,800 ha. This forest as a whole is heavily degraded. The amount of degradation increases from west to east. In the northeastern part of the forest, several areas without any trees at all are visible on satellite images. In the west, some vestiges of old forest can still be found, especially in less accessible areas.

[1] More precisely the shape named Dedo_Satyeo handed to Forest Eye and UNIQUE
[2] More precisely the shape „Dedofliswyaro forest“ handed over by NFA

Table 2: General information about Dedoplistskaro NFA forest area

Height above sea level	650- 1000m
Soils	Calciferous soils of very different depth
Annual mean temperature	10.8°C (min. -11°C – max. +37°C)
Annual precipitation	680 mm
Protection status	Eagle Valley. Natural monument; 130 ha northwest of Dedoplistskaro; outside NFA area but surrounded by it. Vashlovani National Park bordering in the East; not part of NFA area.
Ownership	State forest, represented by NFA.
Last Management plan	1992
Size	11,800 ha, Qediqi - 3,154 ha, Dedoplistskaro – 3,220ha, Qedi – 5,426 ha

Figure 5: Climate data Dedoplistskaro 1990 – 2005[3]; temperature is given in red; blue line = precipitation



The forest plays an important ecological role as a migratory route, and as a forest outpost near the bordering plains. The forests main function was originally (until 1990) considered to be a protection forest. Nevertheless it suffered a rapid degradation and overexploitation in the last 20 years. It is an important resource for the local population providing valuable services, including fuelwood for heating and industrial use as well as pasture. Fuelwood and pasture are without any doubt the main drivers of deforestation and degradation in the Dedoplistskaro area. Both, fuelwood harvesting and cattle management take place to a great extent unofficially and unplanned. There is no evidence indicating that some kind of social control is in place against fuelwood theft or browsing. Currently, there is one forest officer

[3] NASA (2016): Earth observation Data Set Index – retrieved from: https://sv.wikipedia.org/wiki/Dedoplists'q'aros_Munitsip'alit'et'i

and six rangers responsible for the protection of 21.000 ha forest land, including Dedoplistskaro and neighboring municipalities.

The last forest management plan dates back to 1992, and those maps are still in use. However, no inventory data was available from this period. Apart from a non-representative 400 ha inventory carried out by Grüneklee on behalf of GIZ in 2012, there is no forest data available. Thus, there is no knowledge of current data about the forest including information such as species composition, volume, number of trees, basal area, etc.

2. Forest inventory results

In 2015, the consortium UNIQUE-ForestEye was contracted by NFA-GIZ to develop an inventory methodology for degraded open forests (coppice forests). The forest of Dedopliskaro municipality serves as a pilot site for the design of the Forest Management Inventory, thus, the developed methodology[4] was applied and a field inventory carried out in September and October 2016. The whole state forest area has been divided into an inventory grid with a resolution of 600 x 600 meters, resulting in 332 permanent inventory plots. Each plot has been visited by one of the 6 field teams of the national service provider, Geographic. An iron bar of 30 cm has been installed in the soil at the field coordinates given.

Additionally, Measurements according to the field manual have been carried out within concentric circles. A field monitoring mission proved that the majority of the inventory parameters (variables) had been entirely or in large parts correctly classified by the original field teams. But it was found also that some of the parameters were not reliably correct[5]. Those parameters have been left out of this chapter and, when used, a justification is given. Data transfer from paper sheets into digital MS-Excel tables has been controlled and partly adjusted. In general, also the data input proved to be reliable although corrections were sometimes necessary. Nevertheless, there is no reason to doubt the quality of data input.

On the basis of the data tables from the final inventory, the following results have been determined.

2.1 Strata definition

In Georgia, stands ("litra") and also strata, were hitherto defined according to slope angle, age, density and dominant species (Res. 179). However, in the case of Dedoplitskaro, age is about the same, as all coppice forests are declared to be younger than 25 years. Moreover, there are only two dominant species (both *Carpinus spec*.), and aspect (slope) has little effect on volume of standing stock (see following chapter). Considering the aforementioned, a subdivision was done using parameters reflecting density.

Field inventory data revealed big differences within the forest, varying from non-forest areas to relatively highly stocked coppice forest with volumes up to 80 m³/ha. In order to be able to deviate comparable entities (="strata") within the forest; a subdivision of comparable entities has been applied. This stratification uses basal area as means to distinct between strata, since basal area is a steadier variable than e.g. volume for reflecting the forest density of each inventory plot. Depending on an assumed optimum of basal area[6], strata were classified as follows:

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[4] Fehrmann, L., Fuchs, H., Kleinn, C., 2016. Draft Methodology for Forest Management Inventory (FMI) in Georgia. Short version for inventories in Dedoplistskaro. ForestEye Research GmbH
[5] See Pawlowski, G., Wenzel, M.(2016): "Field inventory supervision and quality control"
[6] Basal area in the context of strata definition always means „basal area of trees >=8cm DBH"

Table 3: Strata definition

Strata	Criteria
Strata 1 - Dense forest (closed forest)[7]	Basal area ≥ 10 m²/ha (highly stocked)[8]; this value is roughly equivalent to more than 50% of the basal area to be expected in a fully stocked hornbeam forest of low fertility ("Bonität") under Dedoplistskaro conditions.
Strata 2 – Open forest	Basal area between 1 and 10 m²/ha (lowly stocked), equivalent to 5-50% of a fully stocked forest area as defined above.
Strata 3 – Dissolving forest (bushland/"Shibliak[9]")	Some trees and/or regeneration of tree species still present, but basal area ≤1m² and therefore <5% of a fully stocked area. Also, the position of plots was taken into account. Plots with basal areas slightly higher than 1m²/ha surrounded by „non -forest", were included into this entity, too.
Strata 4 – Non-forest	Areas without trees >=8cm and additionally classified by field teams as land use class "barren land / agriculture".

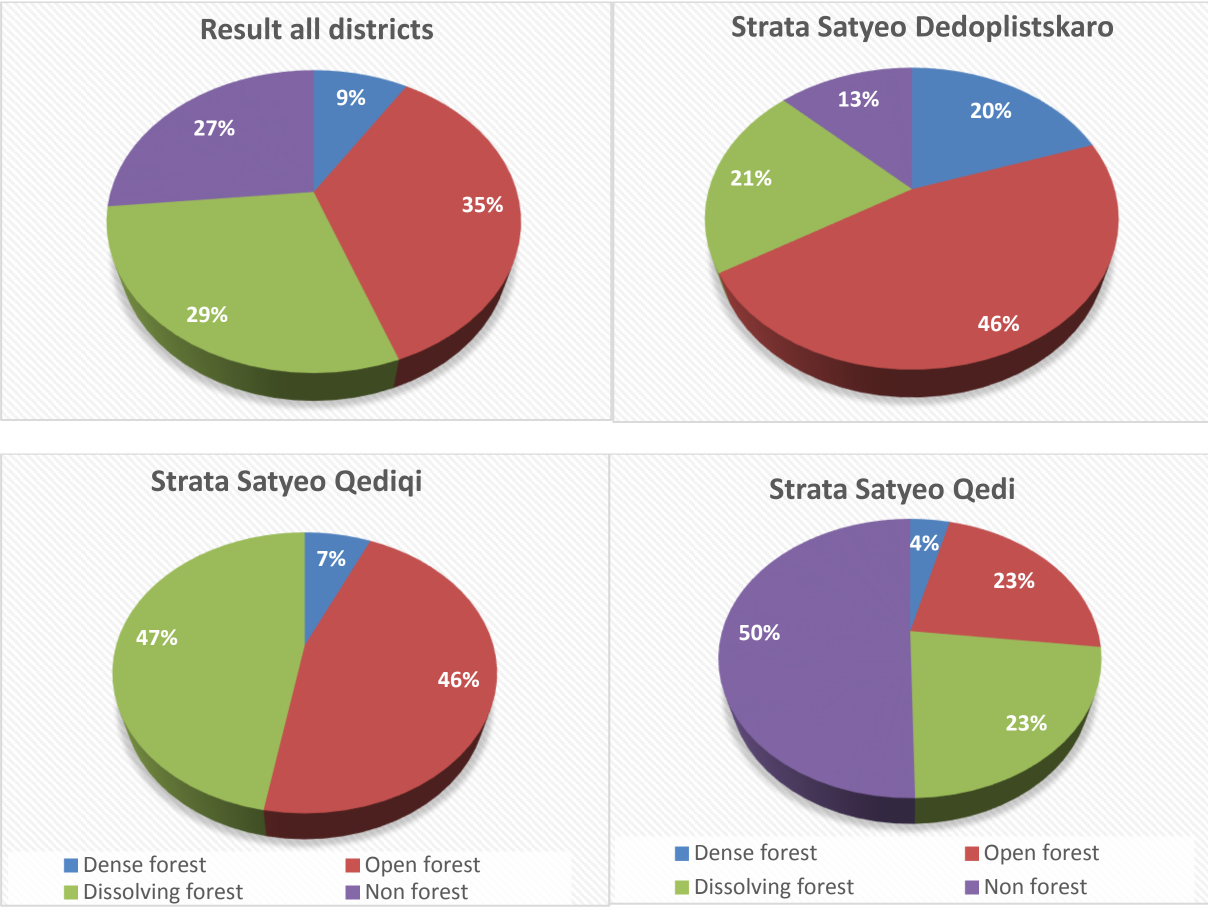
The strata classification methodology resulted in a plot distribution presented in table 4. In total, dense forests account for 9 % of the area, whereas about 65% of the dense forests are located in Dedoplistskaro district with small patches within the other 2 districts. Open forests represent 35 % of the total forest area and can be found in all three districts alike. Dissolving forests / Bushland present 29 % of the forest area and play a relatively high role in Qediqi district. Finally, non-forest areas represent 27 % of the total forest area, showing a very strong difference between the districts. Whereas "non-forest" areas do not occur in Qediqi district, 50 % of the Qedi district are classified as non-forest.

Table 4: Strata distribution in ha per district

Districts	Dense forest	Open forest	Bushland	Non-forest	All strata
Dedoplistskaro	637	1,497	674	412	3,220
Qediqi	213	1,453	1,488	-	3,154
Qedi	218	1,238	1,238	2,731	5,426
Total	1,068	4,188	3,400	3,143	11,800
In %	**9 %**	**35 %**	**29 %**	**27 %**	**100 %**

[7] This strata is – in terms of phytosociology this forest is a degradation state of the "Q. iberica Forests with Carpinus orientalis" as defined by Nakhutsrishvili, G. (1999).
[8] Harvest tables from central Europe (e.g. Kenk 1979 for oak, Volquardts 1958 for ash, and especially Lockow 2009 for Hornbeam (Bonität IV)) allow to conclude that in the lowest bonity, fully stocked stands of ash, oak and hornbeam aged 50 to 100 years, display a basal area of 15-25m²/ha, 20m² in average. This was confirmed by own field measurements for fully stocked areas within Dedoplistskaro, giving results of 20-22m²/ha.
[9] This term was used by Nakhutsrishvili, G. (1999) to describe the degradation state of dry forests in East Georgia. The description matches almost perfectly to this strata („About 25–30 species contribute to the formation of shibliak. Mediterranean shibliak consists of the following species: Paliurus spina-christi, Berberis vulgaris, Cotinus coggygria, Punica granatum, Carpinus orientalis.")

Figure 6: Plot distribution throughout the different strata of the NFA carried out in Dedoplistskaro state forest



2.2 Key inventory results

2.2.1 N/ha

Results regarding number of trees per hectare were calculated for trees > 8 cm and for regenerating trees < 8 cm, using representation factors according to the size of the respective inventory circle (radius 1,5m, 5m, 10m or 15m). The thornbush species *Palliurus spina christi* and *Rosa canina* were excluded from volume-related calculations, as they practically never reach noteworthy volumes and are never used as firewood. Else, the results for Qedi concerning strata 3 and 4 would have been very misleading.

In general, the number of trees >8cm (in average 251 trees / ha) can be considered as very low - except within strata 1, dense forest, where numbers of 1.000/ha and more occur.

Table 5 illustrates tree numbers per hectare, divided into trees >8 cm and trees <8 cm DBH within the existing strata of the three districts. The table includes the corresponding statistical standard error in absolute numbers. The standard error of the total area is calculated in percent for trees > 8cm is 8.3 %. Concerning regeneration numbers, the standard error drops to 5 % which is comparatively low.

Table 5: Number of trees / ha, distribution per district and strata

District / Strata	Number of trees > 8cm DBH / ha	Standard Error in %	Number of regeneration trees < 8cm DBH / ha	Standard Error in %
Dedoplistskaro	**417**	11%	**16,628**	8%.
1	1,105	7%	14,412	26%.
2	401	10%	17,149	10%.
3	59	34%	21,221	15%.
4	0	-	7,074	35%.
Qediqi	**323**	13%	**20,066**	7%.
1	1.,167	14%	19,240	25%.
2	500	8%	17,649	9%.
3	30	37%	22,467	11%.
4[10]	0	-	0	-
Qedi	**111**	20%	**5,408**	10%
1	1,025	26%	10,893	41%.
2	253	13%	7,757	17%.
3	54	28%	6,060	0%
4	0	-	3,060	16%
Total area	**251**	8%	**13,105**	5%

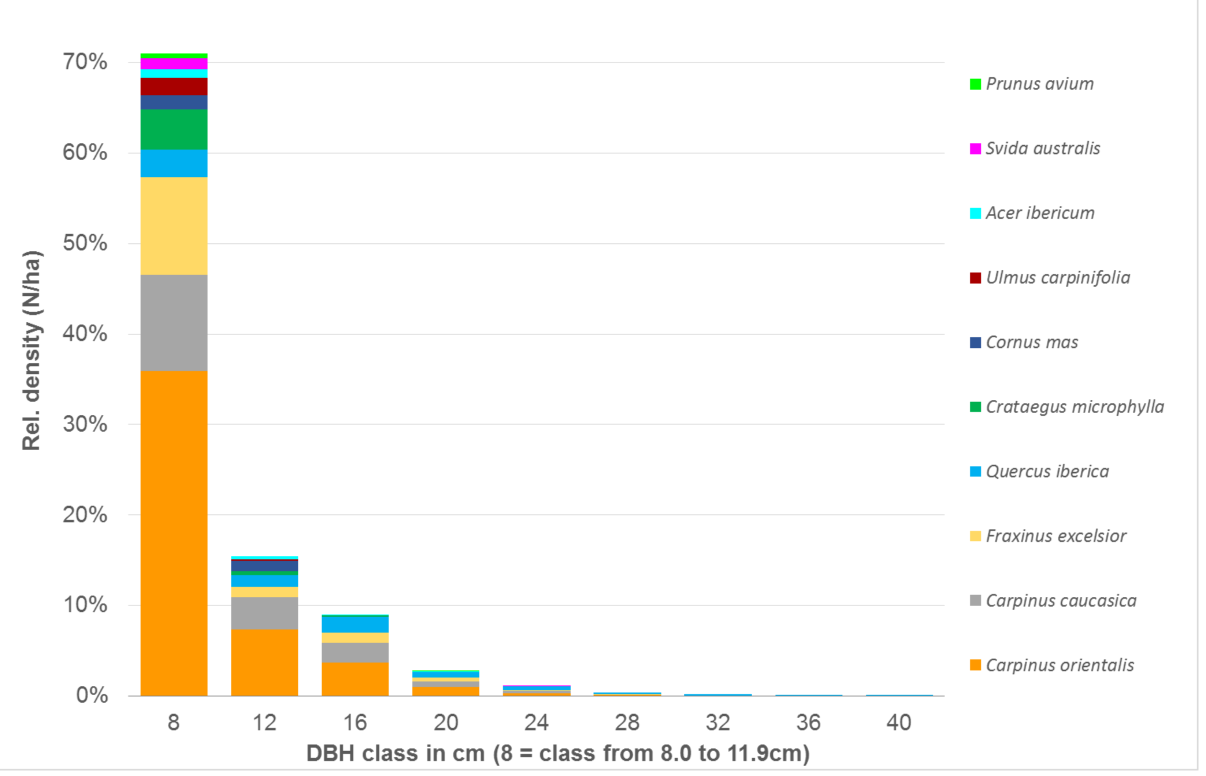
The results concerning regeneration show a different picture. There are numerous smaller (DBH<=8 cm) trees/ ha present in all strata, except in the non-forest strata, amounting to quite high numbers of 20.000/ha and more in Qediqi. Such extreme high numbers of regeneration are typical for very young forests or forests regenerating after extreme events like wildfire or storm, and shows the regeneration potential for the development of future stands. The results for the non-forest strata shows a limited potential for regeneration, at least at short notice. In the other strata, the results concerning the number of trees / ha can be considered typical for a young forest and a high potential for regeneration.

2.2.2 DBH distribution

The DBH values of all inventory plots were used to elaborate the following figure showing DBH distribution of all species in relation to their appearance (N/ha). It can be seen, that 70% of all trees show a DBH smaller than 12cm and 95% of all trees are below 20cm DBH. Diameters above 30cm DBH only occur under exceptional circumstances. These trees above 30 cm DBH are nearly exclusively high coppice trees. Nearly all trees (96%) exceeding 20cm DBH are either oak, ash, elm or one of the hornbeam species.

[10] No Non forest plots in Qediqi.

Figure 7: Relative DBH class distribution for the total area



2.2.3 Tree height

Field height data was used to elaborate height curves for each tree species or species group, which served as the basis for volume calculation. In this process, improbable data were excluded for each species (e.g. trees with height/ diameter ratio >120 or <40), as they were either wrongly measured or, not suitable for height curve calculation (as high coppice trees).

Also, although most height measurements were within the right dimension, when controlled, differences of 1m and more could be found, which can be considered a big deviation within the circumstances[11]. For this reason, although the elaborated height curves give a general idea about the relations between DBH and height in Dedoplistskaro, they do not comply to scientific standards. Despite this reservation, it turned out that all height curves are roughly within the same dimension. Figure 8: shows an example for *Carpinus caucasica*[12].

Figure 8: Height curve for *Carpinus caucasica; tree class 1 (trees from seed)*

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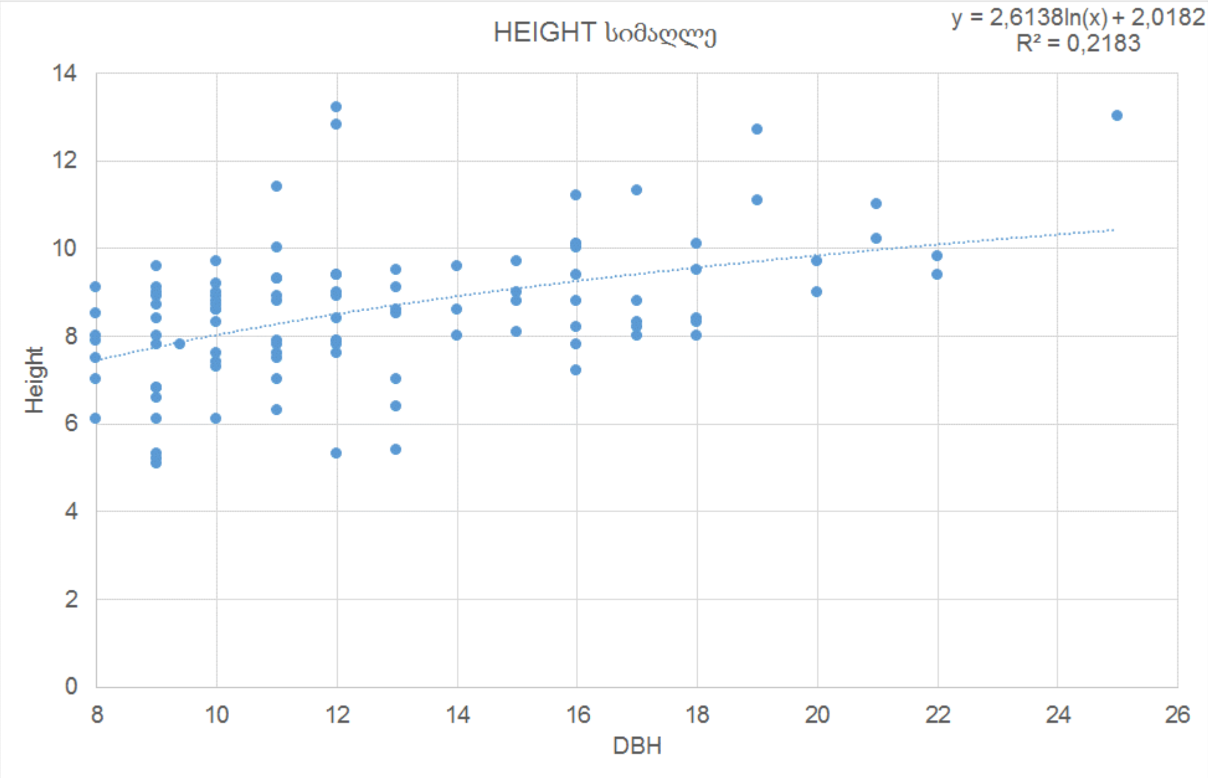
[11] In relation to average heights of about 6-8m. A certain proportion of estimations is probable. See Supervision report for details.
[12] The other height curves can be found within the annex.



