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Full Length Research Paper

Investigation of the structure and distribution diameter classes models in beech forests of Northern Iran

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The study of natural stands structures and investigation of the utilization facility from probable theories can be a suitable instrument for future natural stands planning. Anyway, the present study was conducted at beech stands of uneven-aged from the southern aspect of Dorfak at a height of 1200 m of sea level in number 21 of the watershed basin, Guilan province. Four sample plots with 1 ha of dimensions' 100*100 were chosen in four aspects of the region (northern, southern, western and eastern). Inventory of trees was taken with an upper diameter of 7.5 cm as 100%. Then necessary measurements were done by drawing the horizontal and vertical profile on the tape with dimensions' 100*100 in the eastern north side of each plot. Based on analysis of the obtained data, the estimated frequencies calculated from the result of different statistical distributions were considered by CHI-Square test. The results showed that between different statistical models, the calculated Beta model created good fitting with the frequency diagram for three (southern, western and eastern aspects) of the four studied aspects. As such, the fact that today Meyer Model is used as a pattern to guide the stand by the selection system method, which in most cases does not accommodate the study's forest sites, should be taken into consideration. In the site of the study (the southern aspect stands), the Beta model can be used to guide and manage the natural stands.

Key words: Guilan beech, south aspect, statistical distributions, beta model.

INTRODUCTION

Forests are complicated, in that live and dynamic ecosystems have an impact on the process of formation. The Caspian region, which is included in the multitude forests from Astara to Gildaghi area, has valuable species in which beech stand is one of them. On the basis of existence statistics, this species included about 23.63% of the sample and 29.96% volume of the commercial forest's standing in the northern part of Iran, which is the main reason for investigating this species. The study of natural stands structure is essential for planning due to a determination of the species distribution, frequency and the method of trees mixture. In the investigation of the evolution phases, Leibungut (1959) divided the evolutionary and evolution phases in virgin forests into optimal, aged or to grow old phase, demolition (destruction) phase, single selection phase and young phase (Sagheb, 2001). In a research by Liocort (1898), it was indicated that trees distribution in an uneven-aged high forest has a decreased conditioning and the sample in the upper diameter classes decreased according to the determined coefficient from the sample in the preceding diameter class. He showed the optimal N of single selection stands as which is a geometric progression. However, a study was conducted on the structure of the uneven-aged forest by Meyer (1933), who defined the forest as a site that its primary volume and the remainder diameter distribution would not change if the current growth was removed as a periodical. He presented the power equation as ni = ke-adi to show the diameter distribution of this forest in which the number of diameter class, adi (the desired diameter class), e (the natural logarithm base) and a and k are coefficients of the equation. Leibungut (1959) believed that the

