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Regeneration Status in Logged and Non – Logged Forest Stands of Southern Caspian Forests

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ABSTRACT

With considering to importance of forest trees the effect of silvicultural system on structure and regeneration in logged and non – logged stands were investigated. Studied stands areas involve two sections of logged with shelterwood system and non – logged that were studied 10 years after logging. In order to study was installed 60 plots (with 1000m^2 area) and 60 micro plots (with 100m^2 area) by randomized systematically method. Diameter at breast height of whole trees, diameter at breast height, total height, bole height, crown height, crown small and big diameter for four trees that were nearest to center plot were measured. Under story covers were also, estimated. Results showed that there was significant differences between under story cover in two stands ($p<0.01$). Comparison of tree diameters (DBH) in two stands specified there was varied ($p<0.05$). Vegetation characteristics of four nearest trees to center plots show there were significant differences between DBH ($p<0.05$), bole height ($p<0.001$), crown height ($p<0.01$), basal area of diameter at breast height ($p<0.01$), volume ($p<0.05$) and there were not significant differences between total height, crown small and big diameter and crown area in logged and non – logged stands. Frequency comparison of species in plots showed there were not differences. Total regeneration in logged and non – logged stands had significant varied ($p<0.01$). Quality of regeneration in four classes weak, moderate, well and excellent show that there was significant difference ($p = 0.05$) in logged and non – logged stands.

Key words: Forest, shelterwood system, regeneration, structure, logged, non – logged.

INTRODUCTION

Northern forests of Iran are one of worthiest world forests that have rare life forms with considering to the special characteristics such as geology, pedology, and climatic conditions. These forests have special important viewpoint biology, ecology, physiognomy and economic with high ecological reserves and gene stores. Therefore, they are the appropriate fields for important and valuable scientific researches [16]. Every forest ecosystem has the ability for auto regulation and auto conservation, thus this powers are able to control of disturbance that are due to increase of population, humans, animals, machines traffic etc., in these natural ecosystems [12]. Ecosystem processes are forming the forest structure. Performed researches in current years showed inappropriate managements for utilization are cause changes of forest structure following inappropriate yield of forest. Total attention to forest structure, its ecological role and the effective of degradation on changes of forest structure are ways to perform forest managers [20]. Non - specialized managements and don't assessment of economic and society problems and silvicultural methods are the effective factors on degradation of northern forests in Iran [16].

Pay attention to degradation of environmental, especially forests, reduction of forest natural regeneration and areas by reason of some inappropriate silvicultural methods are cause of incomes reduction and increase of different damages in long times. Therefore, investigation of the important factor of duration (forest natural regeneration) is necessary [1]. Selection and performing of appropriate silvicultural methods will produce forest stands with good

natural regeneration, appropriate and normal structure [17]. These subjects are mentionable that conservation of biodiversity with finding of the appropriate silvicultural methods for forest stand is necessities for sustainable management of forests [11]. The utilization methods are effective on forest trees regeneration. Regeneration and viability of beech saplings in shelterwood method are more during the first year and it is opposite to clear cutting method [2]. In selection method, the frequency of climax species is increased as considerable opposite to primary species [6]. Totally, utilization was affected on regeneration establishment in forest [7]. Primary speed of regeneration increment is more in regions with high disturbance of soil [18].

Increment and density of species are more in logged regions opposite to undisturbed regions in despite of soils compaction that is produced by skidder in forest [19]. In order to true logging of forest, the selection of cultural methods that are appropriate with forest conditions and characteristics are necessary. Thus, forests should be recognized as sustainable and natural ecosystems and inter relations of theirs should be analyzed [13]. Study area is included two sections of logged and non - logged forest stands. Logged section utilized with shelter wood method in last years and the other section is non - logged [4]. Pay attention to the same ecological conditions, investigation of regeneration in these two sections which are next to each other, is necessary in order to determine of appropriate algorithm for performing of future interferences in the same stands. In this research was tried to estimate frequency, diversity, structure, desirability and non - desirability of regeneration in logged and non - logged stands.