2.2.4 Volume and volume per district incl. regeneration

Volume was calculated for trees ≥ 8 cm DBH as well as for regenerating trees < 8 cm DBH. Trees ≥ 8cm were calculated by multiplying the basal area per tree with an extension factor according to whether each tree was measured within the 5-, 10- or 15 m circle. The corresponding basal area per hectare was multiplied by the height of the tree, which has been derived using a height curve based on all inventory results for the respective species or species group. To calculate the volume per tree, a conservative approach was used using the lowest possible form factor of 0.3[13].

For trees < 8cm, an expansion factor was calculated according to the area of the regeneration circle. As the individual diameter of each tree had not been measured, some generalized calculations based on tree numbers were made. The following assumptions were considered to this purpose:

[13] Form factor 0,3 was used since it is the lowest form factor for young deciduos trees. KRENN's tarifs as well as German yield tables for birch (applicable for *Carpinus spec.), Fraxinus excelsior* and *Quercus spec*. show values between 0,23 and 0,46 for trees between 8 and 15 cm DBH at the lowest bonity class available. A comparison with Georgian tables for „other species" (applicable for oak) and „birch" (perhaps applicable for hornbeam) in the aftermath of calculation shows that Georgian yield tables aim a little higher with form factors between 0,4 and 0,45. Perhaps it would have been better to use these values (resulting in a volume 30-50% higher). On the other hand, these tables are not directly applicable for most Dedoplistskaro main species (*Fraxinus excelsior, Carpinus spec., Acer iberica*) and not applicable for coppice either. As mentioned, a conservative approach in order not to overestimate the standing stock of, 0,3 was used. This means, a certain underestimation of standing stock is probable.

- To estimate the average biomass, represented by each tree, an average diameter of 5 cm was assumed for small trees within height class 4 (4 - 7,9cm DBH)
- An average height of 4 m[14] and a form factor of 0,3 was assumed for small trees of height class 4.
- For established regeneration (height class 3 with height >150 cm, and DBH <4 cm) – an average diameter of 2 cm was used[12].
- An average height of 2 m and a form factor of 0.3 was assumed for height class 3.

Thorn bushes (*Palliurus spina Christi* and *Rosa canina)* occurring within the regeneration circles were excluded from volume calculation.

On average, 10.6 m³/ha of standing volume can be found in the Dedoplistskaro state forest area, whereas 6.5 m³/ha are trees ≥8 cm and 4.1 m³/ha are trees below 8 cm DBH. The calculated standard error for trees>8cm is 0.7 m³/ha or 6.5 % and the calculated standard error for regenerating trees is 0.4 m³/ha or 9.7 %. These average numbers, however, are deformed by a high number of non-forest areas being included in the calculation. Thus, volume numbers must be analyzed per district and strata, as shown in the table below. The high proportion of "Non-forest"- area points to a severe loss of forest area in recent years. It is evident that a loss of forest happened, although this effect could not be quantified as there was no reliable and comparable data available.

Although, on average, small trees <8 cm DBH and established regeneration < 4cm DBH make up for nearly 40% of the total volume, this number changes drastically between districts. Whereas in Qedi regeneration represents only 22 % of the volume, it is 26 % in Dedoplistskaro district and 58 % in Qediqi.

Concerning strata, within open forests and dissolving forests, regeneration trees make up for the bigger part of volume. In non-forest areas, the volume percent of regenerating trees increases to nearly 100 % of all volume.

Regarding volume figures within dense forests, these values vary between 37.9 m³/ha and 42.8 m³/ha depending on the district. Open forests however differ between 5.8 m³/ha in Qedi, 13.1 m³/ha in Dedoplistskaro and 17.2 m³/ha in Qediqi, respectively. For Qedi, the volume of the regeneration is underestimated, as there regeneration trees in height class 4 were counted as height class 3[15].

The following table and Figure 9: summarize the volume of standing stock per hectare divided into volume of trees ≥8cm and trees <8cm DBH, including the corresponding standard error.

Table 6: Volume of standing stock per strata and district, divided into volume of trees≥8 cm and trees <8 cm DBH

[14] One can assume an h/d relation of roughly 80-120 at a diameter of 5cm and of 100-120 at a diameter of 2cm. Once again, to use a conservative approach, the lower value was used. For form factor see preceding footnote. The resulting values for small trees <8cm and established regeneration <4cm have some characteristics of an estimation, but based on sound figures.
[15] Once more see Field inventory supervision and quality control report

District	Volume of trees ≥ 8 cm DBH in m³/ha	Standard Error in %	Volume of trees < 8cm DBH in m³/ha	Standard Error in %	Sum of volume in m³/ha
Dedoplistskaro	**12.4**	**15%.**	**4.3**	**16%.**	**16.7**
Dense forest	40.8	9%.	2.0	30%.	42.8
Open forest	8.9	11%.	4.2	21%.	13.1
Dissolving forest	1.0	30%.	8.0	33%.	9.0
Non forest	.-	.	1.3	31%.	1.3
Qediqi	**7.1**	17%.	**8.3**	13%.	**15.4**
Dense forest	37.6	17%.	2.3	61%.	39.9
Open forest	9.6	10%.	7.7	19%.	17.2
Dissolving forest	0.3	33%.	9.7	20%.	10.0
Qedi	**2.8**	25%.	**0.8**	13%.	**3.6**
Dense forest	37.0	21%.	0.9	33%.	37.9
Open forest	5.0	12%.	0.8	25%.	5.8
Dissolving forest	0.7	29%.	0.5	20%.	1.2
Non forest	.-	.	0.9	11%.	0.9
Total area	**6.5**	**11%.**	**4.1**	**10%.**	**10.7**

Figure 9: Relation between tree volume > and < 8cm in different strata and districts

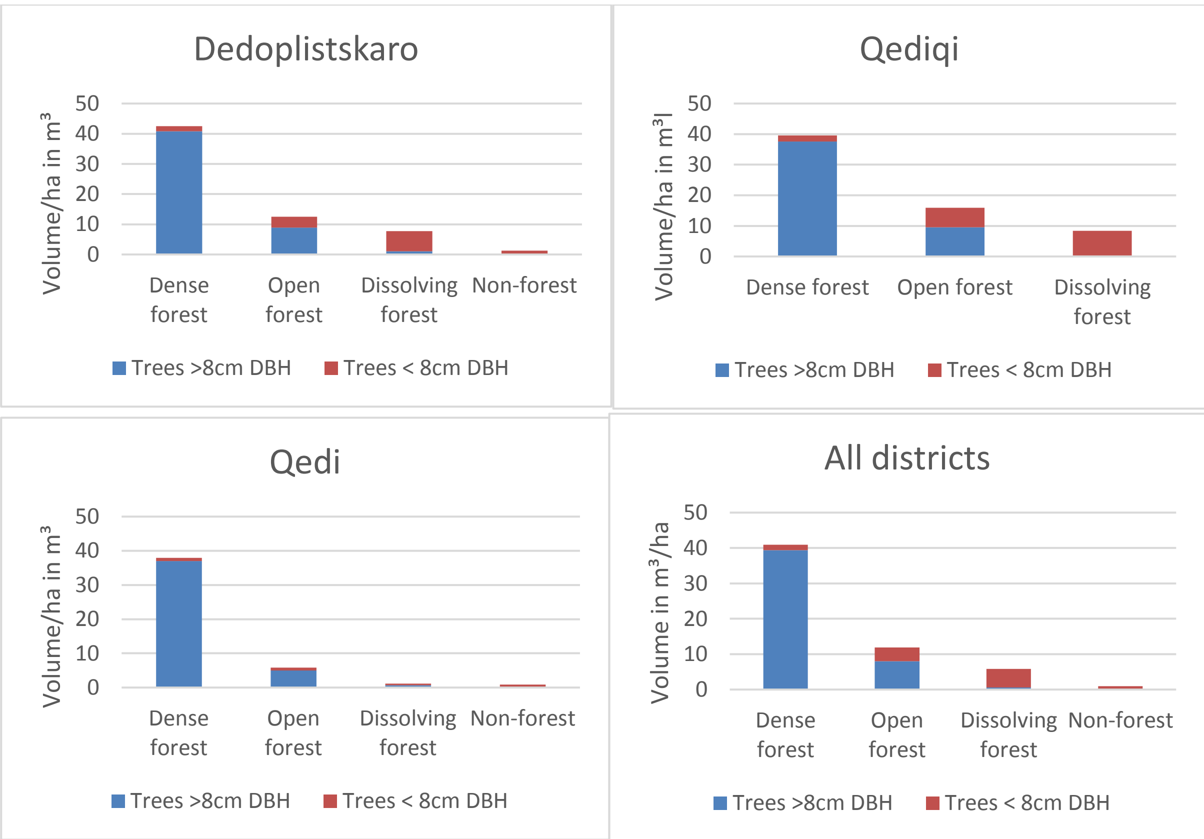


Table 7 demonstrates volume results as mean of the strata regardless of districts. It reveals that the overall volume is 41.3 m³/ha in dense forest, 12.6 m³/ha in open forest, 6.9 m³/ha in dissolving forest and 0.9 m³/ha in non-forest areas, respectively.

Table 7: Volume of standing stock per strata divided into volume of trees ≥8cm and trees <8 cm DBH

Strata	Volume of trees ≥8 cm DBH in m³/ha	Standard Error in %	Volume of trees < 8cm DBH m³/ha	Standard Error in %	Sum of volume in m³/ha
Dense forest	39.4	7%	1.9	26%	41.3
Open forest	8.0	7%	4.6	15%	12.6
Dissolving forest	0.6	17%	6.3	17%	6.9
Non forest	-	-	0.9	11%	0.9
All area	**6.5**	**11%**	**4.1**	**10%**	**10.6**

2.2.5 Species composition

Overall species composition

All collected tree data of trees >8cm has been used to calculate the species composition for the total forest area as well as for each District.

Figure 10: visualizes the species composition in % of tree numbers of the total area and per strata. It is clearly visible that the two *Carpinus* species dominate the forest, representing 65% or roughly 2/3 of all tree species. Ash (*Fraxinus excelsior)* (14%), oak (*Quercus iberica.*) (7 %) and *Crataegus microphylla* (5 %) are further species, which occur considerably often. In total, 16 species have been identified, 10 of which are tree species, and 6 are bush species (including *Crataegus microphylla* which is a species, representing an intermediate structural state between shrub and tree species).

Furthermore, the tree data has been used to calculate the distribution of species by strata.The change in species distribution for the individual strata is shown in Figure 11:.

Whereas changes concerning species composition within the dense forest and the open forest strata do not seem to be drastic, species composition within the dissolving forests changes completely. Whereas hornbeam species dominate dense and open forests to ¾ and 2/3 respectively, their occurrence drops to 43% in dissolving forests and several other species occupy the territory. In the dissolving forests, bush species such as *Crataegus macrophylla*, *Cornus mas,* and *Svida* australis occur to 25%, and there is a high proportion of *Quercus iberica,* and *Pyrus caucasica*, which is very rare elsewhere. Furthermore, species composition analysis on the basis of district and strata would illustrate the dynamic within the forest more specifically, but this is beyond the frame of this study. However, data to conduct such an analysis exist.

Figure 10: Species composition of trees ≥ 8cm DBH for the total sampling area and the individual strata.

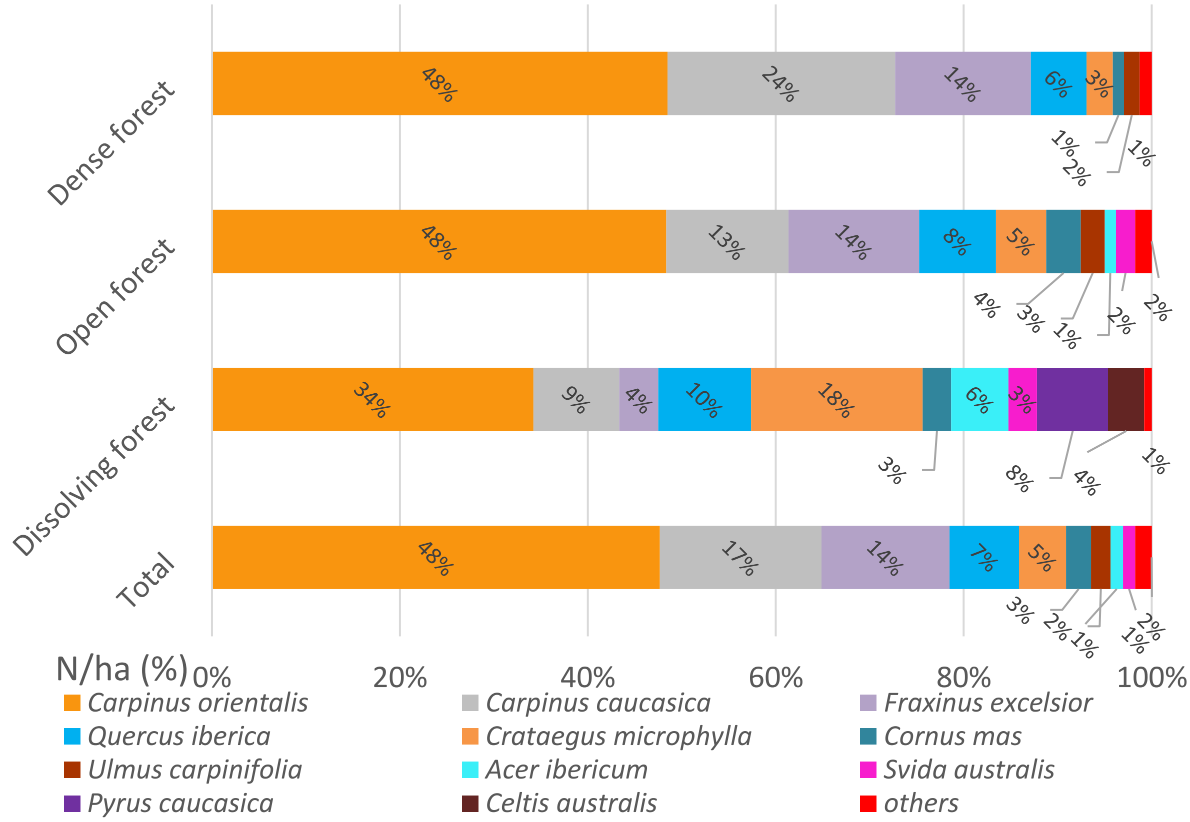
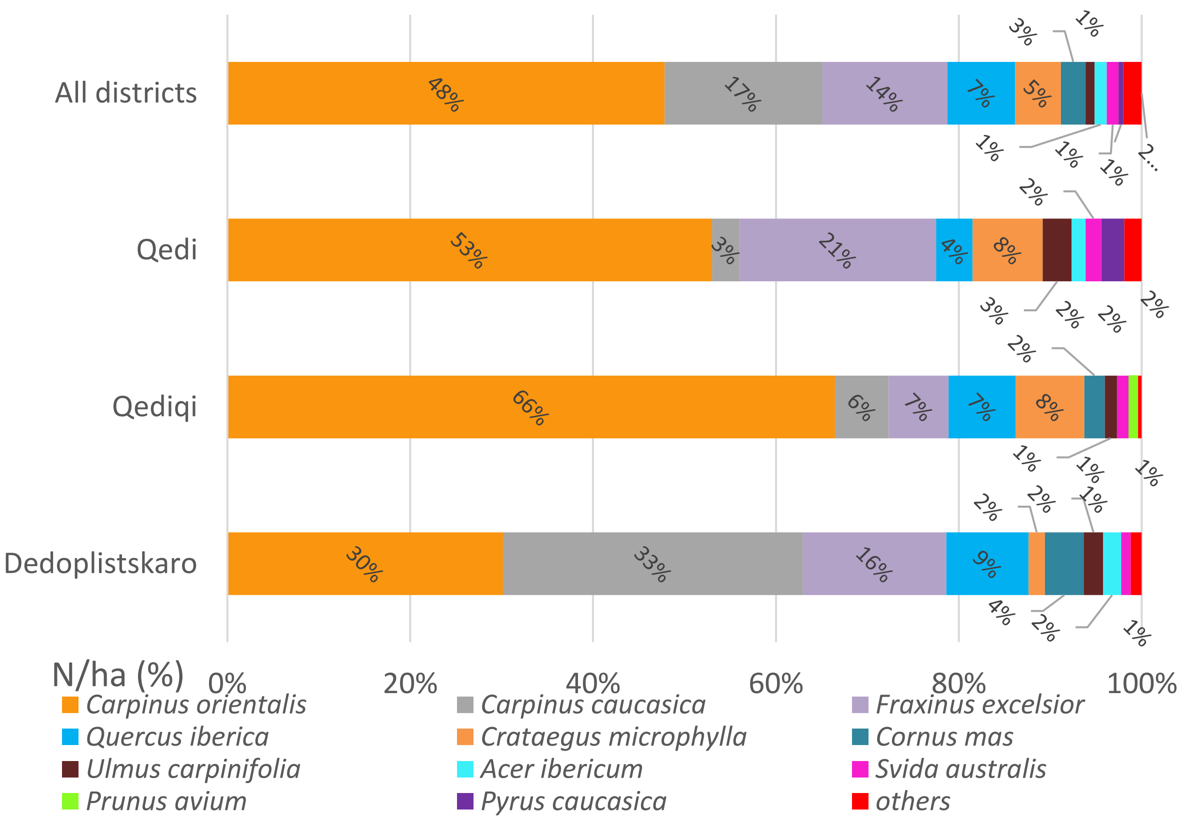


Figure 11: Species composition of trees ≥ 8cm DBH for the total sampling area and districts.



Important aspects in Dedoplistskaro satyeo:

- Carpinus spec. and Fraxinus excelsior dominate. Fraxinus is present above average.
- Quercus iberica, Acer iberica and Cornus mas occur in comparatively high proportions also.
- Very high proportion of C. caucasica and comparatively low proportion of C. orientalis.
- Some rarer species like e.g. Fraxinus oxycarpa, Prunus avium, Ulmus carpinifolia are present.

Important aspects in Qediqi satyeo:

- Hornbeam dominating the stands (>70% !).Highest proportion of Carpinus orientalis in all districts.
- Tree species reacting well to coppice cuts (Beside Carpinus orientalis e.g. Crataegus, Cornus mas) are significantly present.
- High proportion of oak and low proportion of ash.
- Many rarer tree species (Pyrus, Celtis, Pistacia, Juglans, Fraxinus oxycarpa, Runus avium, Eleagnus) occuring in Dedoplistskaro or/and Qedi are missing. All told, tree species composition seems more altered than in Dedoplistskaro.

Qedi:

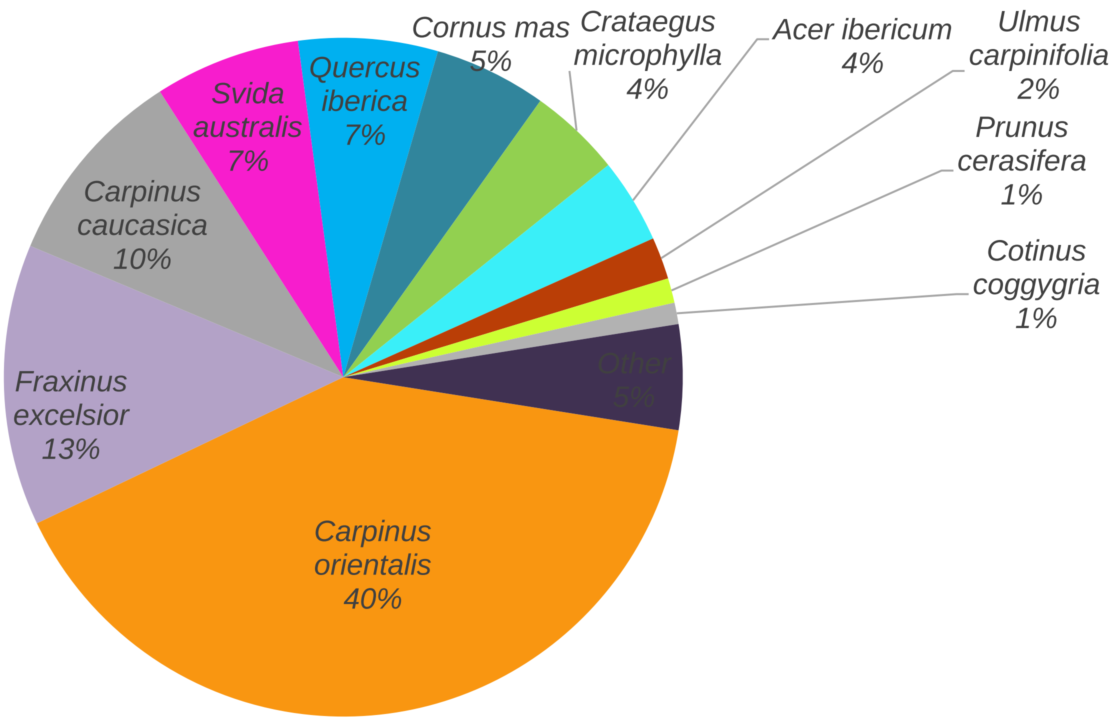
- Carpinus orientalis dominant;
- Drought-resistant species (Pistacia, Celtis, Crataegus) and fruit trees (Pyrus, Juglans) occur more often than average.
- Proportion of Fraxinus excelsior is very high. This species is comparatively good at re-colonising non-forest areas, which might be a reason for it.
- The same goes for Crataegus microphylla, as a species whose thorns prevent cows from browsing and men from cutting as long as alternatives are present.
- Proportion of Quercus iberica and Carpinus caucasica very low but species are still present.
- No cornel cherry in Qedi. It is ecologically probably replaced by Svida australis.