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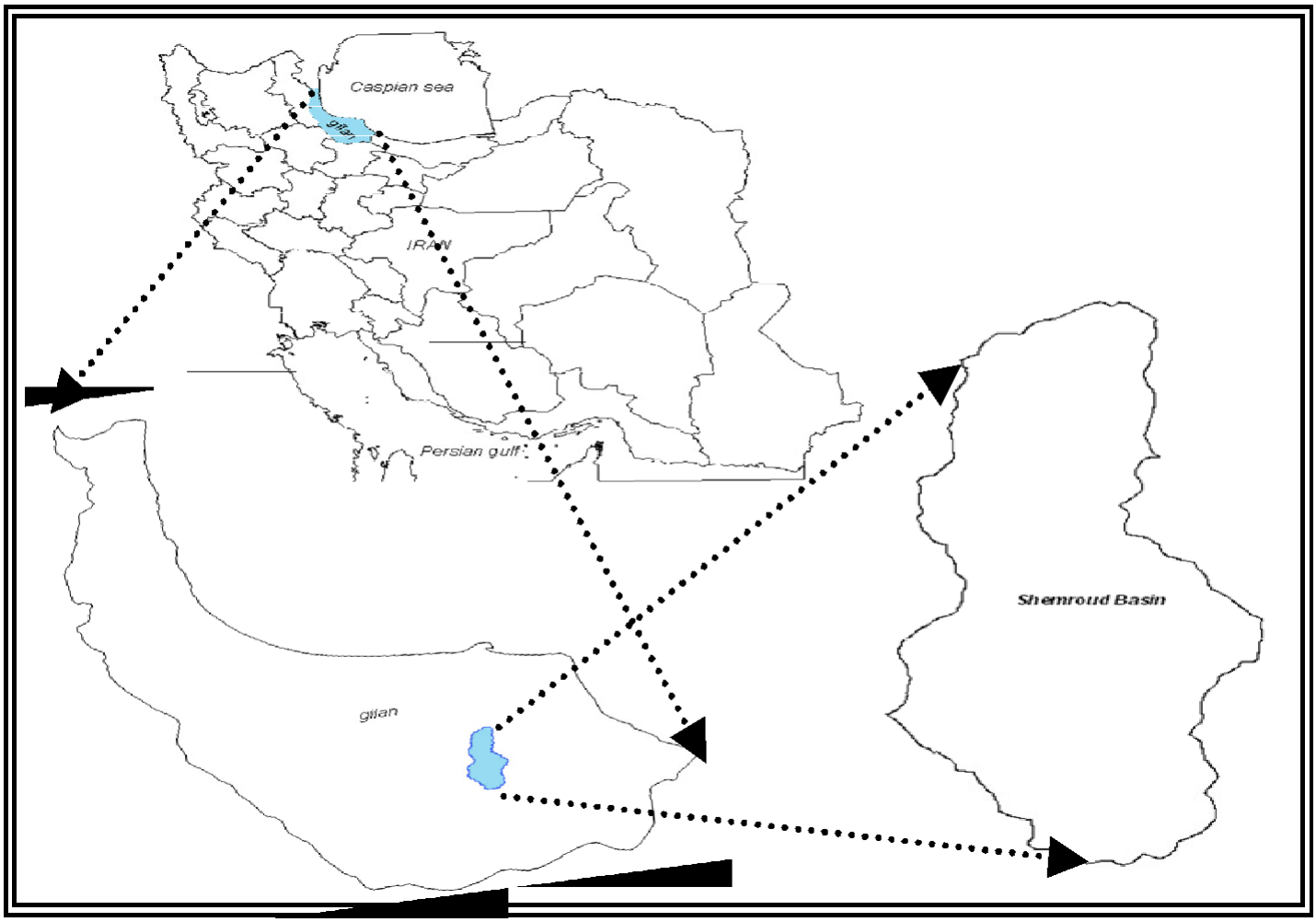

Figure 1. Location of the study area.

information relating to the mixture of trees, layering, healthy and juicy volume stands, the condition of the crown, the tree and situation of stands evolution should be collected carefully and should be considered in the future. Nanag (1998) indicated that the use of suitable probable theories for prediction of the distribution condition of the number of trees in a stand is important in estimation of the production type at different ages. According to Schreuder and Halfy (1977), Beta and Viboul distribution between the distributions that are to be used today, would be suitable in showing the method of number distribution in different diameter classes. Korpl (1995), in a distribution which was conducted at a protected area of Youhorlit in Slovakia, distinguished three evolution phases, such as: destruction, ascending and increasing of growth and optimal. Concerning the demonstration of the best suitable distribution, the selection of higher model and its parameter estimation and the selection of the best inventory distribution for the evolution of trees distribution volume, quality and the number in diameter class were presented with suitable precision in the future. Shunzhong et al. (2006) utilized the Exponential distribution for mixed forests of United States and also described satisfactorily this distribution for other forest stands. MohammadAlizadeh et al. (2010) considered the Exponential distribution as the lack of suitable fitting from among three distributions of Exponential, gama and log normal without consideration of the stands' evolution stages and two distribution of gama and log normal which was evaluated. Anyway, the purpose of this study, at first, was the consideration of the case study stands and then designing of a suitable model of diameter in the southern slope beech stands.

MATERIALS AND METHODS

Site of the study

The studied region is located in the southern slope of DorFak, in 21 basin of Guilan Province, and in the area under the protection of Department of Natural Resources of Roudbar Province, where it is about 20 km far from Tootkabon (Figure 1). This region is located in