MATERIALS AND METHODS

Study area: Studied forests are located at the northern aspect of Alborz mountains chain and medium heights of watershed number 74 of Iran northern forests in hyrcanian vegetative region. These forests are belonging to Darabkola forest management design that is 10 kilometers far from east of Sari city (North of Iran). In this research, a site of 57 ha^{-1} area which consists of two logged parts in shelterwood cutting with 3 used cutting preparatory, seed and light felling without find cutting and non - logged with almost equal areas, studied the region to be studied, is placed between geographical longitudes of eastern 53˚ 19′ 25″ to 53˚ 19′ 57″ and latitudes of northern 36˚ 30′ 6″ to 36˚ 29′ 19″. The maximum elevation is 750m and the minimum elevation is 560m. Minimum temperature in December (1.6˚C) and the highest temperature in June (28.4˚C) are recorded, respectively. Mean annual precipitation of the study area were from 600mm to 750mm at the Sari city meteorological station, which is 10Km far from the study area. The region's soil type is washed forest brown with classic horizon, a few heavy soil texture on the top and heavy on the lower deep. Maternal stone of the region is of Marne sort, lime stone sand and sanding and related to third age of geology [4].

Data collection and analysis method: In this research the map of 1:5000 scales prepared and inventory method selected random - systematically. Inventory network with 75m × 75m dimensions and plots (circle form) with 1000m^2 area were designed for this research. Micro plots (circle form) with 100m^2 area were also selected in inters every plot for measuring of regenerations. Herbal covering, diameter at breast height (DBH), basal area, crown covering of trees were recorded in every plot for two regions. Two trees nearest and two trees with the most diameters were recorded in every plots, also. Diameter at breast height (DBH), total height (TH), bole height without branching (BH), crown height (CH), crown small diameter (CSD), crown big diameter (CBD), crown basal area (CBA), and tree basal area (BA) were estimated for beech, hornbeam, alnus, maple, iron tree, and elm species that involved in regions. Also, regeneration quality viewpoint fork, unit stem, browsing, vigorous were investigated and classified in weak, moderate, good, excellent classes. EXCELL, SAS, and SPSS software's were used to analyze data. ANOVA, SNK, and U - Mann Whitney test used to compare group means.

RESULTS

Comparison of herbal covering in logged and non – logged forest stands: Frequency every herbal species in aforementioned forest stands showed in figure 1. U - Man Whitney test showed significant differences at 99% confidence limit ($p<0.01$) between two stands viewpoint frequency and under story diversity.

Comparison of tree diameter: Analysis of variance (ANOVA) showed significant differences at 95% confidence limit ($p<0.05$) between two stands viewpoint trees diameter (Table 1) but the diameter of beech trees which are dominant in every two stands, haven't significantly different (Table 2).

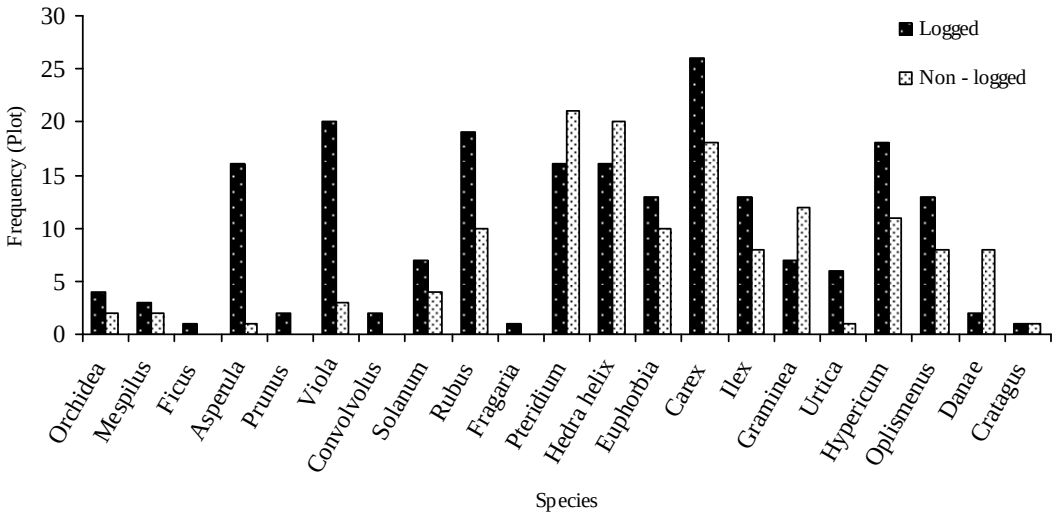

Fig. 1. Frequency of shrubs and herbal species in logged and non - logged forest stands