2.2.6 Regeneration

The analysis of the regeneration data shows a relatively high species richness with a total of 31 different bush and tree species in the Dedoplistskaro forest district.

This species richness also reflects the different situation within the different Satyeos of Dedoplistskaro, Qediqi and Qedi. Nevertheless, 90% of all regeneration is made up by 8 species (highlighted in yellow), also accounting for most of the standing stock.

Figure 12: Species composition - regeneration (N/ha of all regeneration plants)



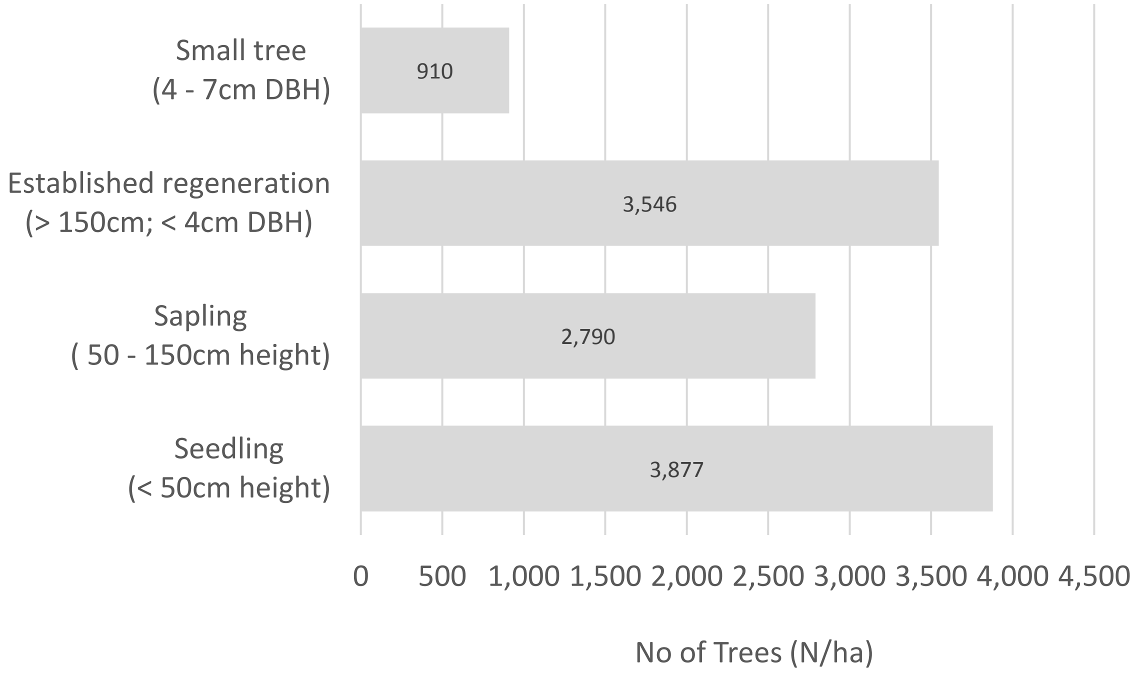
The following table (8) shows the names and proportions of all the species <1% of all regeneration. As before, *Palliurus spina-Christi* is not regarded as a forest plant. If so, it would have outnumbered even the *Carpinus orientalis*.

Table 8: Proportional part of total examined regeneration for forest plants

Species	Regeneration	Species	Regeneration
Carpinus orientalis	40.4%	*Berberis vulgaris*	0.3%
Fraxinus excelsior	13.4%	*Frangula alnus*	0.3%
Carpinus caucasica	9.6%	*Ostrya carpinifolia*	0.3%
Svida australis	6.9%	*Elaeagnus angustifolia*	0.3%
Quercus iberica	6.6%	*Malus orientalis*	0.3%
Cornus mas	5.4%	*Ficus colchica*	0.2%
Crataegus microphylla	4.4%	*Pyrus caucasica*	0.2%
Acer ibericum	4.0%	*Ulmus suberosa*	0.2%
Ulmus carpinifolia	2.0%	*Pistacia mutica*	0.1%
Prunus cerasifera	1.2%	*Ulmus glabra*	0.1%
Cotinus coggygria	1.0%	*Prunus cerasus*	0.1%
Rhamnus cathartica	0.5%	*Acacia dealbata*	<0.1%
Prunus avium	0.5%	*Punica granatum*	<0.1%
Rubus caesius	0.5%	*Corylus avellana*	<0.1%
Rosa canina	0.5%	*Celtis australis*	<0.1%
Mespilus germanica	0.5%	*Paliurus spina-christi*	Not counted here

Figure 13: and Figure 14: illustrate the number of living regenerating plants per hectare and regeneration class. In total, over all districts and strata, more than 11,000 regeneration plants are present per ha, and about 1,000 of them have a DBH of more than 4 cm[16]. Considering these average numbers, natural regeneration seems to be very much present in the Dedoplistskaro state forest. Of course this does not implies anything about quality of regeneration, browsing[17] , or other damages that might prevent these plants from becoming trees. The most dominant regenerating species in all regeneration classes is the *Carpinus orientalis* is, followed by *Fraxinus excelsior* and *Quercus iberica*.

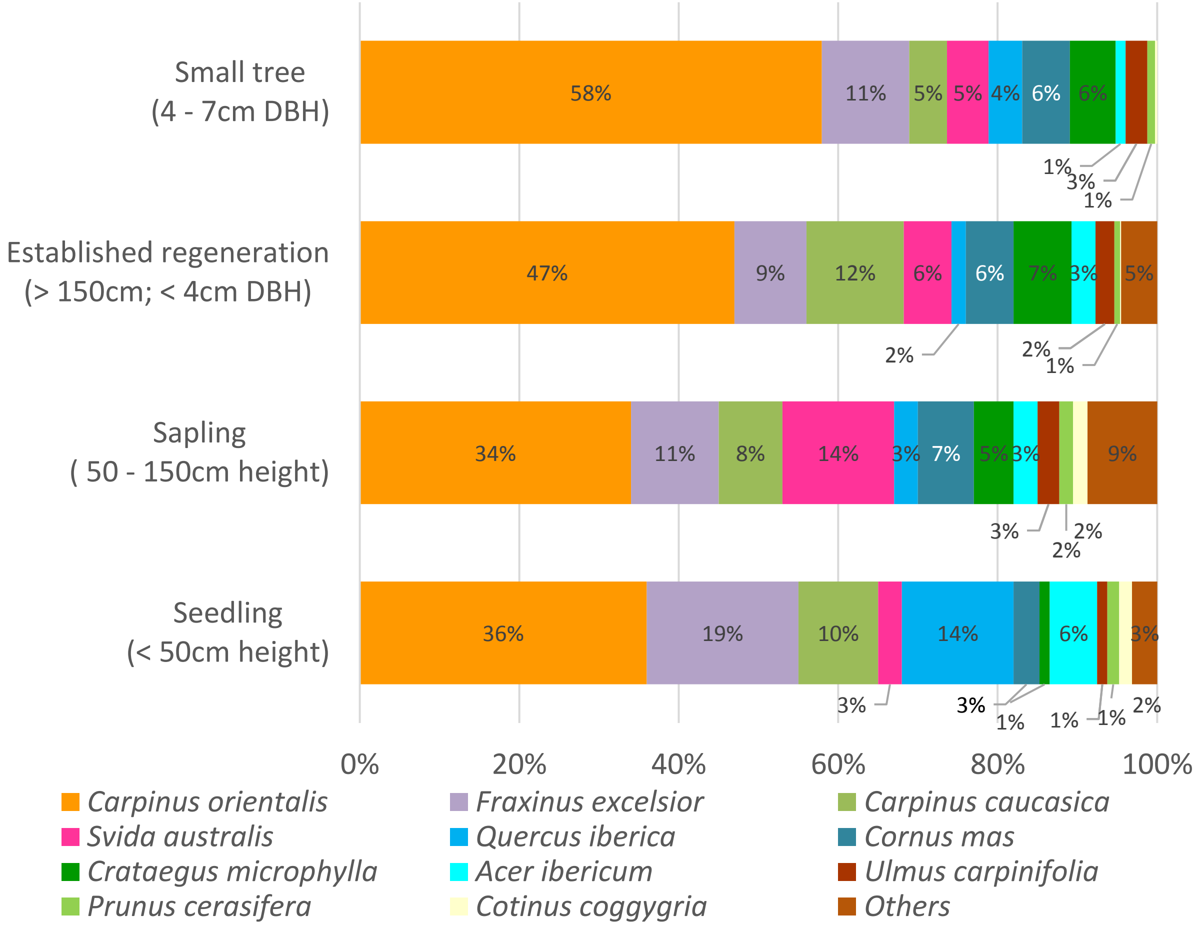
Figure 13: Regeneration numbers per regeneration class



[16] It is highly probable that in Qediqi, all regeneration of >150cm was classified as class 3 (>150cm and <4cm DBH) and class 4 (> 4cm DBH and < 8cm DBH) was not used at all. This systematic mistake needs to be taken into account for any interpretation. Here, it can be assumed, that the average number of trees > 4cm is even higher.

[17] Damages from browsing are not regarded here, as the browsing inventory results were of restricted value only. But it has to be emphasized that all accounted plants had to be alive at the moment of field inventory.

Figure 14: Tree species per regeneration (height) class [14]



In most of the strata, even in dissolving forests, regeneration is sufficiently present to mostly rely on natural regeneration for the purposes of rejuvenating forests and for replacing coppice shoots by trees from seed, as long as browsing can be controlled[18]. Also, relations between regeneration plants differ only slightly between the strata, but there is one important exception from both issues, the strata “Non-forest”:

Within the non-forest strata, only about 600 regeneration plants / ha can be found (see Figure 15: / 16). Moreover, most of them belong to bush species, especially *Svida australis*, a species representing more than 50% of all regeneration within the non-forest area. Trees exceeding 4cm DBH are practically nonexistent. At the same time, tree species are rare in all regeneration classes and represent only about 140 individuals / ha or about 6% of all regeneration in non-forest areas. If regeneration of natural forest is indeed a management goal for this strata, there are far too few plants to rely on natural regeneration within a short period of time. In this case, there is a need either for special protection of these few plants or for tackling reforestation by planting.

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[18] Unfortunately it is not possible to say much about this aspect, as the parameter wasn’t assessed precisely enough in field.

Figure 15: Regeneration numbers per height class in strata 4 - Non forest

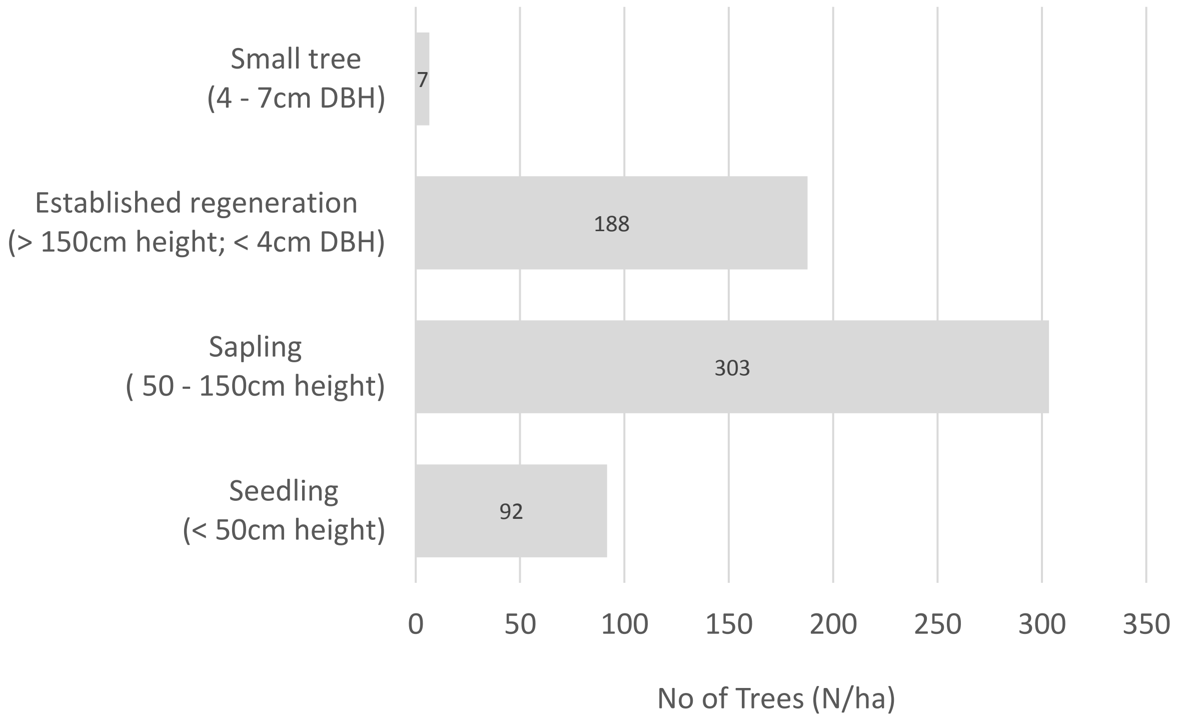
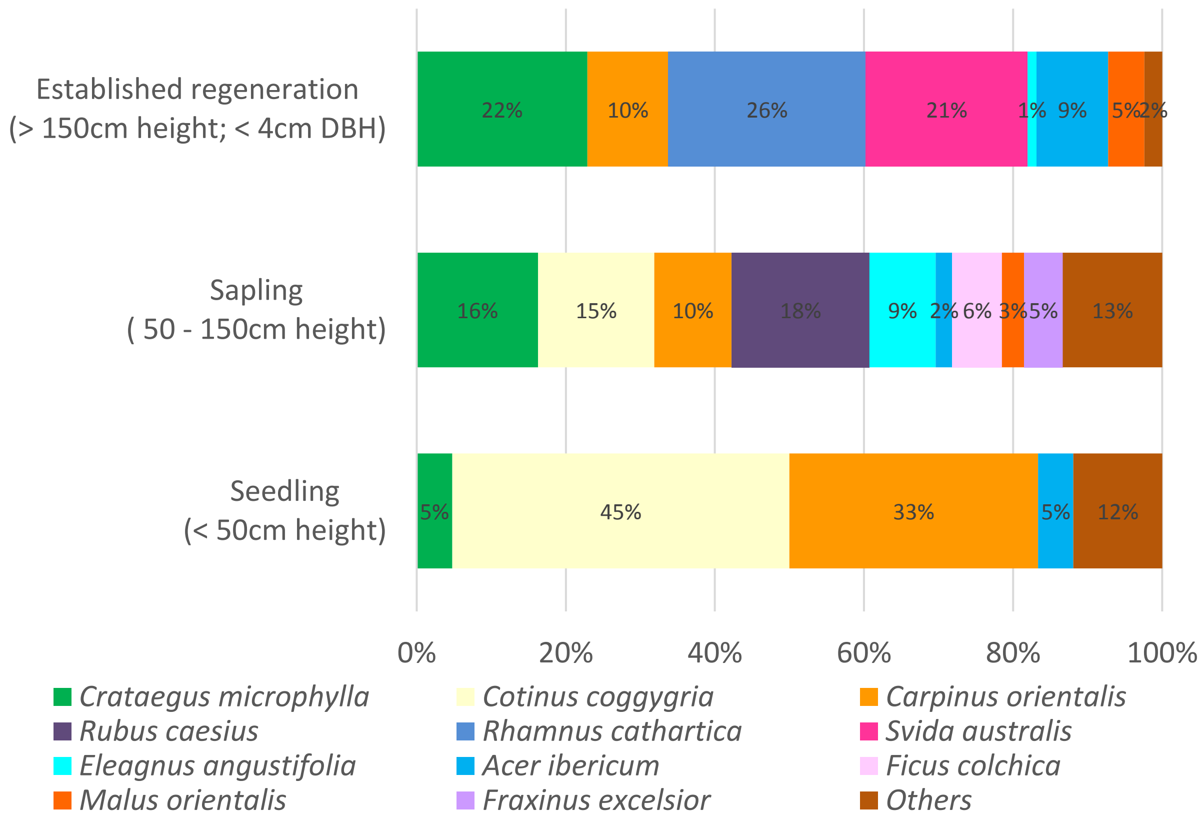


Figure 16: Proportion of species in regeneration per height class – Non forest stratum



2.3 Further results on point and plot level

2.3.1 Exposition aspect

Main exposition aspects in Dedoplistskaro are facing towards northern directions, as can be seen in Figure 17:. Northwest, North and Northeast expositions are those of 65% of all measured plots.

Northern expositions generally influence growth rates negatively due to a reduced intensity of sun radiation, and on the other hand it can have a positive influence on trees during periods of drought. An interesting aspect is that dense forest plots have a very strong tendency to occur in North-facing expositions.

Figure 17: Number of plots per exposition

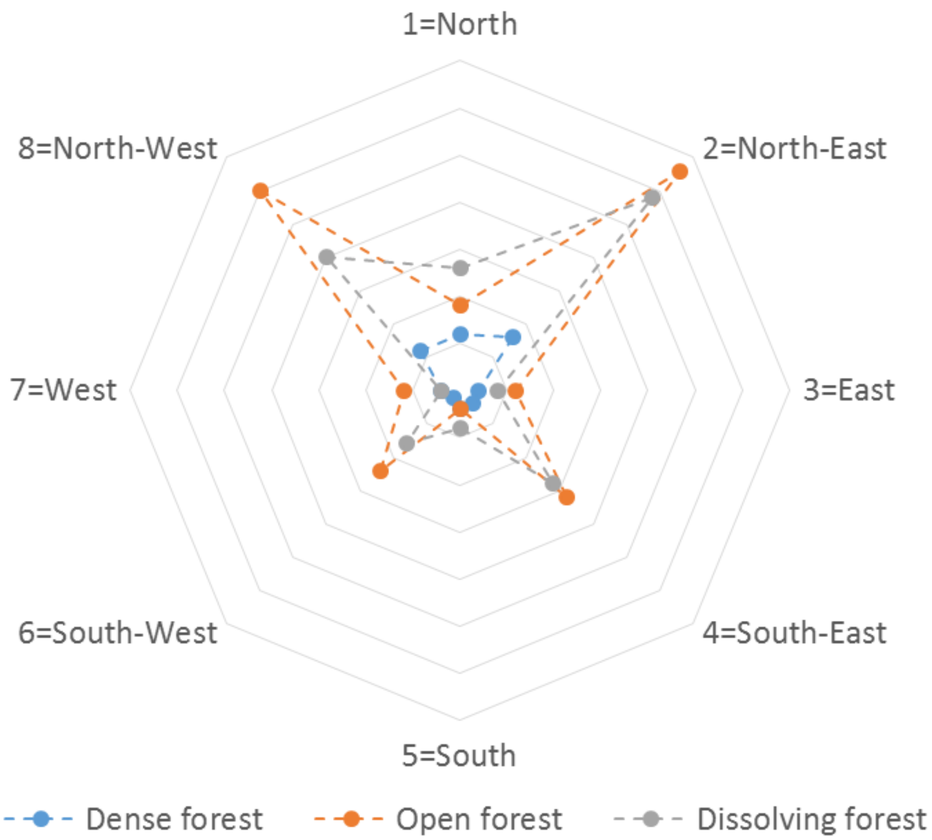


Table 9: No of plots in comparison to geographical exposition

	Dense forest	Open forest	Dissolving forest	Sum
1=North	6	9	13	28
2=North-East	8	33	29	70
3=East	2	6	4	12
4=South-East	2	16	14	32
5=South	2	2	4	8
6=South-West	1	12	8	21
7=West	2	6	2	10
8=North-West	6	30	20	56

2.3.2 Results on compartment ("qvartali") and district ("satyeo") level

Qvartalis (compartments) are sub-dividing the forest districts in units of about 100 ha. In the Georgian forest system, compartments are subdivided by stands ("litra"), sized between 1 and 30 ha. An assessment of standing stock is possible at Qvartali level, although the number of plots for interpretation is comparatively low and the standard error is comparatively high. It is very difficult on stand level, although orientation values can be derived from a synoptic view on strata and Qvartali results. The results concerning volumes and number of trees per Qvartali are shown in annex 6.2.