Table 1. Analysis of variance for two stands

Variable resource	Sum of square	Degree of freedom	Mean of squares	F
Model (logged and non - logged)	1289.351	1	1289.351	4.266*
Error	366952.1	1214	302.267	-
Total	368241.5	1215	-	-

* Significant at the level of 5%

Table 2. Analysis of variance for diameter factor of beech at two stands

Variable resource	Sum of square	Degree of freedom	Mean of squares	F
Model (logged and non - logged)	89.648	1	89.648	0.281ns
Error	284938.133	893	319.080	-
Total	285027.781	894	-	-

ns = non significant

Comparison of four trees near to plot center: Statistic analysis showed significant differences between diameter at breast height ($p<0.05$), bole height ($p<0.01$), and volume ($p<0.05$) in two stands. Total height, crown small and big diameters, and crown basal area haven't significant difference between two stands (Table 3). Statistic parameters are presented in table 4, also.

Table 3. Analysis of variance for four trees near to plot center

Measured parameters	Variable source	Sum of square	Degree of freedom	Mean of square	F
Diameter at breast height (cm)	Model (logged and non - logged)	2801.667	1	2801.667	5.697 *
	Error	1117046.7	238	491.793	
Total height (m)	Model (logged and non - logged)	22.204	1	22.204	0.615 ns
	Error	8597.592	238	36.124	
Bole height (m)	Model (logged and non - logged)	352.838	1	352.838	19.799 ***
	Error	4256.558	238	17.884	
Crown height (m)	Model (logged and non - logged)	198.017	1	198.017	6.661 **
	Error	7074.983	238	29.727	
Crown small diameter (m)	Model (logged and non - logged)	4.267	1	4.267	0.665 ns
	Error	1550.917	238	6.516	
Crown big diameter (m)	Model (logged and non - logged)	1.350	1	1.350	0.166 ns
	Error	1930.250	238	8.110	
Crown basal area (m2)	Model (logged and non - logged)	550.415	1	550.415	0.446 ns
	Error	293888.5	238	1234.826	
Basal area at breast height (m2)	Model (logged and non - logged)	0.227	1	0.227	7.199 **
	Error	9.172	238	0.039	
Volume (silve)	Model (logged and non - logged)	43.575	1	43.575	5.412 *
	Error	1916.284	238	8.052	

* *Significant at the level of 5%;* ** *Significant at the level of 1%;* *** *Significant at the level of 0.1%; ns = non significant*

Table 4. Statistic parameters for mentioned stands

Stand	Variations source	DBH	TH	BH	CH	CSH	CBH	CBA	BBH	V
Logged	Mean	50.67	21.78	8.01	13.16	6.74	8.17	48.9513	0.2348	2.8856
	Standard deviation	20.681	6.158	3.967	5.855	2.369	2.866	35.48477	0.16425	2.39239
	Standard error	1.888	0.562	0.362	0.535	0.241	0.262	3.23927	0.01499	0.2183
	Variance	427.703	37.922	15.739	34.286	6.950	8.213	1259.148	0.027	5.714
	Coefficient variance	40.82	29.10	49.54	44.50	39.10	35.05	72.49	69.95	82.91
Non – logged	Mean	57.50	21.11	10.43	11.34	6.48	8.02	45.9225	0.3028	3.7378
	Standard deviation	23.577	5.859	4.475	5.017	2.466	2.830	34.79230	0.22382	3.22175
	Standard error	2.152	0.535	0.409	0.458	0.225	0.258	3.17609	0.02043	0.2941
	Variance	555.882	34.327	20.029	25.168	6.083	8.008	1210.504	0.050	10.380
	Coefficient variance	41.00	26.90	42.89	44.23	38.09	35.26	75.76	73.91	95.92
Total area	Mean	54.08	21.47	9.22	12.25	6.61	8.10	47.4369	0.2688	3.3117
	Standard deviation	22.393	6.006	4.392	5.516	2.551	2.843	35.09932	0.19884	2.86361
	Standard error	1.445	0.388	0.283	0.356	0.165	0.184	2.26565	0.01284	0.18485
	Variance	501.457	36.066	19.286	30.431	6.507	8.082	1231.962	0.040	8.200
	Coefficient variance	41.40	27.97	46.21	45.03	38.60	35.09	73.99	73.76	86.45

DBH: Diameter at breast height; TH: Total height; BH: Bole height; CH: Crown height; CSH: Crown small height; CBH: Crown big height; CBA: Crown basal area; BBH: Basal area at breast height; V: Volume.