2.4 Inventory results on tree level

The future tree status of each tree has been collected during field inventory, allocating each tree as future tree, competitor, indifferent tree or damaged tree (see Figure 18:)[19]. The analysis of these variables shows that about half of the standing stock was considered to belong to a "future tree", and relatively few trees were considered to be "competitors". Although this is in line with the general findings of a very low tree number, the ratio of future tree volume to competitor volume (3:1) is unusually high and probably shifted somehow towards future trees (usual is 1-2:1 for young stands of deciduous trees). The ratio between tree numbers/ha is +/- the same than the ratio between volumes (in dense forest: 627 future trees/ha: 217 competitors/ha).

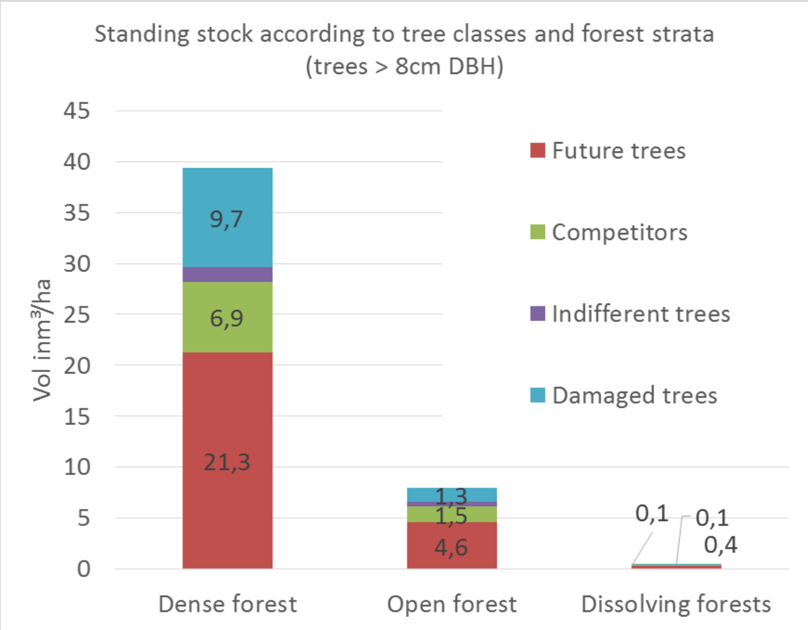
This data can – with all its weaknesses- be used to make a rough guess at possible harvest volumes from the existing forest strata without calculating increment rates. To do so, competitors, indifferent trees, and 66% of damaged trees have been considered as harvestable. Also, 33% of the damaged trees have been considered habitat trees which should be conserved, although the assessment of habitat trees is not entirely free of doubts.

This calculation reveals for the dense forest:

- 7m³/ha of existing competitors should be harvested to maintain future trees
- 6m³ of damaged trees, and 2m² of indifferent trees might be harvested if really necessary; in total, there is a possible harvest volume of about 15 m³/ha in dense forest.

[19] Results from supervision show, that this variable should be interpreted with care, as the supervision report states clearly „Thus, many trees have been classified differently concerning future trees, competitors, indifferent trees and harvestable / damaged trees. Thus, the evaluation of this variable can give a rough guess on harvestable volumes and number of competitors but it is of restricted value beyond that." The findings should thus be treated as an estimation. Nevertheless, it is one of few estimators present to appraise harvestable volume.

Figure 18: Standing stock per future tree status and strata



In open forest, the corresponding numbers are1.5 m³/ha of competitors and 1m³/ha of damaged /indifferent trees; about 2.5 m³/ha altogether; a very low number for serious harvest activity. With only 8m³/ha of standing stock and tree numbers of 392/ha (among them 213 future trees/ha), efforts should certainly concentrate on regenerating the forest and any use should be restricted as far as possible.

It can be clearly concluded that there is not enough standing stock left within the dissolving forest strata to talk about any harvest. In this sense, 45 trees/ha (among them 27 future trees/ha and 7 competitors/ha) are not enough to even allow for a decent canopy cover.

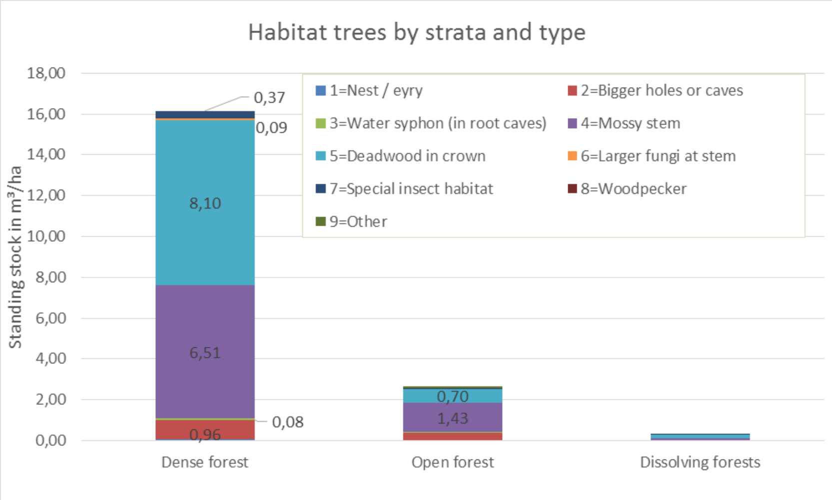
Habitat trees

Data concerning tree habitat has been collected during the field inventory - the following figure presents the corresponding results. Within strata 1, dense forest 16.2 m³/ha of standing stock belongs to trees of special ecological importance, which represents 41 % of the standing stock. Most of the habitat trees, however, qualify because of mossy stems or deadwood in crown. Furthermore, special insect habitat and bigger holes or caves have been registered commonly representing about 1.3 m³/ha.

Within the open forest, 2.6 m³/ha of standing stock belongs to trees of special ecological importance; this is 31% of the standing stock. Results according to habitat tree categories were roughly the same as in the dense forest with habitat trees being considerably rarer.

Within the dissolving forest, 0.3 m³ of standing stock belongs to trees of special ecological importance; this is equivalent to 50% of the standing stock.

Figure 19: Tree habitat results



2.5 Inventory results concerning red list tree/bush species

Table 10 shows the red list species documented during field inventory within all 5 m plots of Dedoplistskaro state forest. Nevertheless, the data does not provide a full view on red list species since documentation within the Dedoplistskaro district is missing. It is probable that there were no red list species assessed (other than the shrubs and trees assessed within the respective circles).[20]

With the exception of *Juniperus foetidus*, all species were additionally assessed at least once during the “normal” tree and / or regeneration inventory.

Table 10: Red list species found during inventory

Species	Number of documented individuals
Celtis australis	4
Ulmus carpinifolia	91
Ulmus glabra	1
Crataegus microphylla	15
Pyrus caucasica	8
Juniperus foetidissima	29
Ostrya carpinifolia	12
Acer ibericum	3
Sum	**163**

[20] The results vary a lot according to species knowledge and accuracy. When conducting field tests, some of the groups correctly determined red list species on their own (Juniperus, Pistacia mutica, although the latter was outside the respective circle and it was not noted). Therefore, there was a basic knowledge of species, but it was not clear whether this was the case for all the teams. The results on red list species can be considered as a guide to determine which red list species are often present, but it does not represent a certain list of all red list species, nor to cover ground vegetation species or species very difficult to determine.

2.6 Inventory results concerning Non timber forest products (NTFP)

Table 11 illustrates all NTFP wooden species documented by the inventory teams within all 5m inventory circles. The results show that numbers per hectare are comparatively high for some species. Mostly fruit bearing shrubs and trees have been counted. The fruits are partly used for eating, partly as medicine. Some fruits are also sold at the roadside (*Cornus mas*). Some species, like *Punica granatum* and *Berberis vulgaris* prefer open spaces (strata dissolving forest, non-forest), whereas the more common ones (*Svida australis, Cornus mas, Rosa canina, Crataegus*) are indifferent or prefer open to dense forest.

All of these species were also part of the "normal" assessment of trees and regeneration. Therefore, their occurrence does not represent new information. Data on new species, e.g. ground vegetation species was not collected. Additionally, it was unclear whether ground vegetation had to be assessed at all. According to the inventory handbook, NTFP species should have been selected from a pre-defined list that was not devised.

It can be concluded that occurrence and density of species whose products might be used as NTFP is high. However, whether the occurrence is of any real importance cannot be assessed by inventory but only by survey techniques with locals.

Table 11: NTFP species found during inventory. [red] = absence of the respective species [yellow] = limited occurrence of respective species within strata [green] = normal or high density of respective species

	Number/ha in dense forest	Number/ha in open forest	Number/ha in dissolving forest	Number/ha in Non forest area
Celtis australis	0	5	0	2
Prunus avium	0	2	0	0
Crataegus microphylla	105	291	241	125
Rubus caesius	70	157	4	0
Pyrus caucasica	0	4	13	9
Rosa canina	147	107	63	163
Mespilus germanica	63	7	39	0
Punica granatum	0	0	0	14
Berberis vulgaris	0	0	30	42
Svida australis	49	146	196	0
Cornus mas	818	689	498	0

2.7 Increment

In October and November 2016 an increment analysis was conducted in Dedoplistskaro using 102 tree core samples. From these, 60 samples could be attributed to trees measured during inventory. Growth level of these samples was unexpectedly low with year rings averaging 0.7 mm and diameter increment averaging 1.4 mm per year. Some influences considered important at first (such as DBH, or status as coppice or non- coppice tree) had no apparent influence in this case[21]. The results of coppice and seed trees were both averaging 1.4 mm diameter increment per year. This growth level is far lower than the increment expected by the experts, and it certainly reflects the difficult climatic conditions for trees in the Dedoplistskaro.

There were limited differences between districts, with the Dedoplistskaro district averaging 0.15 mm/year diameter increment, Qediqi averaging 0.13 mm/year, and Qedi averaging 0.12 mm/year. However, it is possible to determine increment differences by analyzing different species. In this sense, bush species average diameter growth was of 10 mm per year, whereas most tree species average 0.14 mm per year. Differences between strata could not be assessed, due to a lack of enough core samples from dissolving forests (see table 12).

Figure 20: demonstrates diameter growth in relation to the DBH. All other increment data, especially increment per species can be found in annex, chapter 6.4. However, as the amount of data per species is quite low, these results might show a certain trend but are still doubtable. Acer and Celtis for example might be capable of higher growth rates but sample number is far too low to know with n = 2, respectively.

Figure 20: Diameter growth in relation to DBH of sample trees from all species

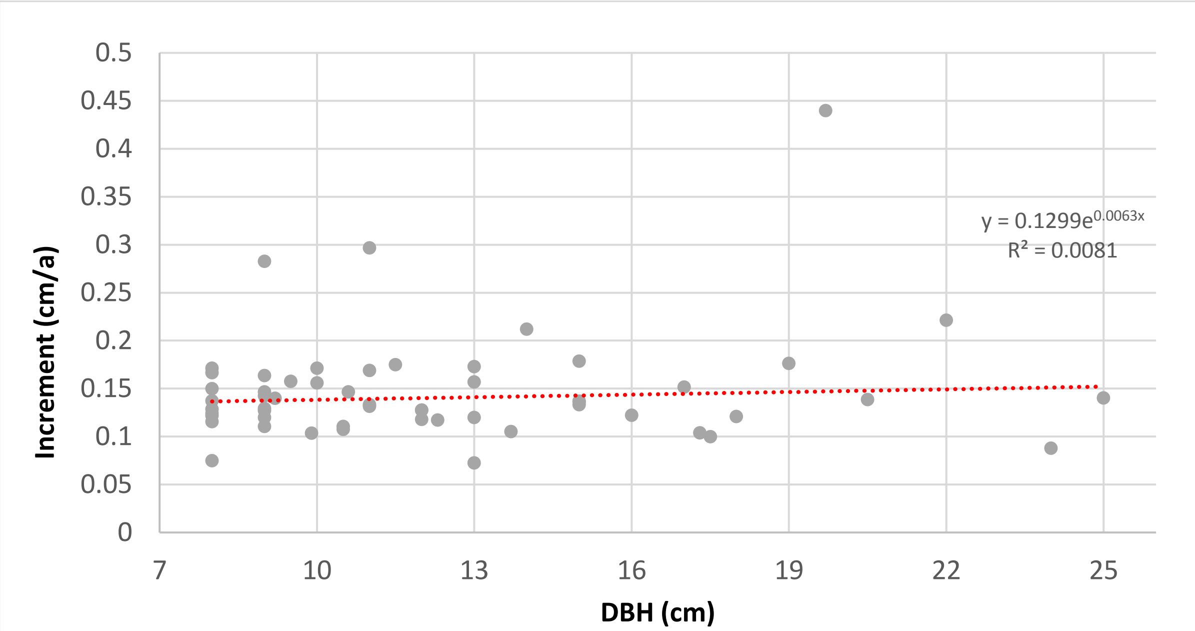


Table 12: Number of increment samples per district and strata

	Dense forest	Open forest	Dissolving forest	Sum
Dedoplistskaro	24	16	1	41
Qediqi	4	9		13
Qedi	2	2		4

[21] Some doubts remain on whether the tree classes have always been correctly assessed. Since in 12 out of 13 controlled plots, this was done "in large parts correctly", it can be concluded that the influence on this analysis is probably small.

Total	30	27	1	58

Using the diameter increment data from this recent study, the per-hectare value for growth (volume increment per year) could be calculated (resp. estimated). This was done for each strata separately. The calculation is based on the following assumptions:

- Every tree > 8cm DBH sampled is capable of an average diameter growth of 0.14 cm per year.
- Height growth of trees > 8cm has been estimated in a conservative manner with 30 cm/year.
- For small trees >4cm DBH, that were part of regeneration assessment, it has been estimated that they are capable of 10 mm diameter growth per year (less than older trees) and a height growth of 50cm (as height growth of very young trees is generally higher than that of older trees).
- Increment of trees in dissolving forest and Non-forest strata is the same as in dense or open forest (which is an optimistic assumption).

Table 13: Estimated Volume Growth per strata in m³/ha/year

Districts	Dense forest	Open forest	Dissolving forest	Non-forest	All strata
Increment of trees > 8cm DBH (m³/ha/yr)	2.16	0.56	0.05	0.00	
Increment of regeneration >4cm DBH (m³/ha/yr)	0.32	0.75	1.00	0.21	
Sum of increment (m³/ha/yr)	**2.48**	**1.30**	**1.05**	**0.21**	
Represented area	**1,068**	**4,188**	**3,400**	**3,143**	**11,800**
Estimated increment	**2,650**	**5,440**	**3,570**	**660**	**12,323**

Conclusions from increment inventory

Considering these results, it seems that the general deterioration of the forest eco-system has come to a point where the rates of increment are considerably lower in all forest strata outside the remaining “dense forest” patches.

Only in dense forest, a part of tree increment can be considered as harvestable without generating grave concerns. This means that the priority for all other strata has to be the recovery of the forest, in order to get back to a point where increment and thus the process of recovery takes place at a normal pace.

This means that also in open forest strata there should be no harvest. If exceptions are made due to local and insofar political reasons (e.g. because of high demand and no alternatives), a sustainability approach should be followed. In this sense, harvest should always be less than the volume growth of 1.3m³/ha and year.

In Dissolving forests and Non- forest areas, harvest should not take place under any circumstances. At least as long as regeneration, and non-conversion into agricultural use, is the desired policy. The necessity for replantation activities has already been described.

2.8 Mapping of results

All inventory results are visualized in a qgis online application which is located under the flowing link:

http://qgiscloud.com/AWeinreich/FI_Study_GIS_web_2

3. NFA State Forest Management Concept Dedoplistskaro

3.1 Situation analysis

In general, the inventory results reveal that the Dedoplistskaro state forest is in an ecological severe situation. More than 25% of the forest area has already been transformed into non-forest. Open and dissolving forests represent about 66% of the area and show respectively strong to severe signs of degradation. Only about 10% of the forest area can be considered dense forest with a mean volume stock of about 40 m³/ha. However, even this type of forest shows signs of human interference in the past.

The main drivers of degradation are influenced by cattle management and fire-wood harvesting. So far, it was assumed that the main driver of degradation are private households that use fire-wood for heating their homes in the winter season. However, it appears that unofficial fire-wood harvesting brigades are organized mainly by regional private bakeries who are forced or who prefer heating their bakery ovens with cheap fire-wood instead of more expensive gas. Although large parts of all fire-wood harvesting activities seem to be unofficial, forest roads are surprisingly well developed and a good system of forest and secondary-forest road exists. Local knowledge of the forest area concerning roads, use of chain saw, and wood transportation can be regarded as very high. Furthermore, near urban or village infrastructure, there is a high cattle grazing pressure.

Taking into consideration

(1) the current ecological situation of the Dedoplistskaro forest, consisting in its majority of highly degraded coppice forests,

(2) the social demand for firewood and grazing areas, and

(3) the opinion of the main local, regional and national stakeholders concerning the future management of the Dedoplistskaro forest,

it is necessary to elaborate a technical, social, institutional and financial forest rehabilitation concept on a long term basis for the Dedoplistskaro forest area. Concerning the technical part, this rehabilitation concept should be based upon a silvicultural concept to transform the existing degraded forest of mainly coppice sprouts into a forest consisting of out-of-seed grown trees. This way the forest can transform within the next decades into a vital close to nature structure.

The following chapter illustrates a first concept proposal on the basis of the inventory results and the lessons learnt from all project activities. This concept should not be regarded as a blue print approach but as a discussion basis for a participatory project follow-up in order to decide on the future management objectives and their implementation. Generally, the average annual precipitation in the western part (Qediqi and Dedoplistskaro) is sufficient for forest growth and sustainable forest management, even if an extension of the drought period could have negative impacts on forest growth. The soils have a good nutrient supply (lime soils) and the water storage capacity should be enough to bridge a drying period of a few weeks (Grüneklee, Working Papers – 43/2012).

3.2 Vision and objectives

Illegal harvesting practices and cattle grazing have led to severe ecological damages, a loss of forest cover and severe degradation of the Dedoplistskaro NFA state forests. Thus, the vision concerning this forest area is **rehabilitating the forest ecosystem within the next 50 years.**

The objective of the management concept is twofold and includes (1) a **sustainable socio-economic coppice-forest management** concept and (2) an **adapted, spatially arranged cattle-management** concept within the next decade. Through these interventions, the heavily degraded forests are (1) to be used sustainably for fire-wood harvesting and converted into productive high forest on the long run and (2) the already existing non-forest areas are to be used (a) partly in a structured way for cattle farming and (b) partly to permit forest regeneration in order to be transformed gradually into natural forest in the medium to long term.