Comparison of height curves and trees volume: The obtained results are displayed in figures 2 and 3.

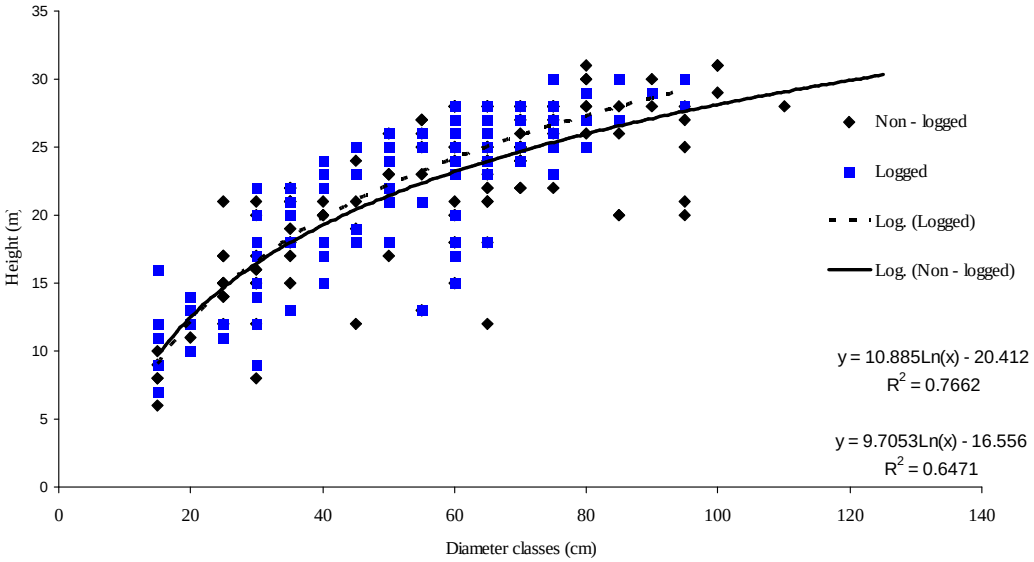

Fig. 2. Height curves for logged and non – logged stands

Comparison of H/D ratio: Results of this research showed that h/d ratio has significant differences ($p<0.05$) in logged and non – logged stands (Table 5) as the logged stand has high h/d (~ 45.49) opposite to non – logged stand (~ 41.82).

Table 5. Comparison of h/d coefficient in logged and non – logged stands

Variable resource	Sum of square	Degree of freedom	Mean of squares	F
Between groups	0.081	1	0.081	5.231*
Within groups	3.692	238		
Total	3.773	239	0.016	

* *Significant at the level of 5%*

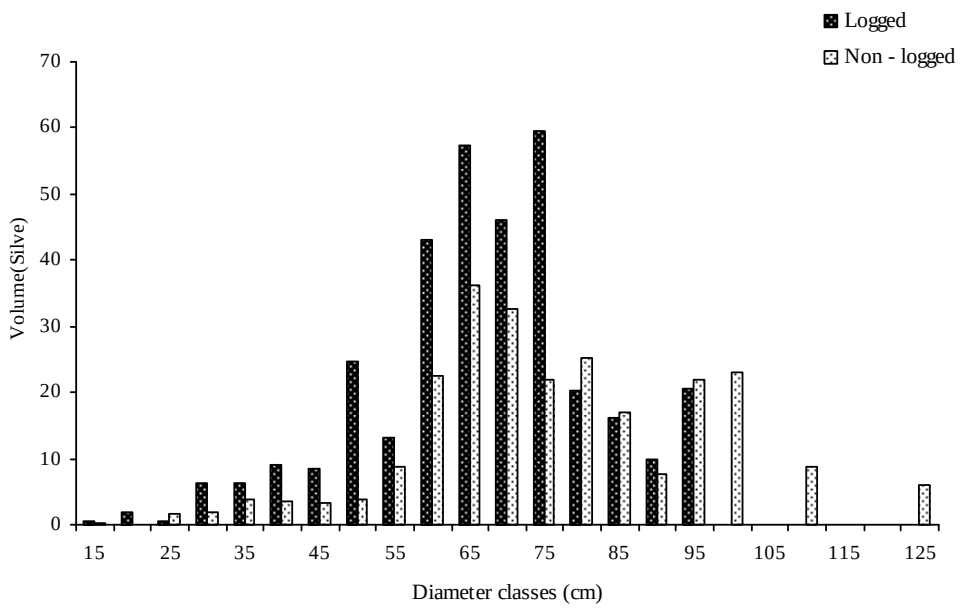

Fig 3. Comparison of trees volume for logged and non – logged stands

Comparison of regeneration total in two stands: Results showed that regeneration of beech and iron trees species are more than the other species (Fig 4). U – Man Whitney test is showed significant differences ($p<0.01$) for this factor.

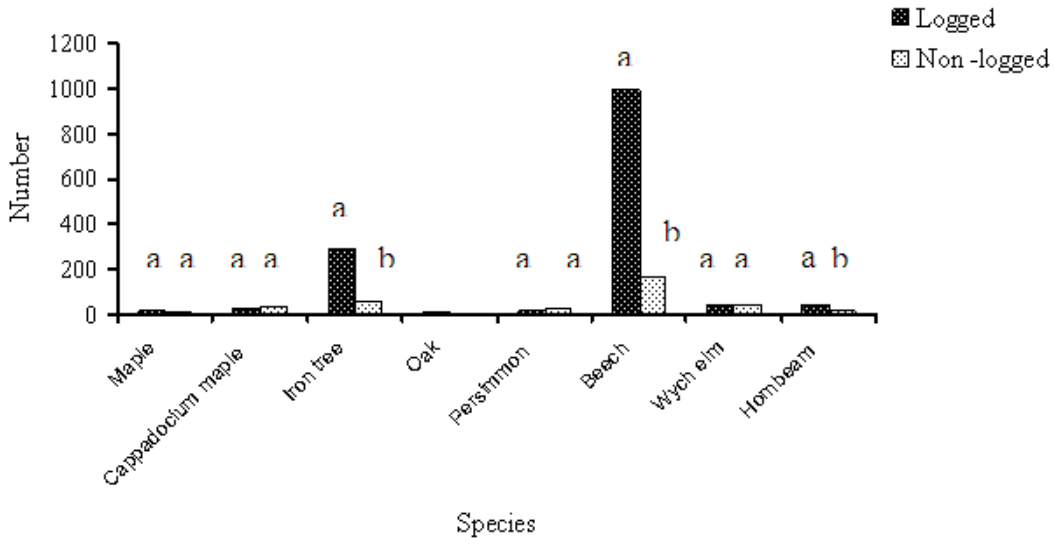

Fig. 4. Comparison of regeneration total for all of species

Comparison of regeneration desirability: Comparison of regeneration viewpoint desirability showed that the weak, moderate and good classes have significant differences each other ($p = 0.05$). Regeneration of two stands in good class has more frequency in every two regions (Fig. 5).