3.3 Approach / General concept idea

To make the mentioned vision come true, and to reach the mentioned objectives, the following approach should be followed:

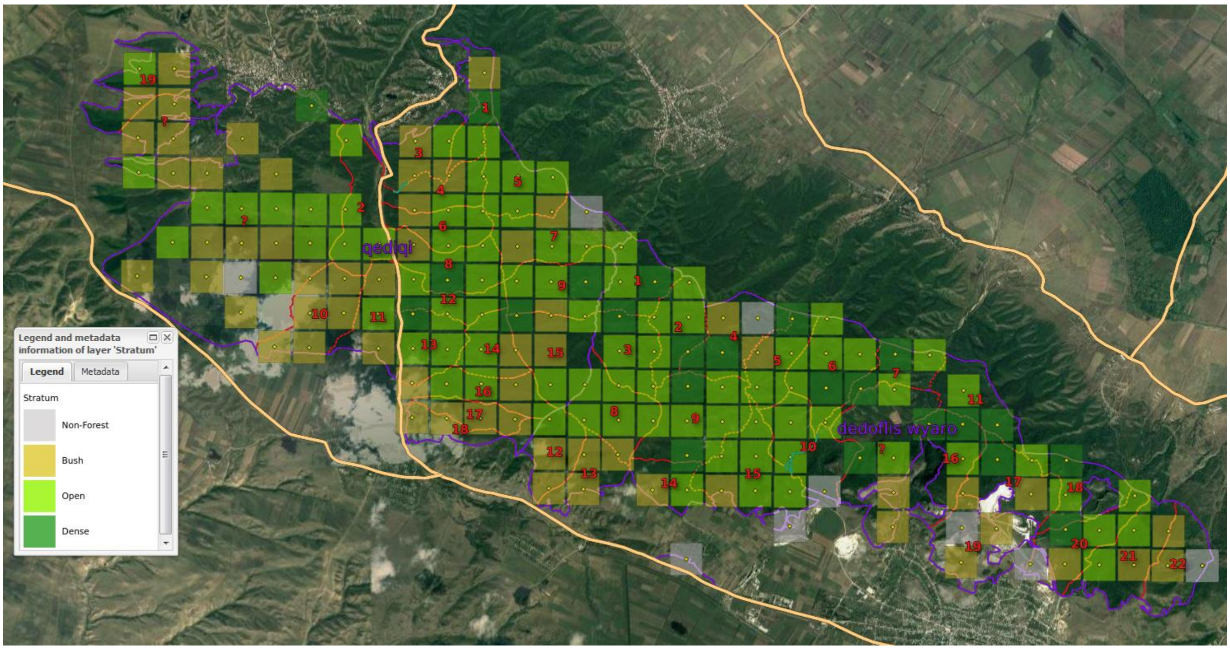
1. to zone forest and non-forest areas according to functions, thus, to define forest functions within the forest area, as
    a. Production forest areas
    b. Rehabilitation forest areas
    c. Grazing areas
2. to distinguish between two main production purposes
    a. fire-wood harvesting and,
    b. cattle farming
3. to ensure participation of all stakeholders concerning management planning and use, this implies:
    a. to assign middle term fire-wood harvesting licenses for the local population within production forest area under new performance based conditions
    b. to protect forest rehabilitation areas, prevent fire wood-harvesting, cattle grazing or other forest uses
    c. to assign middle term grazing licenses to local population within parts of non-forest areas under performance based conditions
4. to ensure public respect, as well as institutional and personal capacities concerning concept / license management and state control.

3.3.1 Zoning

On the basis of the inventory results, we propose the following general zoning concept. However, this concept does not yet allow for a detailed planning on sub-quartile or litter level. This kind of planning has to be carried out in a second step which is described below.

The following two images visualize the four different strata which have been defined due to inventory results in the two forest blocks: dense forest, open forest, bushland and non-forest.

Figure 21: Strata for Dedoplistskaro and Qediqui district



Zoning of Qediqi district

Qediqi district -situated in the very west of the NFA state forest area- is divided by a north-south road in two parts. As the western part, Qediqi is classified as bushland / dissolving forest (66%) and open forest (33%), and it can be mainly considered as a regenerating forest. In order to increase the standing volume, we propose to zone this part as Forest rehabilitation area, without any use for the next decade. The east part of Qediqi, however, is generally in better conditions (55 % open forest, 10 % dense forest, 35 % bushland), allowing for fire-wood harvesting in parts. Consequently, we propose to zone this part as production forest. No grazing areas are foreseen for Qediqi.

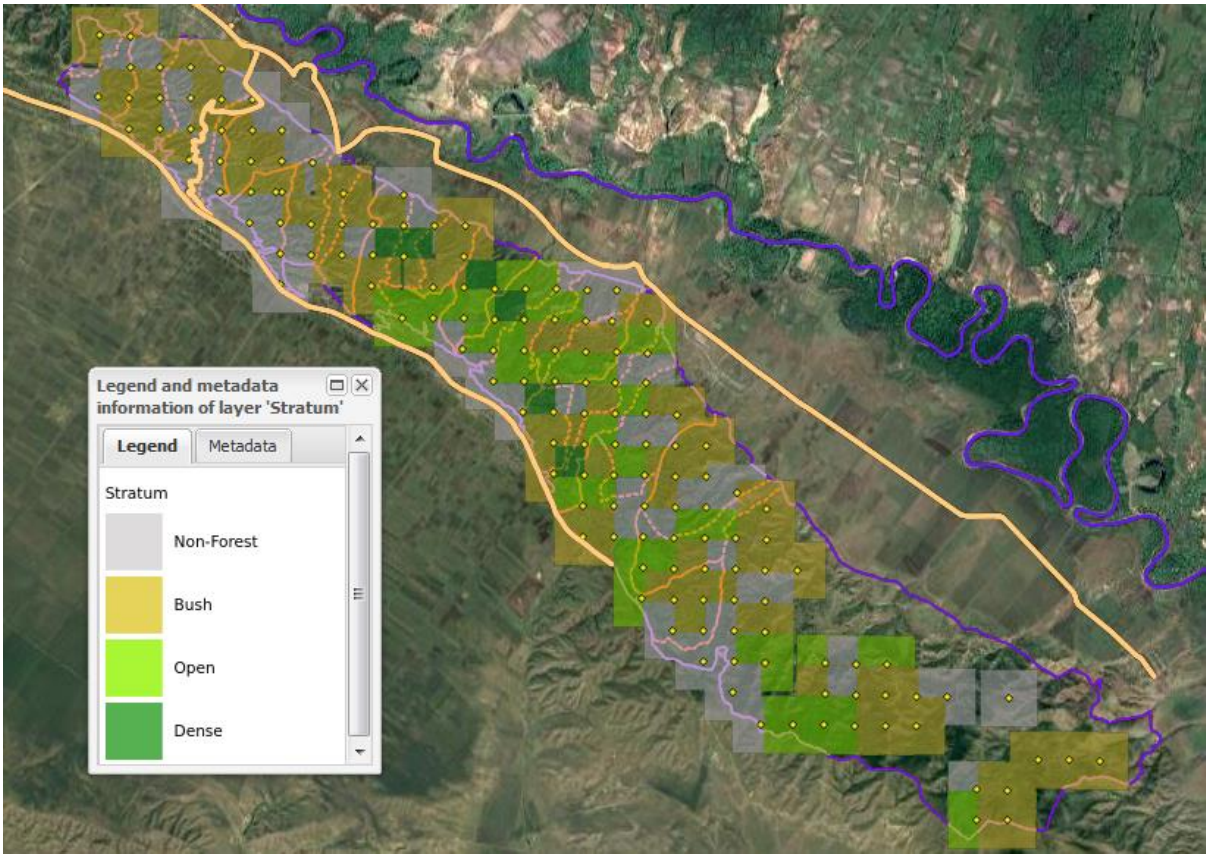
Zoning of Dedoplistskaro district

Dedoplistskaro district is the district with the most standing timber volume. It is characterized mainly by dense and open forest strata which are situated in the northern parts. Bushland / and non-forest areas dominate the southern parts, located in a narrow stripe directly next to the urban areas and villages of Dedoplistskaro. We propose to zone the buffer zone next to urban areas and villages as Forest rehabilitation areas and to zone the main northern part as production forest. No grazing areas are foreseen for Dedoplistskaro.

Zoning of Qedi district

According to the forest inventory results, Qedi is the most degraded district of the NFA state forest area. It is characterized by bushland and non-forest areas. Only minor parts of open forest or dense forest remain. We propose to consider Qedi district mainly as forest rehabilitation area. Additionally, we propose to establish grazing areas in the southern buffer zone area parallel to the main road, and in parts inside the Qedi district directly next to secondary roads.

Figure 22: Strata for Qedi district



The following maps visualize the above mentioned zoning proposal for the two main forest blocks, (1) Dedoplistskaro and Qediqi and (2) Qedi district. These maps can be seen and individualized under the following qgis online application link:

http://qgiscloud.com/AWeinreich/FI_Study_GIS_web_2

Figure 23: Proposed zoning for Dedoplistskaro and Qediqi districts

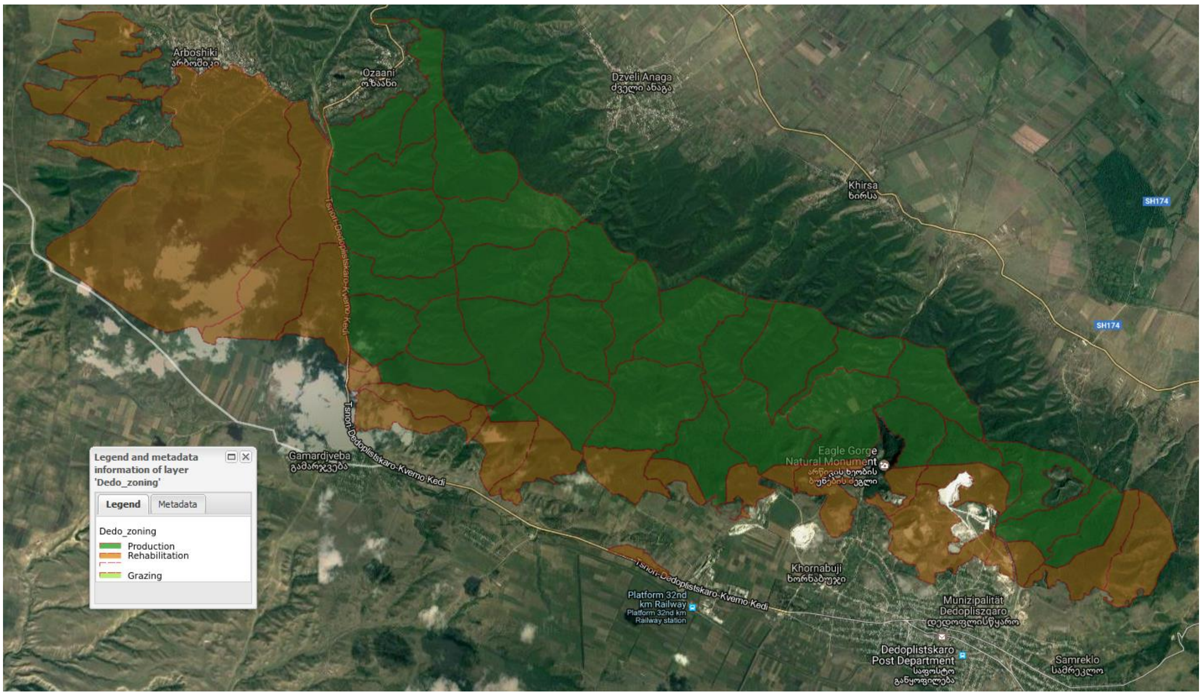
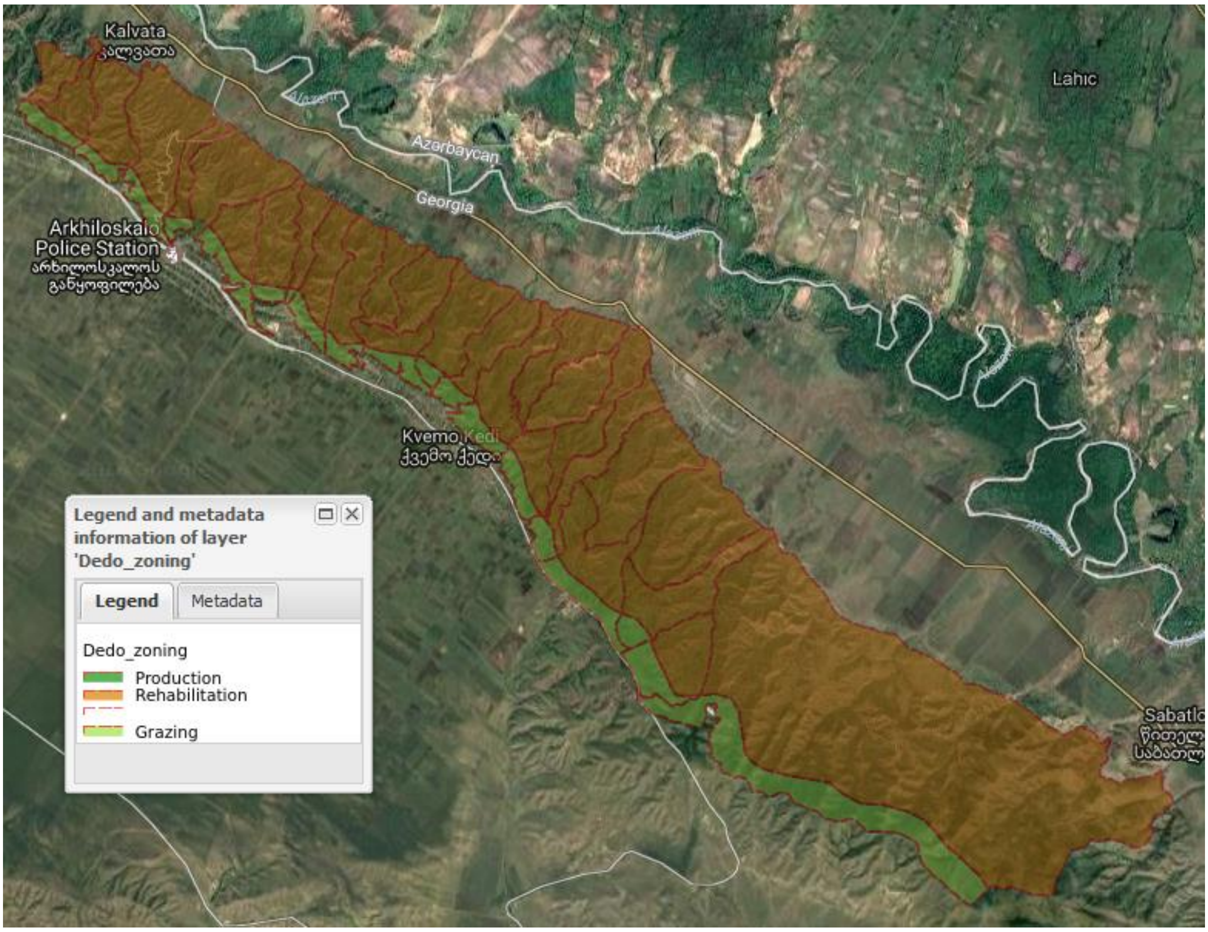


Figure 24: Proposed zoning for Qedi district



Regarding the zoning proposal, a total of about 4,000 ha should be used as future fire-wood production forest, about 9,400 ha as forest rehabilitation area without any human interference, and about 1,000 ha as grazing-land. The following table illustrates the proposed zoning areas per forest block.

Table 14: Zoning areas forest block 1 (Dedoplistskaro and Qediqi)

	Block 1 (Dedo./Qediqi)	Block 2 (Qedi)	Total
Production forest	3,990 ha	-	3,990 ha
Rehabilitation area	3,042 ha	6,351 ha	9,393 ha
Grazing area	-	1,008 ha	1,008 ha
Total	7,032 ha	7,359 ha	14,391 ha

3.3.2 Production forest

Within the production forest, we propose to establish a socio-economic coppice-forest management concept to allow structured and sustainable fire-wood harvesting. The concept should be based on the following structure:

1. Identification, documentation and registration of production litters (dense forest or highly stocked open forest).
2. Grouping of litters in sizes allowing for 10 sub-plots (yearly harvesting plots) with a yearly harvest of about 15 m³ of firewood each[22]. This corresponds in dense forest to litters of roughly 10 ha with 10 x 1 ha plots.
3. Assignment of medium term fire-wood harvesting licenses to registered individuals (local population) on litter level valid for 10 years. This implies:
    a. Provide training of fire-wood harvesting practices and rules for license holders (see below).
    b. Carry out individual participatory stand descriptions with each license holder in year 0, including a documented transect analysis; evaluating the relation of coppice trees to seed grown trees, the amount of secured regeneration, and number of single trees (no-coppice-trees) > 8 cm.
    c. Carry out yearly participatory monitoring stand descriptions with license holder.
4. Introduce a performance based payment scheme. The yearly payment to NFA should depend on forest development and forest restauration processes which will be influenced by applying the proposed fire-wood harvesting practices and rules – thus, it is necessary to monitor the license areas in regard to illegal logging. We propose the following payment scheme:
    a. Yearly payment base: 150, - Lari / year as initial deposit.
    b. Yearly payment reduction of up to 80 % depending the development of each individual license area.
    c. The stand description and transaction analysis of year 0 serves as reference for forest development / payment reduction. Parameters to be monitored are

[22] Inventory results of the present study and from Grüneklee, 2012, conclude independently from each other a harvesting volume of 15 m²/ha within dense forest at a 10 year cycle. This calculation refers to harvestable tress only and does not include yearly increment.

forest cover of litter, relation of seed grown trees to coppice trees and number of secured regeneration of timber species.

Fire-wood harvesting practices and rules (sub-litter mosaic approach)

The following management rules concern only the main management aspects for Dedoplistskaro. General rules concerning the handling of chainsaws, environmental aspects, ergonomics, safety aspects, etc. are not explicitly mentioned in this chapter. Nevertheless, these general forest management aspects are to be communicated and trained as well.

The main harvesting practices proposed for the production forests of Dedoplistskaro are the following:

- **Seed grown tree stimulation:** It is strictly forbidden to harvest seed grown trees. All harvesting activities are meant to stimulate the growth of seed grown trees (non-coppice trees)
- **Ground level cut:** All harvesting cuts have to be at ground level, thus within the first 10 cm from soil level.
- **Removal cuts of old stumps and coppices:** Harvest all old stumps of diameter > 20 cm and all their coppice shoots.
- **All or nothing coppice cuts:** If coppice trees are cut, then all coppice shoots at ground level are cut as well (all or nothing).
- **Single seed grown tree stimulation:** Stimulate secured regeneration of single trees (tree height > 1.5 m) by cutting those coppice trees shading the single regenerating tree (especially oak).
- **Regeneration cones:** Stimulate seed grown regeneration by clear cutting on ground level pure coppice tree stands in circles of up to 7 meters diameter.
- **Secondary forest roads:** The installation of secondary forest roads to the license areas is permitted. Secondary roads should have a medium distance of 50 m and should not exceed an inclination of 15°.
- **No grazing:** In case of signs of grazing or trampling in the forest production zone, immediately inform the forest ranger and game owner.

3.3.3 Rehabilitation forest

Forest rehabilitation zones should be protected against any human influence for the next decade / decades. Especially illegal harvesting and cattle grazing should be eliminated in these areas. This implies the following management activities:

- To block all forest entrance roads to these areas with rocks, bars or barriers.
- To carry out weekly to monthly monitoring patrols in these areas.
- To penalize and ticket illegally operating persons within these areas.
- To consider planting activities in areas where no natural regeneration exists.

3.3.4 Grazing areas

Parallel to the fire-wood harvesting concept, we propose a similar approach for grazing areas. Within parts of the non-forest areas we propose to establish a structured, spatially arranged socio-economic cattle farming concept to allow local people legal access to grazing areas. A possible grazing management concept could have the following structure:

1. Identification, documentation and registration of litters of non-forest areas
2. Grouping of litters in sizes between 10 to 20 ha
3. Assignment of medium term grazing licenses to registered individuals (local residents) on litter level valid for 10 years.
    a. Provide training of grazing practices and rules for license holders (see below).
    b. Carry out individual participatory site descriptions of grazing areas and bordering bushland together with each license holder in year 0.
    c. Carry out yearly participatory monitoring including site descriptions with license holder.
4. Introduce a performance based payment scheme. The yearly payment to NFA should depend on forest development of bordering stands which will be influenced by applying the proposed grazing practices and rules as well as monitoring the license areas concerning unauthorized cattle grazing. We propose the following payment scheme:
    a. Yearly payment base: 150,- Lari / year as initial deposit.
    b. Yearly payment reduction of up to 80 % depending the development of each individual license area.
    c. The site description of license area and neighboring sites of year 0 should serve as reference for payment reduction. Parameters to be monitored are forest cover and secured regeneration of neighboring sites.

Cattle management practices and rules

The elaboration of cattle management practices and rules should be based on the introduction of fencing techniques. This must be a participatory process evaluating the social acceptance and feasibility of introducing electric fences, wired fences, barbed wire fences, or fences made from shrubs and bushes.

Regardless of the chosen technique, mechanisms to impede the movement of cattle outside grazing areas need to be installed, and forests and grazing land are to be separated.

3.4 Institutional and financial implications

The following chapter concerns only the management of Production forests and Forest rehabilitation areas. The institutional setting and financial needs for the grazing concept have to be elaborated separately. Furthermore, the present concept paper is too young for elaborating detailed cost implications. The following considerations, however, give a rough estimate of what kind of workforce and financial input would be needed to put this concept in place.

On the basis of the inventory results, we suggest to assign about 140 fire-wood harvesting licenses, based on the following calculation:

- Dense forest represents within the production forest zone about 925 ha, which in theory allows to assign about 90 licenses with a medium size of 10 ha which will provide harvesting volumes of 15 m³ / ha within 10 year. This sums up to 13,500 m³ within 10 years or 1,350 m³ per year.

- Open forests represent about 3,065 ha which in theory allows to assign 50 licenses with a medium size of 60 ha, which will provide harvesting volumes of about 2.5 m³ / ha within 10 year. This sums up to 1,250 m³ within 10 years or 125 m³/ year.