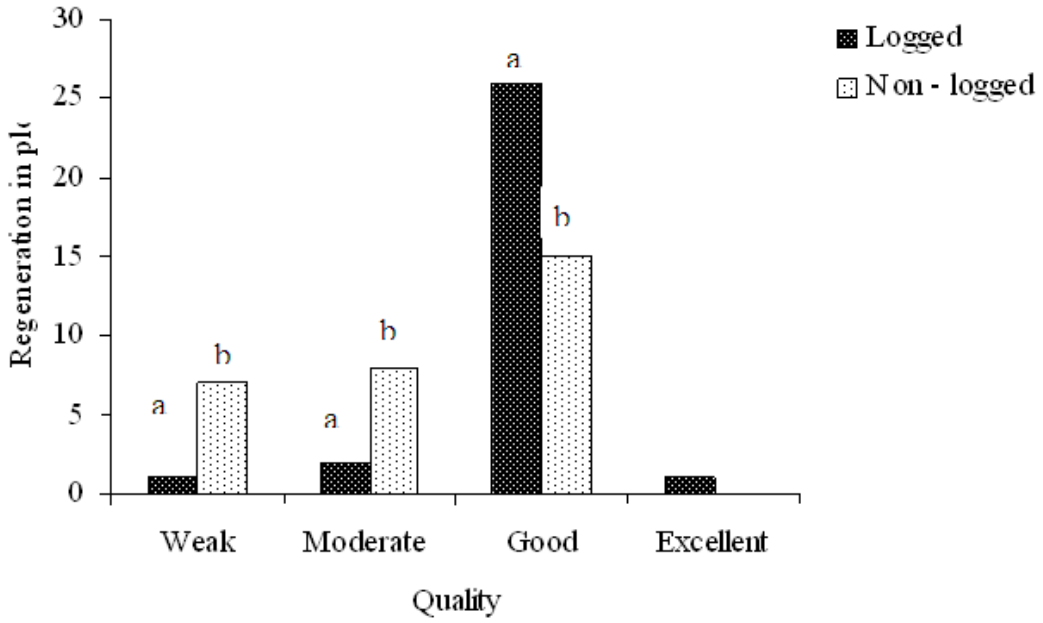

Fig. 5. Regeneration quality and grouping by SNK method

Comparison of beech regeneration in two stands: Results showed that the most regeneration of this species is in 50 – 75% crown cover class. SNK test showed significant differences at 5% confidence level between regeneration frequencies of beech in logged and non – logged stands (Fig. 6).

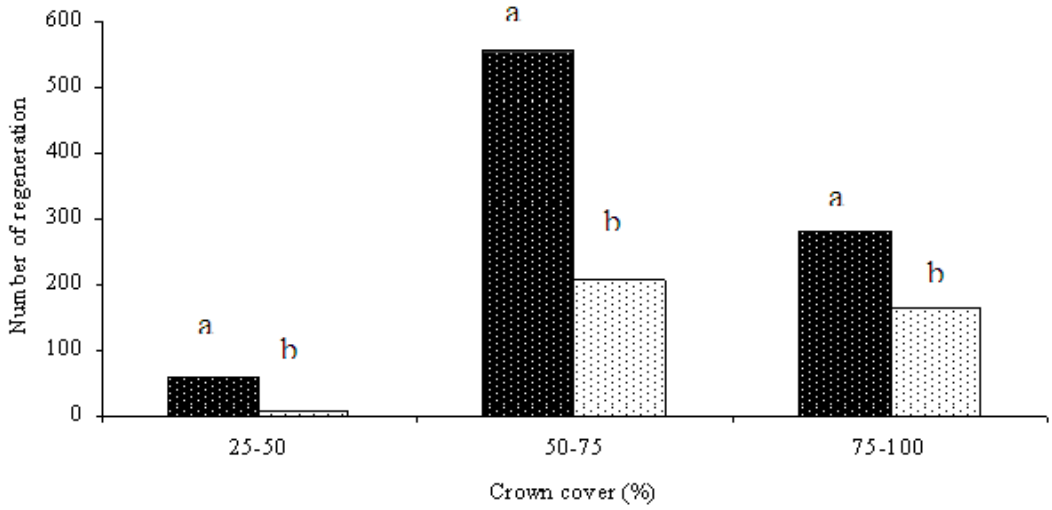

Fig. 6. Comparison of crown cover (%) with number of regeneration in two stands

Also, number of beech regeneration in different aspects is presented in figure 7. This is considerable that the most different of regeneration is in northeast aspect between two stands. SNK test showed significant differences ($p = 0.05$) at different aspects for regeneration (Fig. 7).

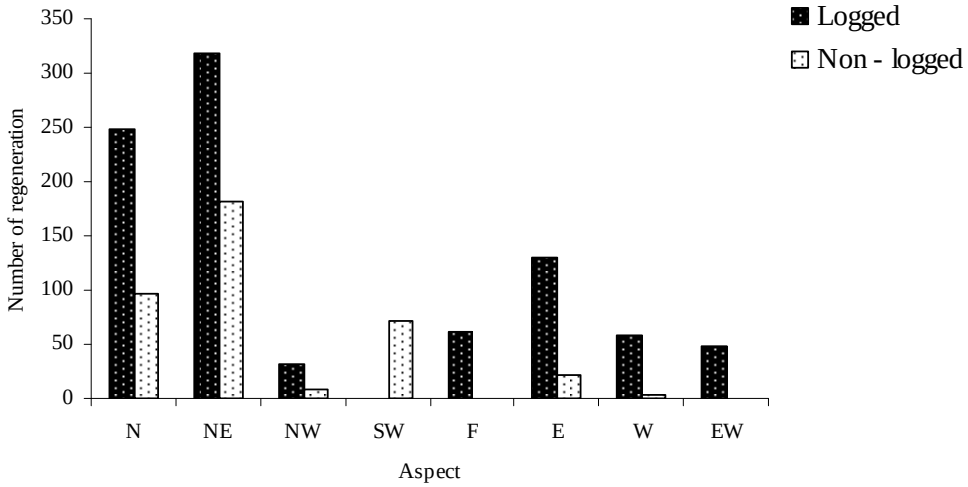

Fig. 7. Regeneration in different aspects for two stands

Number of beech regeneration in different slopes presented in figure 8. The most number of regeneration for logged and non – logged stands are in 40 – 50% and 50 – 60% slope classes, respectively. Regeneration of non - logged stand in 20 – 30% and 50 – 60% slope classes are more than logged stand. SNK test showed significant difference (p = 0.05) between beech regeneration at different classes of slope (Fig. 8).

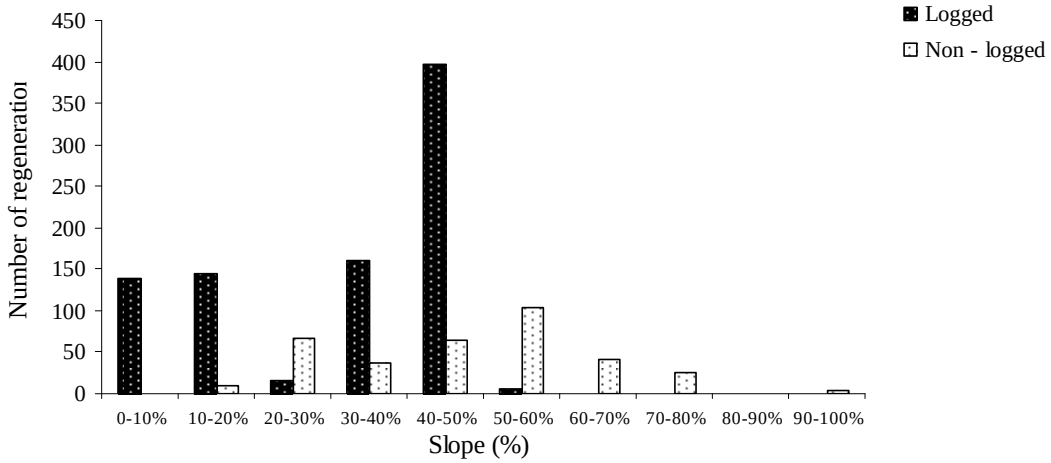

Fig. 8. Regeneration in different slope classes for two stands

DISSCUSSION

Logging in principle of forests can be due to increase of qualitative and quantitative production of forests [7]. Primary increment of regeneration is changed in forest regions with soil disturbance. Despite reduction of site areas by skidding routs but qualitative and quantitative production and forest regeneration can be increased by reason of logging in principle [18]. Investigation of herbal covering in studied areas showed significant differences in surveyed stands as some of invasive species such as Rubus and Ferns were established rapidly with logging and opening of stand and produce the hard conditions for native species (Fig. 1).

Diameter comparison of trees showed the significant difference between logged and non - logged stands (Table 1) as the logged stand had more diameter growth possibility by reason of virginity and until this study has continues to its growth which cause of thick trees harvest in the logged stand and this case can't be observed. But, beech species didn't show significant diameter difference between two stands (Table 2) by reason of the dominance of this species in stands and non- implementation of cutting in the logged part which leads to remaining maternal bases in the mentioned region. In fact it is mentionable that implemented cuttings were improvement and selective cutting which followed regeneration after it. Studying four trees near to the plot center in stands, following cases were specified which will be discussed.

Diameter at breast height: Significant difference of stands in this factor is representative of thicker trees in the natural and virgin stand and higher diameter mean in this (non - logged) which is pointed in the results section (Tables 9 and 10).

Total height: Insignificant difference of two stands in this parameter is representative that the total height two stands are almost equal, by reason of in the logged stand in one hand motive maintenance of some maternal bases, in order to regeneration continuity and in the other hand occasion competition between species toward height increment and attempt to acquire more light (Table 9 and 10).

Bole height: Studying bole height in the two stands and significant difference between them in this parameter is representative that in the non - logged region due to competition problem and more closed stand and less light for trees bole, clean bole, has higher length than the logged stand but in the logged stand cause of the interference in that stand and opening of it and more light contact with trees bole has been increased in this part of the tree which in turn causes to less bole length and this issue, is important economically, which highlights the necessity of tending operations in this region(Table 9 and 10).