On the following page we present an estimation of the necessary workforce for this concept. Assuming an average of 200 working days / year and person, this concept could be carried out with a team of 6 trained personnel. Ideally the NFA management team should be structured as follows:

- 1 GIS mapping expert (team-leader / forester) – responsible for the overall management, communication, cooperation, participatory approaches, mapping and monitoring.
- 4 rangers – responsible for demarcation, field monitoring and patrolling
- 1 license and payment administrator – responsible for tendering and awarding licenses, license administration and invoicing

This team structure implies one central office with working, administration, and computing space and equipment. Ideally the team could count on 5 vehicles or motor bikes, and access to tractors or heavy machinery in order to be able to block forest entrance roads.

Efforts for forest rehabilitation are not included here and would need to be calculated separately.

Table 15: Estimation of needed work force input for realizing the concept for Production forests, Forest rehabilitation areas and Forest reserves

	Activity	**Amount**	**Man days**	**Total man days**
Year 0	Presentation, discussion and adjustment of management concept (participatory approach with main stakeholders)	1	200	200
	Identification and demarcation of license areas / litters in field	140	1	140
	Digital mapping of license areas / litters	140	1	140
	Tendering and awarding of licenses	140	1	140
	Administration of field data and licenses	140	1	140
	Participatory stand description and transect analysis	140	1	140
	Training of fire-wood harvesting practices and rules	35	1	35
	Blocking of forest entrance roads outside production forest area	50	1	50
	TOTAL			985

	Activity	**Amount**	**Man days**	**Total man days**
Following years	Yearly field monitoring of license areas including individual follow up training	140	1	140
	Calculation of reduction factors and invoicing	140	1	140
	Administration and update of field data and licenses	140	1	140

	Frequent monitoring patrols including penalizing and ticketing illegally operating persons	800	1	800
	TOTAL			1,220

3.5 Shortcomings

The technical part of the concept should be based on precise and reliable increment rates. Knowledge about tree volume increment rates for the Dedoplistskaro region are indispensable for elaborating a sustainable forest management concept. However, only few information is available concerning increment rates. According to the local population, the NFA state forest was a broad-leaved high-forest by 1990. Tree ring counts by Wolfgang Grüneklee conducted in 2012 confirm a diameter increment of 4-5 mm/year which is in line with the statement of the local population and own observations. However, results obtained from a recently conducted increment measurement study in Dedoplistskaro, with 102 tree core samples of all three districts reveal a lower average diameter increment of 1.4 mm/year. Thus, about 3 times less than stated by Grüneklee. Details of this calculation were given in chapter 2.7 for 60 trees which could be attributed directly to the single trees of the inventory. This calculation can certainly serve as a basis for defining the bottom-line of increment. The difference in increment estimation might have occurred due to methodology (counts by the tree core study at coppice trees only and by the Grüneklee study by counts at seed grown trees mostly). Seed grown trees might have higher diameter increments as all increment can be invested in one stem, whereas coppice trees have to invest their increment in several coppice shoots (Pipe theory).

4. Recommendations

The presented concept should not be regarded as a blue print approach but as a discussion basis for a participatory planning and management processes. The future management concept must be based on participatory decisions and active participation of all stakeholders in the upcoming planning phase in order to guarantee a successful implementation. First concrete steps include:

- **To distribute the final report,** especially the inventory results and concept ideas to all relevant public or private stakeholder.
- **To communicate inventory results** and the concept ideas via radio on local level in order to build awareness about forest degradation processes caused by illegal fuelwood harvesting and pasture use.
- **To start a public discussion** forum at the municipality in Dedoplistskaro concerning the management concept. This is to adapt, change or fine-tune the proposed concept.
- To coordinate, decide and follow up on the future forest management via this platform.

These participative measures should be complemented by:

- **Strengthening the institutional and public power of NFA** at local level. This includes state control measures such as monitoring and penal actions.
- **Analyzing the drivers of deforestation in more detail**. So far fire-wood harvesting was assumed to happen for the purpose of heating private houses in the winter season. However, it appears that the unofficial fire-wood harvesting brigades are organized by regional private bakeries who are forced or who prefer heating their bakery ovens with cheap fire-wood instead of more expensive gas.
- **Reducing the fuelwood demand**. This refers to the purpose of heating private houses, which could be tackled by improving gas supply, with better house isolation, and efficient use of dry fuelwood. Bakeries, where gas supply is mostly given or easily possible, must be encouraged or forced, if necessary, to use gas for producing their goods.
- **Addressing the problem of pasture within forest**. In general, a clear separation of forest and pasture must be guaranteed. This improves the situation and leads to a more fertile pasture on one and a more productive forest on the other side of the separation line.
- **Offering training courses** for local fire-wood license holders. They should see that there is a future for them on a legal base.

Generally, the consultants recommend the following:

- For the time being, no trustworthy statement can be given concerning increment rates. Confidential data can only be obtained by repeating the inventory after one decade, as permanent sample plot inventories guarantee re-measurements of the same trees – assumed no clear cuts or complete tree removals have been carried out. This will allow for a more precise determination of increment rates.

- The present concept is based on natural regeneration. Generally, enhancing regeneration by tree planting would be an alternative management option. Fire wood plantations could be an additional option. Thus, technical, social and financial feasibility of tree planting measures should be evaluated.

5. References

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6. Appendices

6.1 Height curves of main tree species

All height curves displayed within the annex were used to calculate the height of all trees not measured directly. This can be done based on the scientifically backed observation that for there is a comparatively close connection relation between DBH and tree height, if all other conditions (e.g. trees from seed/coppice, climate, growing conditions) are the same (e.g. Kamer-Akca, 1987 make this observation for stand and district level).

Height curves were calculated separately for each species. Wherever it was possible to calculate separate height curves for trees from seed and trees from coppice, this was done. In general at least 10, better 30 measurements are considered necessary to do so, but sometimes also lower numbers can give an indication. Coefficient of determination (R^2) is a possibility to determine whether a close connection is there or not. $R^2 = 0$ means: No connection at all. $R^2=1$ means an extremely high connection.

In general, problematic data were excluded from analysis. In this case, trees displaying a height/ diameter ratio >120 or <40 were considered as problematic. Looking closer on field sheets etc., these trees often proofed to be measured wrongly or to be (e.g. as high coppice trees) not suitable for height curve calculation from the start. The exception from the "data exclusion" rule is Figure 25:, put there for the express purpose to show the effects of not conducting data quality checks. The tree >20m and the big trees >60cm clearly distort the height curve and R^2 is therefore quite low, although a lot of trees were measured.

Figure 25: Height curve all species; N =675

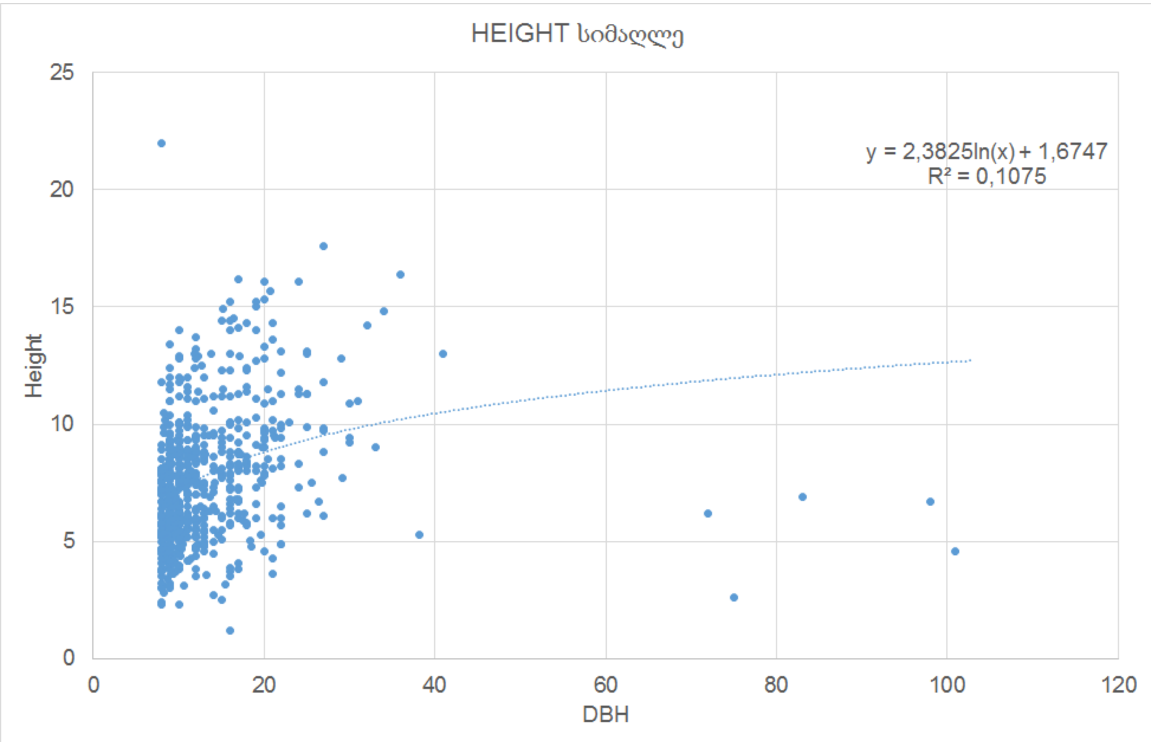


Figure 26: Height curve all species; only trees from seed. N= 319

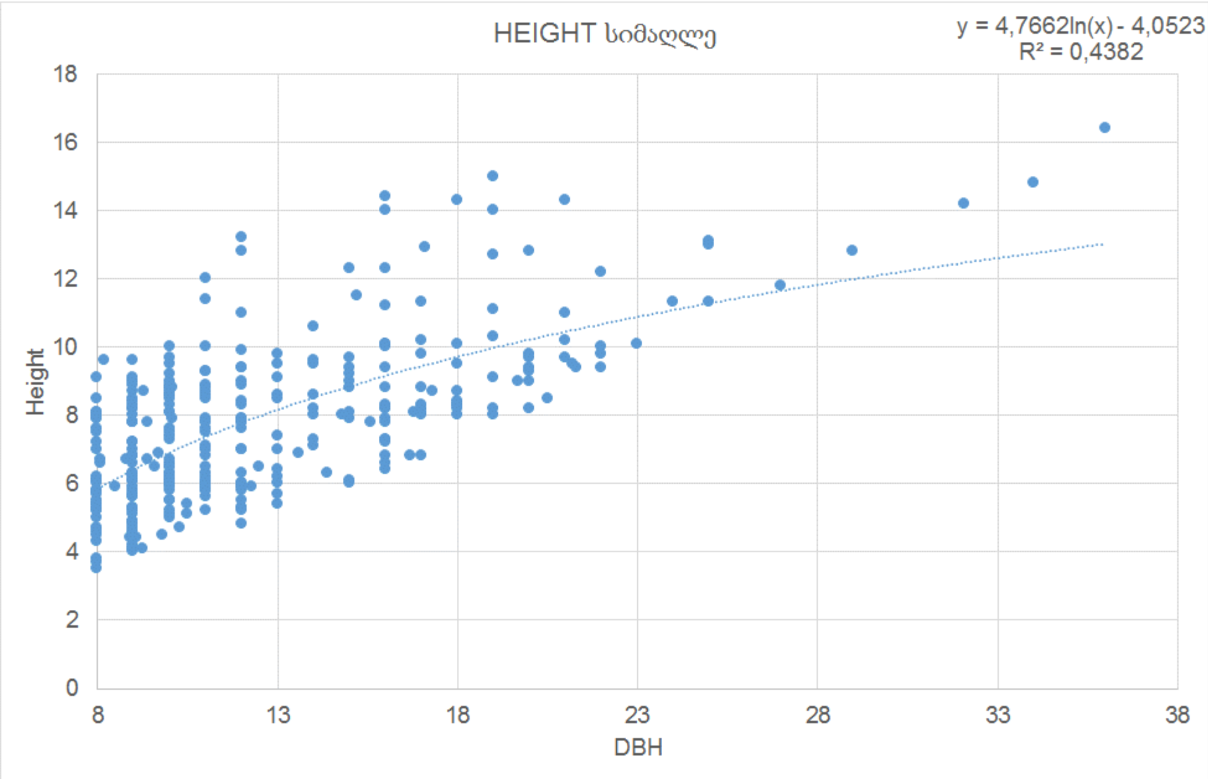


Figure 27: Height curve all species; coppice only; N = 237

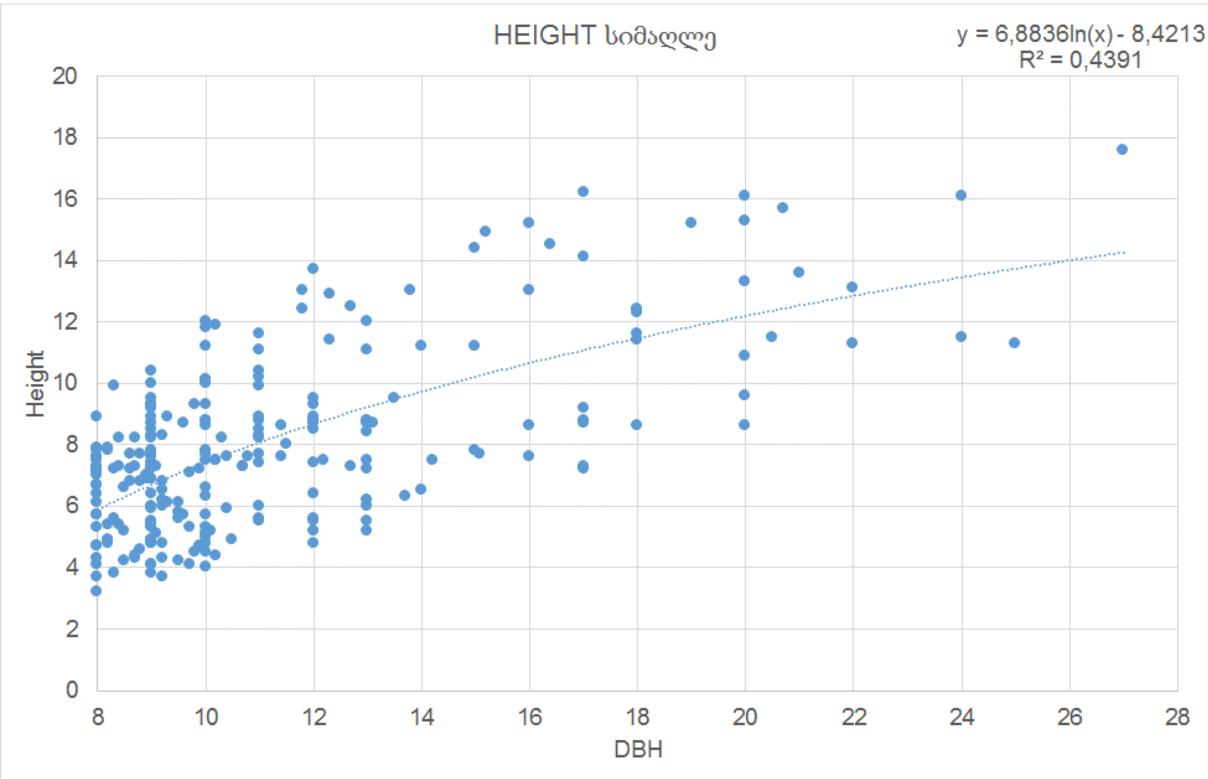


Figure 28: Height curve Quercus iberica; trees from seed; N = 34; some improbable but possible values included; e.g. DBH = 15; h =14,2m; R^2 is high nevertheless

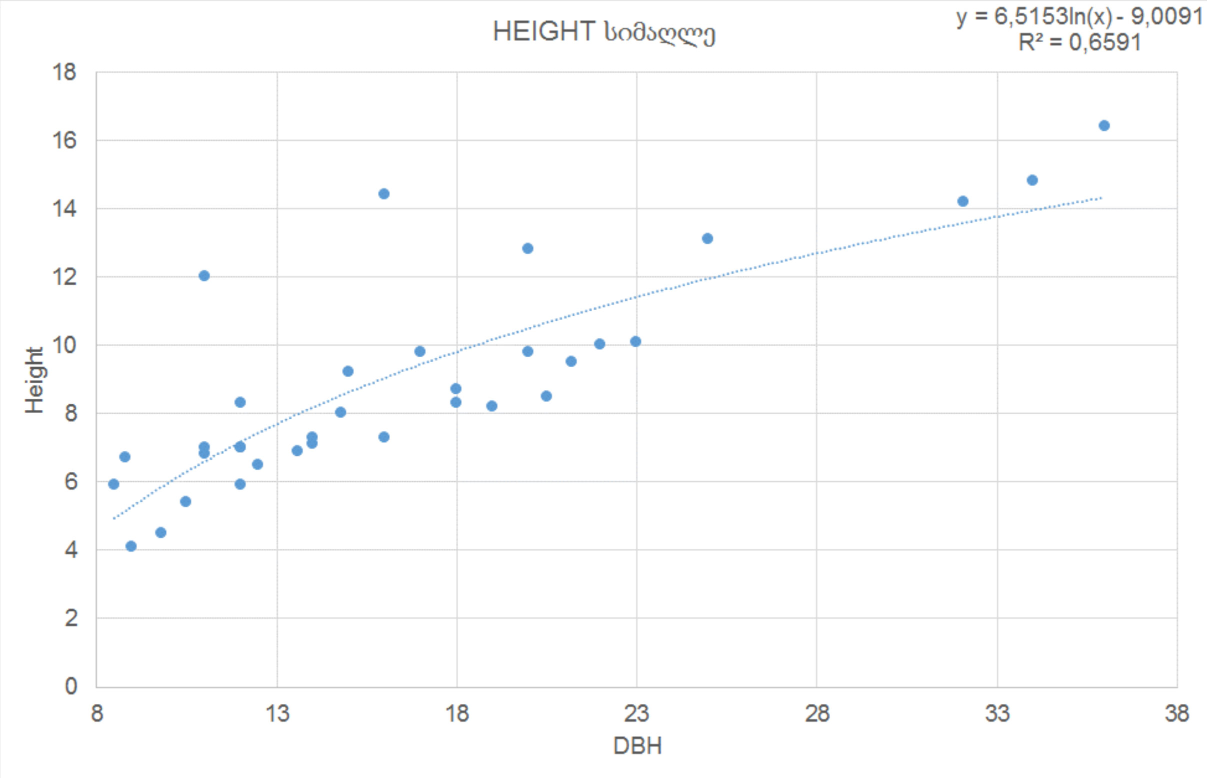


Figure 29: Height curve Quercus iberica; N = 11; coppice trees; one improbable but possible value (DBH = 16; h =13m); R^2 is high nevertheless

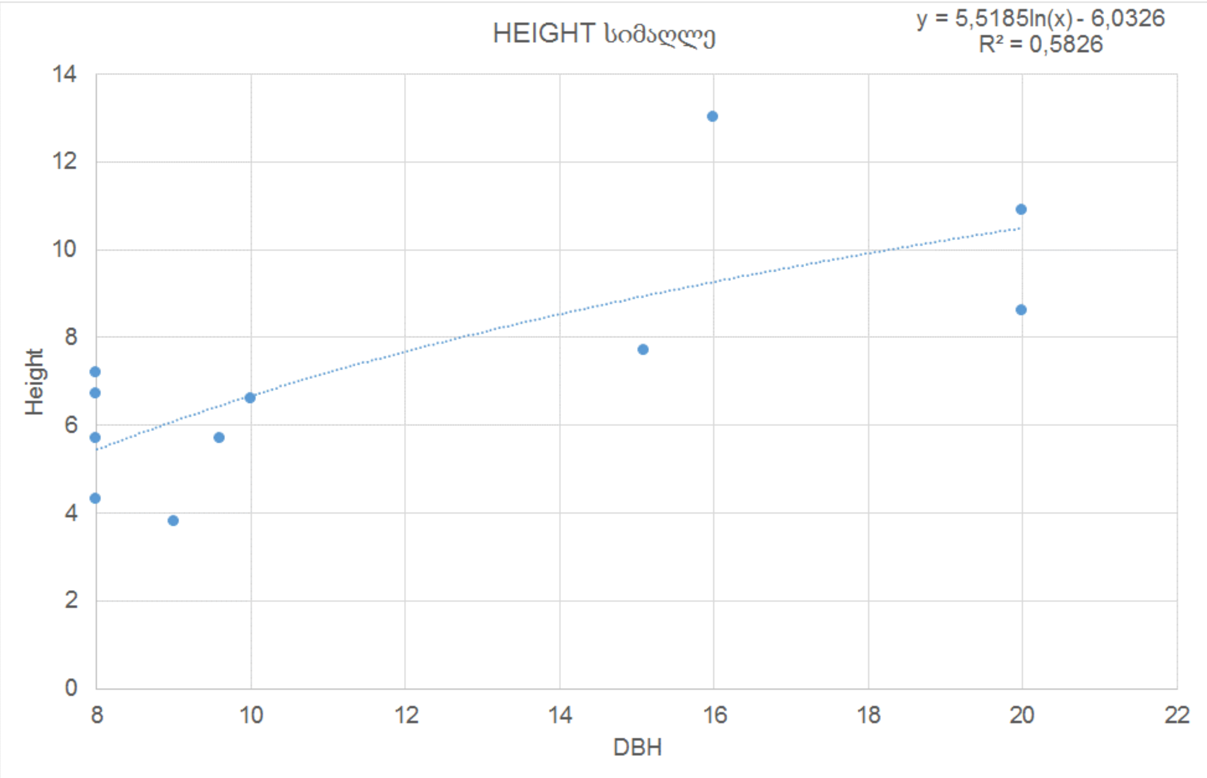


Figure 30: Height curve Fraxinus excelsior; trees from seed; N =33

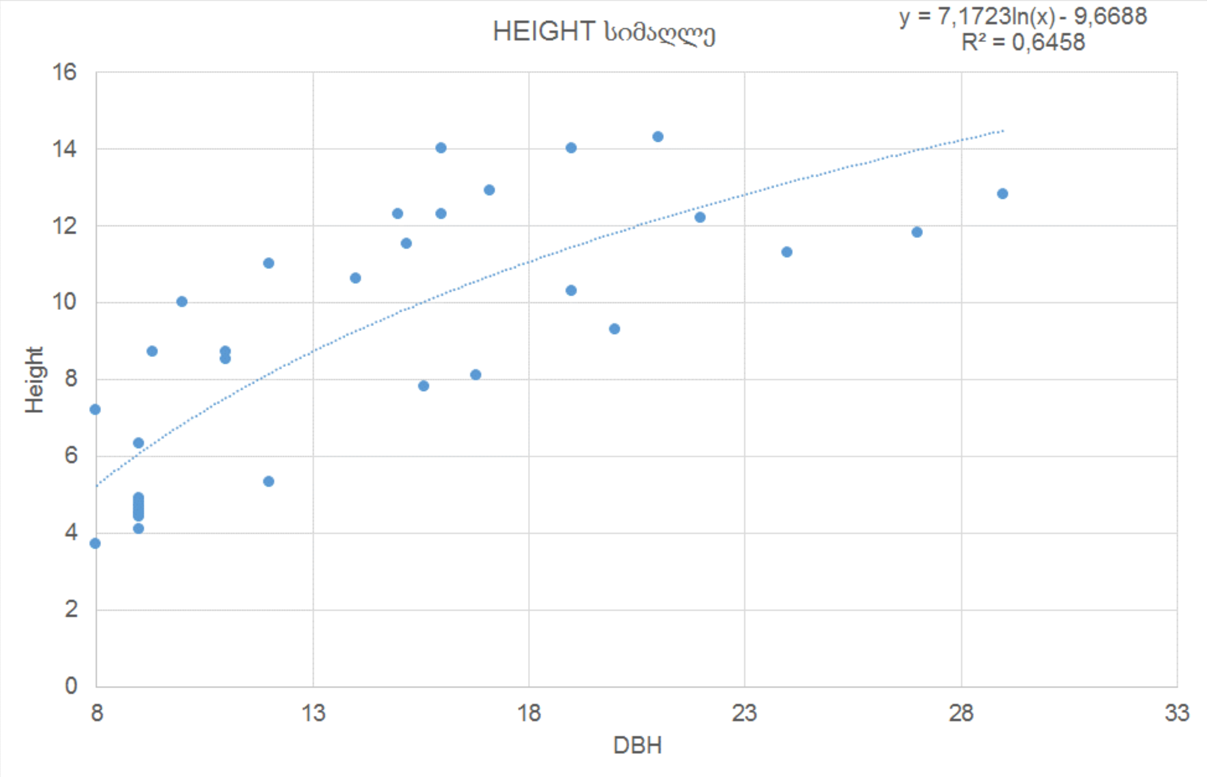


Figure 31: Height curve Fraxinus excelsior; coppice trees; N = 38

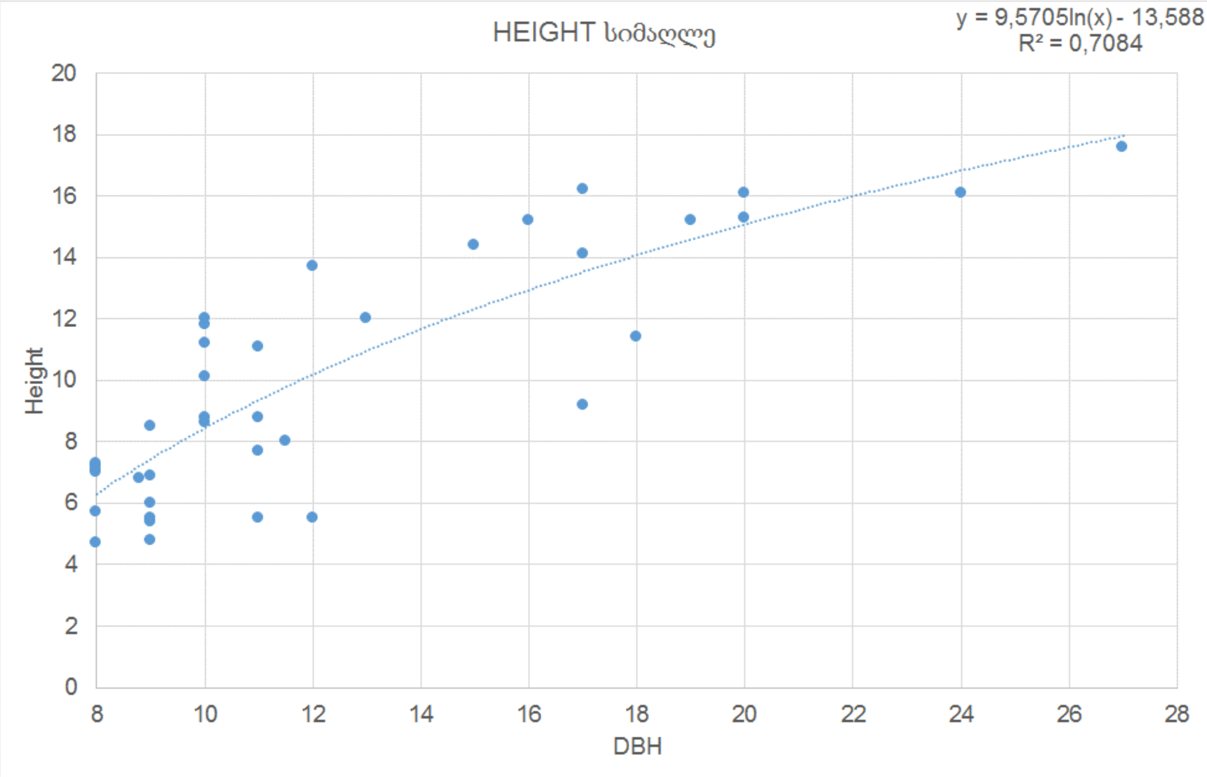


Figure 32: Height curve Carpinus orientalis; trees from seed; N =107

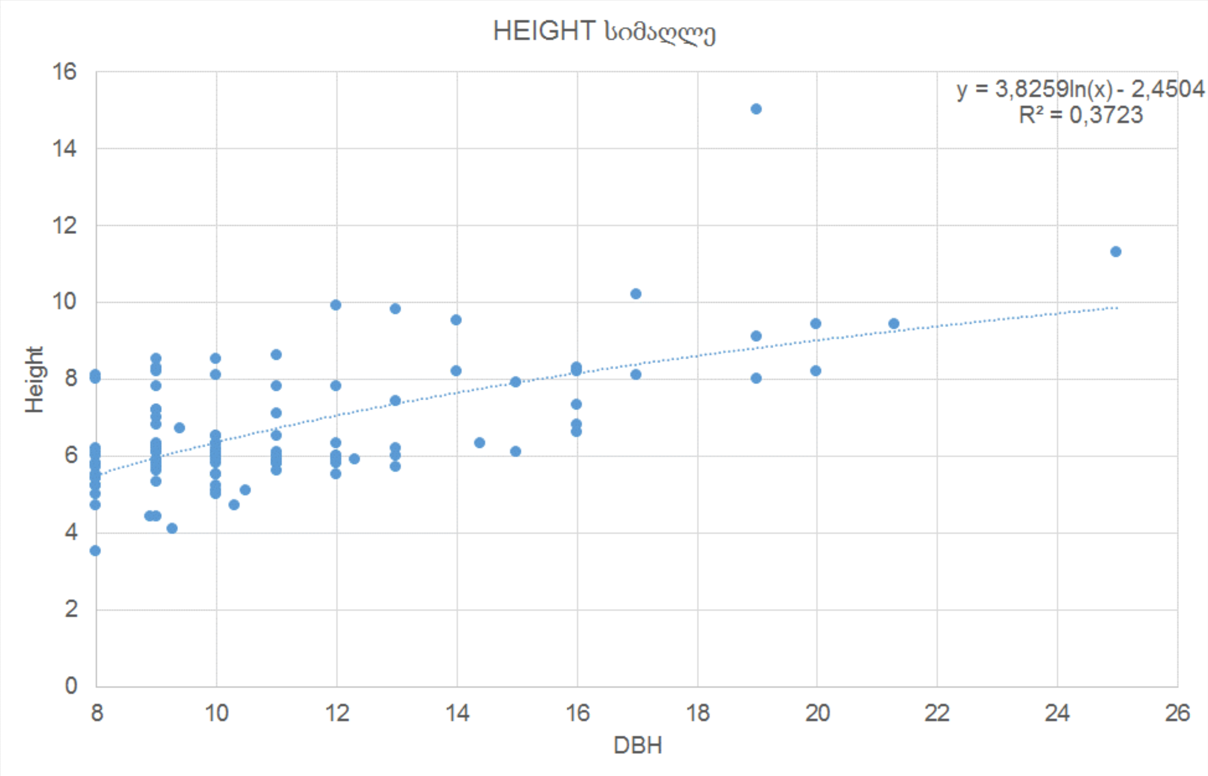


Figure 33: Carpinus orientalis; coppice trees, N = 149

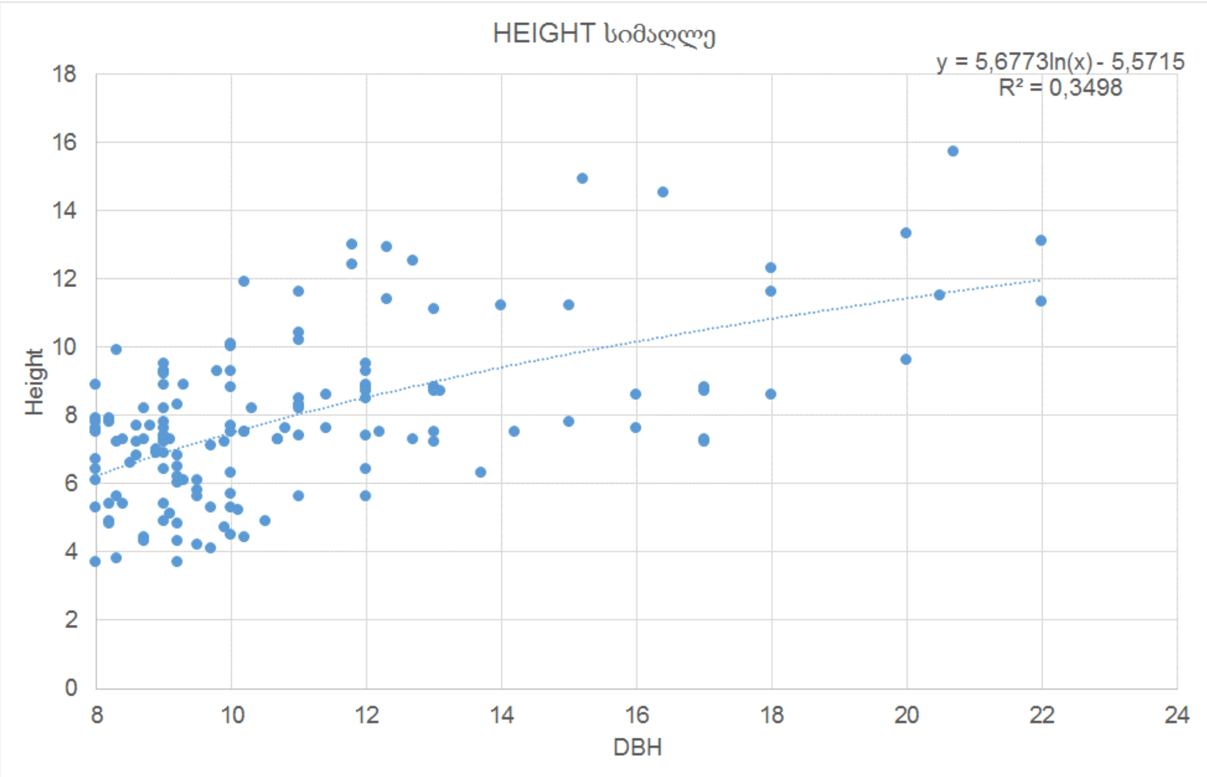


Figure 34: Carpinus caucasica; trees from seed; N = 106

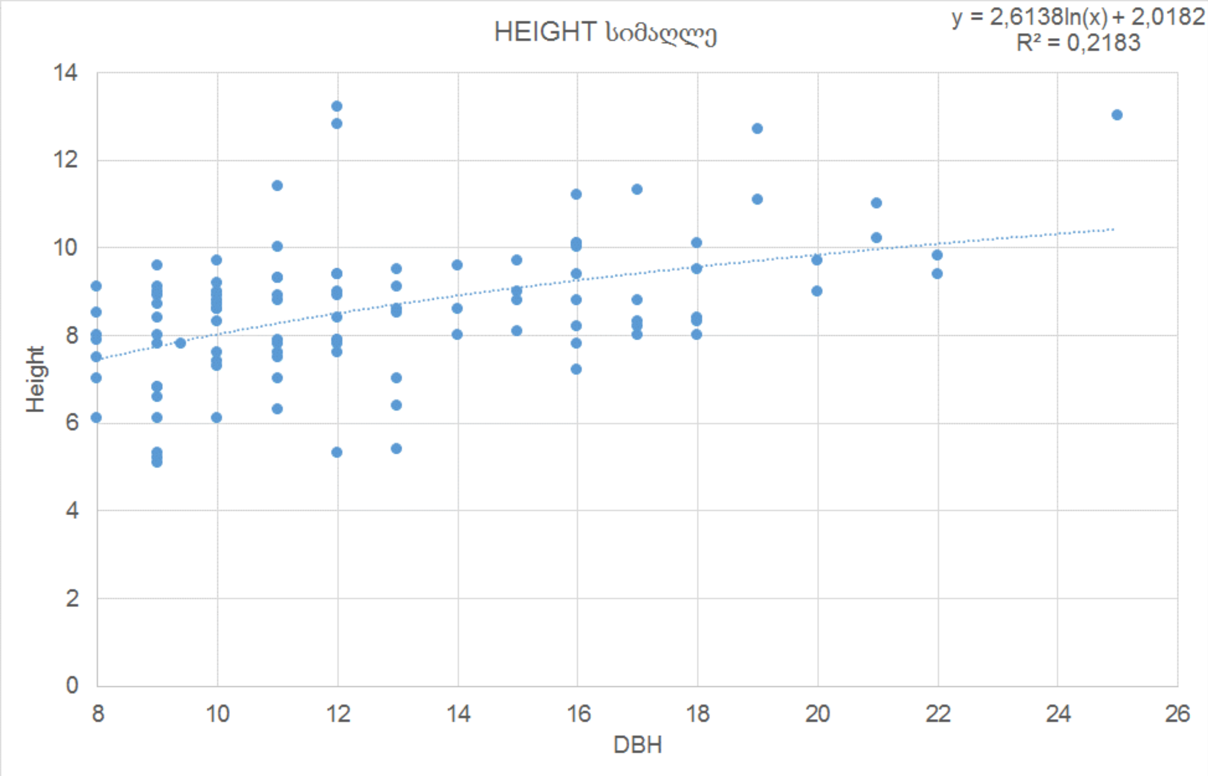
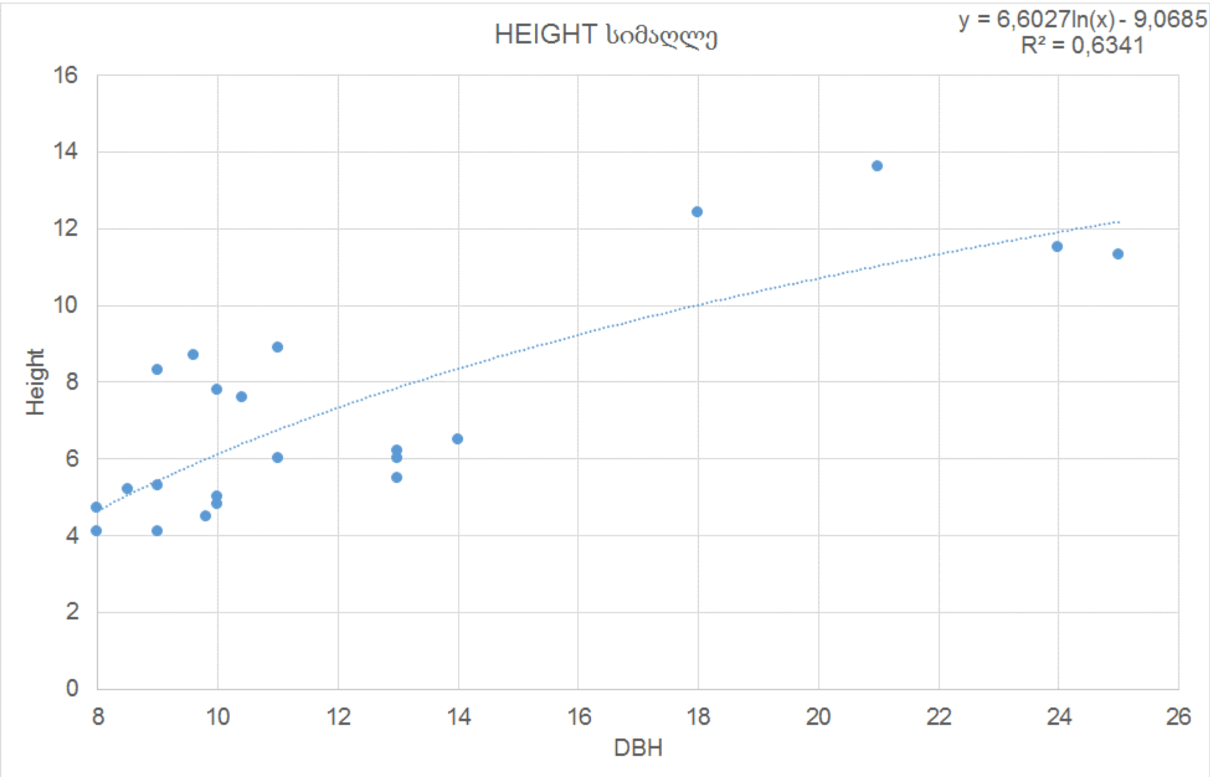


Figure 35: Carpinus caucasica; coppice; N = 26



6.2 Height curves of non main tree species and bush species

Here, height curves for non main tree species are given. In general those curves rely on 10 or more measurements and more than $R^2 \approx 0,4$. Both those values are kind of a minimum.

All the curves displayed here, were used for volume calculation of not directly measured trees. Those height curves have to be considered as less reliable than those in chapter 6.1 but still are a better choice for volume calculation than using the "all species" height curves or other alternatives.