Crown height: Mentioned reasons for previous mode reveals that crown length decreases with increasing of bole length as in the logged stand, higher crown length was observed and in the non - logged stand, less crown length was calculated. Thus, the stands have also significantly different to each other viewpoint crown height (Table 9 and 10).

Small and large diameter and crown basal area: In this case, there was not significant difference between the two stands, which can be indicated that crown spreading in the same size (Table 9 and 10).

Basal area: This factor has direct relation with diameter at breast height. Although there is a difference viewpoint diameter at breast height, thus the difference in these stands viewpoint basal area is inevitable (Table 9 and 10).

Volume: There was significant difference between stands. Pay attention to, diameter and height are the effective factors at calculation of volume. Insignificant difference in stand height and significant differences in stand diameter, thus the diameter factor is very effective in finding volume and caused to volume difference in the stands (Table 9 and 10).

Stature coefficient of the stands showed that the logged stand has more stature than to the non - logged stand which is representative of non – implementation of appropriate tending operations and in this mode, the stand is more susceptible against natural events. In the height curves of the logged and non - logged stands due to less diameter distributions in the logged stand there is more correlation between points forming curve and its correlation is higher. But in the non - logged stand motive of more diameter distributions the correlation between points forming curve is less (Fig. 2).

The volume curves of stands have higher correlation in logged stand and lower correlation in non - logged stand, like to height curves (Fig. 3). Therefore, the aforementioned reasons are acceptable for volume. Also, this subject is mentionable that high diameter classes are more in non - logged stand and more effective in stand volume. Regeneration in the logged and non - logged stands, at the different gradients is different so that at the low gradients and regeneration is higher in the logged stand which is due to the concentration of more generally harvest in this part and it can be said that after utilization the frequency of beech species is increased.

Vegetative pattern of trees in the logged and non - logged stands is different with each other [10] that are according to the results of this research. However, forest managers should implement a method in order to close forest logging to permanent production [5]. In the short term, logging has low effect on remained trees basal area because mortality due to logging is effective on trees with low diameters [15] which this subject was observed in this research.

Sfredrichsen and Mostacedo [18] found that logging increases trees regeneration. Commercial species can be more supported with controlling regeneration and it's leaded to sustainable forest management in next step that this subject is visible in current research for beech species. Mortazavi [14] investigated the effect of shelterwood cutting implementation in the langa forest management design. Result of his research showed that the number of saplings in the logged plot is more than control plot which corresponds with this research.

Ahi [3] studied the effect of shelterwood cutting implementation on the trees regeneration and concluded that logging is due to quantity and quality reduction of regeneration, which is not according to the results of current research. Esteghamat [8] surveyed regeneration in two managed and natural forests and concluded that regeneration frequency is lower in the managed forest which is on the contrary with the results of carried research. Abbasi [1]

investigated the effect of logging operations on the beech species regeneration and mentioned that the overflow logging and opening the forest the regeneration of beech species is decreased, strikingly. Hamidi Rad [9] also knows logging as a factor reducing regeneration, which is exactly vice versa of current research.

The results of this study showed that regeneration between two regions in the difference diameter regeneration classes is different and totally, beech saplings at the average crown coverage of 50 – 75%, northeastern aspect in 40 – 50% slopes, had good freshness (Figures 6, 7 and 8). It was also revealed that logging has caused to more regeneration but it can't be final judge and requires that this research be repeated in the logged and non - logged sites of several regions, in order to judge more confidently.

Pay attention to different results in the different regions purpose of this research was also specifying regenerations difference in non - logged and logged parts of the studied regions, which regard with regeneration difference parts and it was revealed that, after logging the forest should not be remained without attention and should be particularly cared and concentrations should be on the different effective factors on regeneration in each region.

Also, consider with the dynamics and self – reparation of forest and resettlement of natural regenerations with true management it is possible to prepare the forest for next use and also prevent from inappropriate species settlement (in viewpoint industrial) and denaturalization of forest. Therefore, the forest should be harvested in a way that besides maintenance of trees structure can be used economically and purpose of this research was the recognition of differences between the two logged and non - logged stands so that it can be better decided for logged stands and generally try to direct forest toward its natural mode with the appropriate implementation silvicultural methods.

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