Figure 36: Ulmus carpinifolia; trees from seed; N = 11

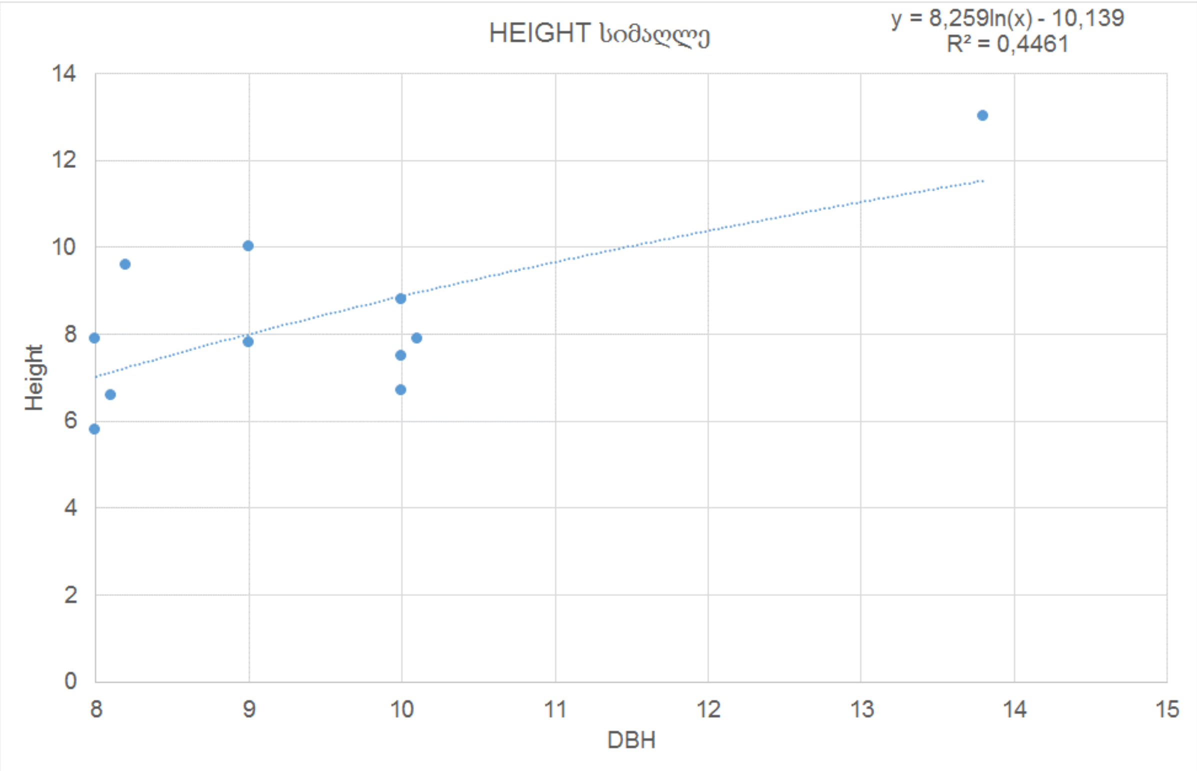
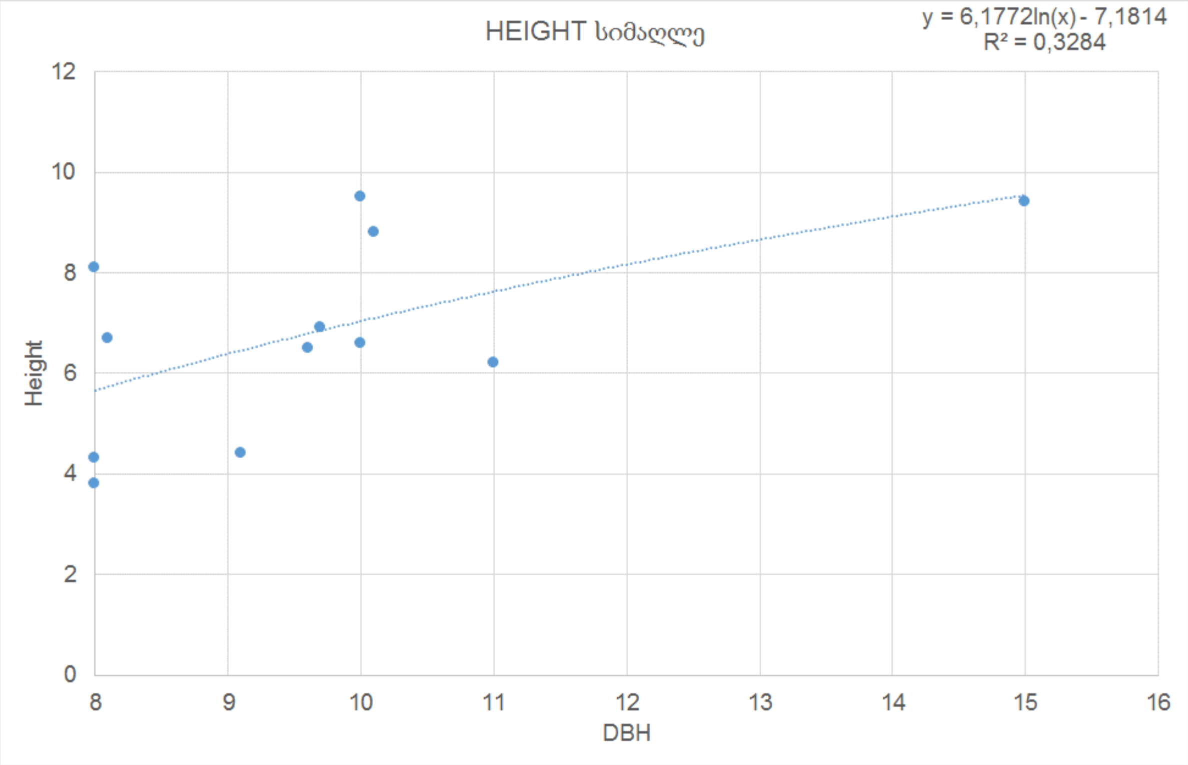


Figure 37: Crataegus microphylla; N = 12; trees from seed;



The oviously high variability of *Crataegus* can be explained by the fact that this species often grew as a stand-alone tree (small h/d-ratio), but also within stands (h/d- ratio higher).

Figure 38: Acer ibericum; trees from seed; N =6; strictly speaking not enough values; but R^2 astonishing high

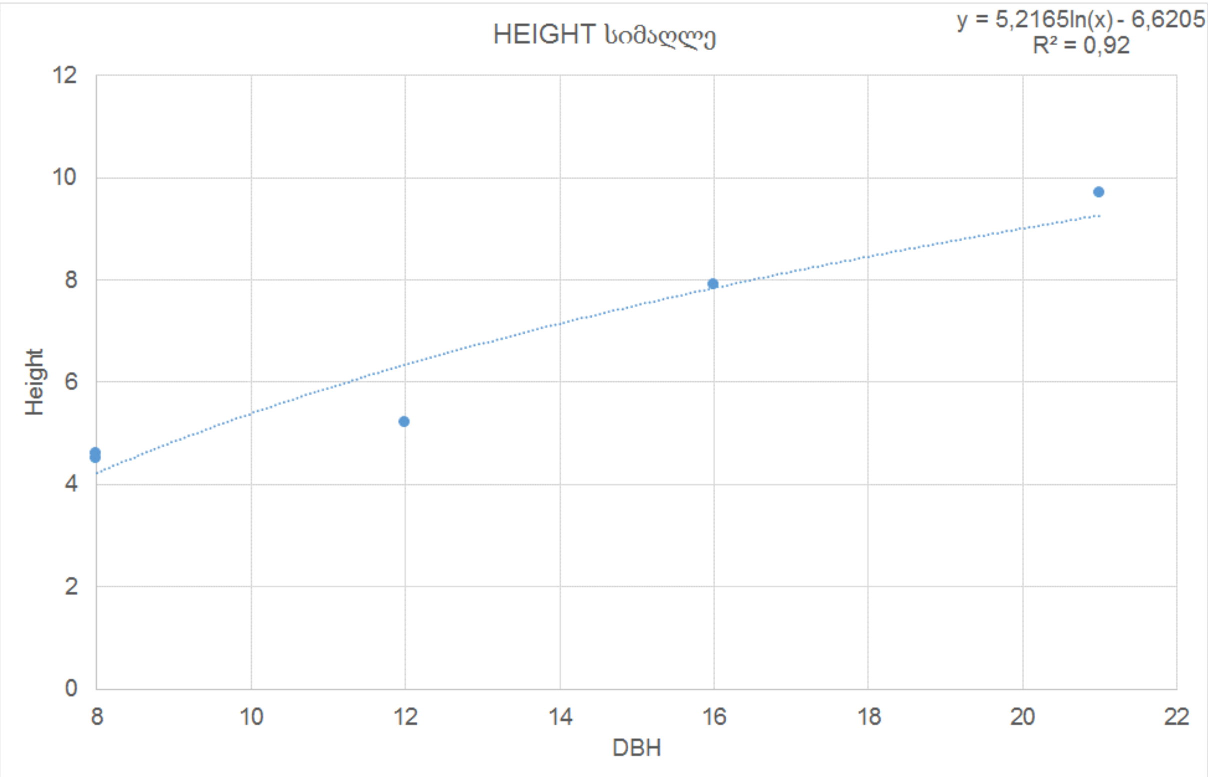
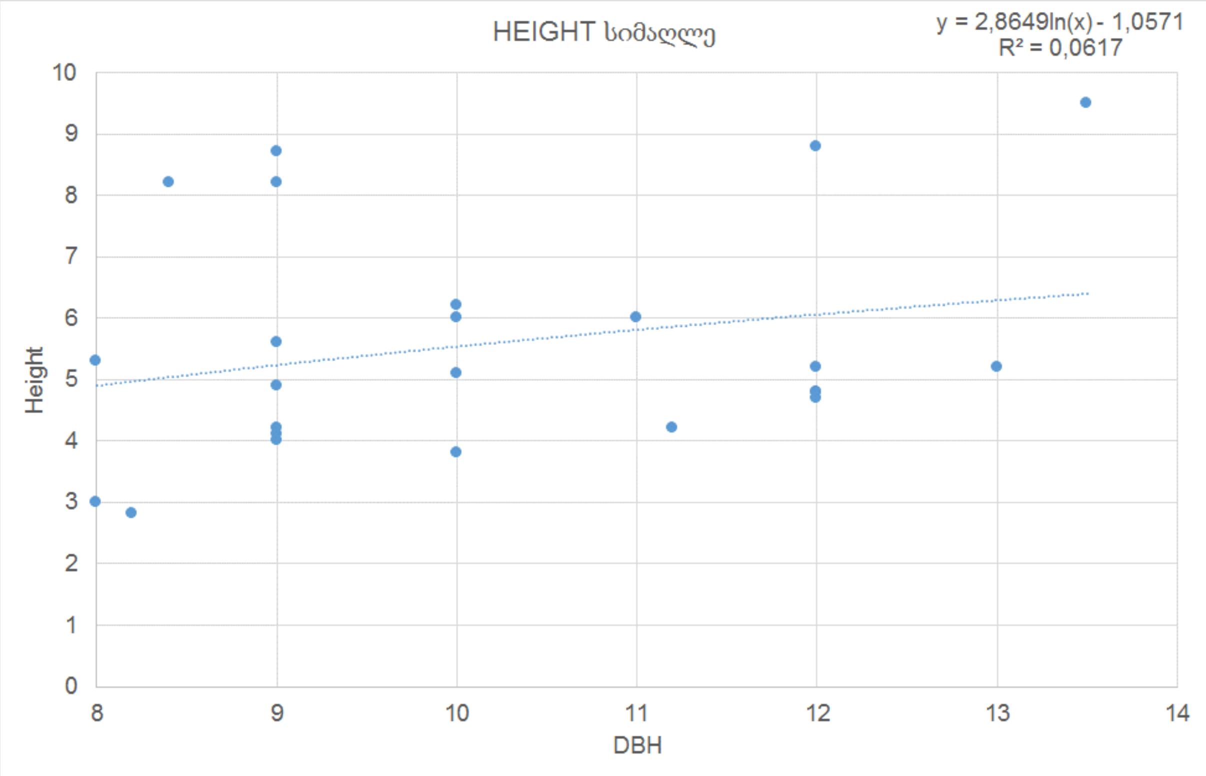


Figure 39: Bush species (Svida australis; Cornus mas); bushes from seed and coppiced bushes.



For bush species, R^2 is very low in relation to DBH and strictly speaking shouldn't be used for height calculation. This doesn't change, if only trees from seed or coppice bushes are calculated. It can be concluded that bush species rarely grow higher than 9m for any reason- Probably height is strongly influenced by other criteria than DBH for these species.

6.3 Volume and number of trees per district and "Qvartali"

Table 16 is giving the results per qvartali.In the second column the number of plots per qvartali is given. This number strongly influences the representativity of data (represented by standard error). In qvartali with only one plot, no standard error can be calculated. In this case, #ZAHL appears. In Qedi, 3 plots could not be assigned to qvartali.

Table 16: Average N/ha and Vol/ha per Qvartali

District and Qvartali Nr.	Nr. of plots in qvartali	Mean_N/ha	SE_N/ha	Mean_VOL/ha	SE_VOL/ha
Dedofliswyaro	**86**	**417**	**48**	**12,4**	**1,8**
1	4	895	302	22,6	9,3
2	3	637	0	8,5	0,7
3	2	541	350	10,3	5,5
4	3	286	226	9,8	8,7
5	6	485	215	10,7	3,5
6	3	467	273	14,2	7,1
7	6	716	176	20,7	5,9
8	3	286	102	8,0	6,0
9	5	547	213	12,7	5,1

10	3	212	112	2,0	1,0
11	1	141	#ZAHL!	20,7	#ZAHL!
12	4	286	204	6,5	5,6
13	2	207	80	3,4	1,9
14	4	350	309	12,1	11,1
15	7	238	105	5,9	2,8
16	3	658	281	34,3	16,3
17	4	656	451	33,9	20,3
18	4	366	147	15,4	10,0
19	5	0	0	0,0	0,0
20	5	461	218	11,9	7,1
21	5	134	70	1,9	1,0
22	2	0	0	0,0	0,0
24	2	898	7	33,2	17,8
gediqi	**89**	**323**	**41**	**7,1**	**1,2**
1	4	430	186	10,8	4,6
2	5	630	134	12,2	2,4
3	1	255	#ZAHL!	2,0	#ZAHL!
4	6	340	122	4,1	2,1
5	4	271	66	7,6	3,7
6	2	477	223	12,7	9,3
7	4	346	202	10,2	6,7
8	3	849	449	16,3	8,9
9	5	655	240	25,0	11,5
10	6	0	0	0,0	0,0
11	3	170	170	2,7	2,7
12	4	828	323	12,1	4,4
13	3	472	116	9,4	5,0
14	2	127	127	1,3	1,3
15	3	174	87	3,4	2,2
16	4	223	131	4,3	2,7
17	2	0	0	0,0	0,0
18	2	0	0	0,0	0,0
23	2	127	127	1,5	1,5
24	6	106	61	1,4	0,9
25	3	382	382	16,4	16,4
26	7	218	99	3,5	1,8
27	4	95	61	1,1	0,8
28	4	382	227	6,2	3,7
qedi	**149**	**111**	**22**	**2,8**	**0,7**
(Leer)	1	0	#ZAHL!	0,0	#ZAHL!
3	2	0	0	0,0	0,0
4	3	0	0	0,0	0,0
5	3	85	85	0,6	0,6
6	3	0	0	0,0	0,0

7	5	25	25	0,2	0,2
8	4	32	32	0,3	0,3
9	3	95	95	1,7	1,7
10	6	42	42	0,2	0,2
11	3	95	49	1,5	0,8
12	2	0	0	0,0	0,0
13	3	11	11	0,5	0,5
14	3	0	0	0,0	0,0
15	2	541	541	11,5	11,5
16	3	0	0	0,0	0,0
17	2	159	95	3,4	1,3
18	3	534	457	21,7	19,7
19	5	108	72	1,3	0,6
20	4	218	107	19,1	14,2
21	6	11	11	0,6	0,6
22	2	0	0	0,0	0,0
24	3	340	278	9,8	9,2
25	7	252	129	5,9	1,7
26	7	116	56	5,1	2,8
27	7	132	87	3,5	2,4
28	7	132	87	1,7	1,3
29	6	42	27	0,3	0,2
30	8	56	28	0,7	0,4
31	10	38	38	0,7	0,7
32	10	134	43	1,7	0,7
33	4	95	95	1,3	1,3
34	3	95	95	1,5	1,5
35	7	318	287	4,6	4,2
x	2	0	0	0,0	0,0
Total	**324**	**251**	**21**	**6,5**	**0,7**

6.4 Diameter increment per species

Table 17: Average N/ha and Vol/ha per Qvartali; species with comparatively fast growth are highlighted in yellow, those with comparatively slow growth are highlighted in brown

	Mean diameter growth (in cm/yr)	Number of cores (n)
Celtis australis	0.27	2
Ulmus carpinifolia	0.11	1
Crataegus microcarpa	0.08	1
Fraxinus excelsior	0.15	12
Acer ibericum	0.20	2
Quercus iberica	0.16	9
Carpinus orientalis	0.14	20
Carpinus caucasica	0.14	10
Svida australis	0.10	1
Cornus mas	0.13	2
	0,15	**60**

Except for Carpinus orientalis and perhaps Fraxinus excelsior, Carpinus caucasica and Quercus iberica, there are not enough samples to say anything about differences between species. The differences in diamtere growth between those 4 species seem small.

It might be interesting to check for the future, whether the apparently high growth rates for Acer and Celtis are just chance measurement or reality. It would be important knowledge for reforestation issues, if these species would be able to grow faster than others under the given climatic conditions and thus establish canopy cover faster. Field observations from a felled Celtis tree also displayed comparatively large year rings.

6.5 Form factors in German yield tables

Table 18: Average N/ha and Vol/ha per Qvartali

	DBH in cm	form factor acc. to KRENN's Tarif for birch (hornbeam, lower form height)	form factor acc. to KRENN's Tarif for ash (lower form height)	form factor acc. to KRENN's Tarif for oak (lower form height)
	8	0,30	0,23	0,34
	10	0,35	0,29	0,37
	12	0,36	0,33	0,39
	14	0,37	0,35	0,41
Age in y	**DBH in cm**	**Form factor yield table birch (Schwappach 1903/29; dGz3)**		
30	8,8	0,42		
40	12,8	0,44		
50	15,7	0,45		
Age in y	**DBH in cm**	**Form factor yield table Ash (Volquardts 1958; dGz4)**		
30	4,7	0,14		
40	8,8	0,4		
50	12,6	0,44		
60	15,9	0,46		
		Form factor yield table oak (Jüttner 1955; dGz3)		
Age in y	**DBH in cm**			
40	5,5	0,2		
50	8,1	0,35		
60	10,8	0,41		
70	13,6	0,45		

The above tables were used to assess possible form factors. The lowest possible dGz class (bonity) was used in every case. The form factor derived from KRENN’s tariff were calculated from form height tables.

6.6 Form factors in Georgian yield tables (extract, translated)

BHD	**Oak, Castanea, Maple, Ulmus sp.**						**Calculated section**					
	2. Class		**5. Class**		**6. Class**							
	Height (m)	Volume (m3)	Height (m)	Volume (m3)	Height (m)	Volume (m3)	Basal area	Basal area*height	Form factor class 5	Basal area	Basal area*height	Form factor class 6
8	11,4	0,03	8,4	0,02	8	0,02	0,01	0,04	**0,47**	0,01	0,04	**0,50**
12	15,1	0,08	10,9	0,06	9	0,05	0,01	0,12	**0,49**	0,01	0,10	**0,49**
16	17,2	0,16	12,4	0,12	11,1	0,1	0,02	0,25	**0,48**	0,02	0,22	**0,45**
20	18,8	0,27	13,4	0,19	11,8	0,17	0,03	0,42	**0,45**	0,03	0,37	**0,46**
24	20	0,41	14,2	0,29	12,5	0,26						
28	21	0,59	14,9	0,42	13	0,36						

BHD	**Birch**						**Calculated section**								
	1a. Class		**4. Class**		**5. Class**										
	Height (m)	Volume (m3)	Height (m)	Volume (m3)	Height (m)	Volume (m3)	Basal area	Basal area*height	Form factor class 1a	Basal area	Basal area*height	Form factor class 4	Basal area	Basal area*height	Form factor class 5
4	11	0,007	5	0,003	4	0,003									
6	14	0,018	7	0,01	6	0,008									
8	16	0,037	9	0,022	8	0,019	0,01	0,08	**0,46**	0,01	0,05	**0,49**	0,01	0,04	**0,47**
10	18	0,065	11	0,04	10	0,038	0,01	0,14	**0,46**	0,01	0,09	**0,46**	0,01	0,08	**0,48**
12	19	0,1	12	0,06	11	0,06	0,01	0,21	**0,47**	0,01	0,14	**0,44**	0,01	0,12	**0,48**
14	20	0,14	13	0,09	12	0,09	0,02	0,31	**0,45**	0,02	0,20	**0,45**	0,02	0,18	**0,49**
16	21	0,19	14	0,13	13	0,12	0,02	0,42	**0,45**	0,02	0,28	**0,46**	0,02	0,26	**0,46**
18	22	0,25	15	0,18	14	0,17	0,03	0,56	**0,45**	0,03	0,38	**0,47**	0,03	0,36	**0,48**
20	23	0,33	16	0,23	15	0,22									

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