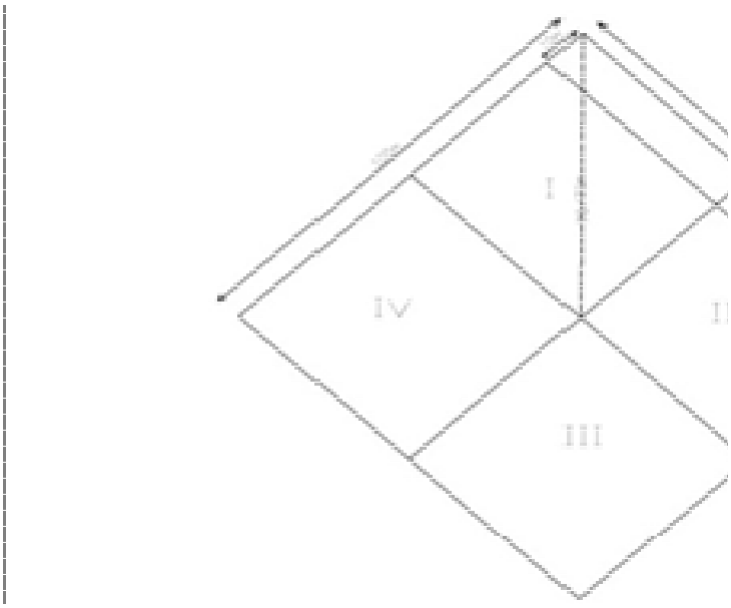

Figure 2. Sample plots.

the boundary line between northern latitude 22, 54 and 36 to 55, 58 and 36 and northern longitude 58, 36 and 49 to 58, 41 and 49. The total and public direction of this region was towards the southern aspect, while the total area of the region is 5383 ha. From this level, the downstream parts are similar to dry-land farms and residential areas or high slope because of having Mediterranean climate condition taken up by *Cupressus semprevirense* species. In the high level area, because of having high and rocky slope, *Juniperus polycarpos, Juniperus communis, Berberis vulgaris* and *Astragalus* were observed. The middle part (the site of the study) is located between two mentioned regions which have a tender slope and fertile soil and the mean altitude of 1200 m. Due to a gap in the Alborz mountain region, the Sefidrood river caused the penetration of rainy currents, and procured the condition for settlement of forest species and beech net stands observed together with other species in the southern slope (unlike the public nature of beech stand that frequently appear in the northern slope).

Methods

In carrying out this study, four sample plots with 1 He of dimensions' 100*100 were chosen in the likeness of lozenge at net beech stand on the series of 5 and 6 in 21 of the basins which are located in the south aspects of Dorfak summit. While no forestry design has been carried out in this forest yet, the stands have protected its natural state completely. Subsequently, these plots in the four aspects of the study's region (northern, southern, eastern and western) were conducted on a basin, which is about 1200 m of sea level, by the method of optional sampling, and in the area that has a similar situation of geology and pedology. Due to creation of the sample plots by the use of a compass, a tape measurement and a clinometer in the center of the area, the distance of 70.7 m was traversed after the choice of the area in the north, south, east and west direction, due to a differentiation of the four corners of the sample plot. After specifying the four corners of the sample plot, points were used as determinants and then the limitation of each sample plot was shut carefully with a string, before its four quarters were specified for facility measurement (Figure 2).

On each one of the executed sample plots, the total number of trees and their qualitative indexes were determined with the upper diameter at a breast height of 7.5 cm. To investigate the horizontal and vertical structure, at first a tape with dimensions' 100*10 m was executed in each one of the sample plots with 1 He along the eastern north side of the sample plots in the area. In addition to the total number of trees with an upper diameter of 7.5 cm, the tape's total height, length of stem, small and big diameter and length of crown and their local position (x and y) were measured too. By the way, regeneration is also counted in classes of -2.5 and 2.5 to 7.5 cm at this tape too. In the present study, the distribution of Beta has been used for the fitting of number distribution in diameter class, power, exponential, vibol, lognormal and normal, so that the best situation of distribution can be determined for the stand diameter classes in future and the suitable pattern of the region can be chosen by using the best fitting test. However, the obtained information can be analyzed by the use of the SPSS soft ware.

RESULTS

Results showed that the beech stands species and the *Carpinus betulus* and *Alunus Subcordata* species covered the level of the studied region with 95 to 98, 1.95 to 3.78 and 0 to 1.5%, consecutively. These two types of species have many percentages in the northern aspect as well (Table 1). In the sample plot with the northern aspect, the number is 476 N at ha, the Baseal area is 39.448 m^2 and the volume is 449.610 silv in ha. Towards other sample plots, they have more number and volume in ha, baseal area and mixed percent.

In the sample plot with the western aspect, the number is 411 N in ha and its volume is 341.883 silve in ha, while the Baseal area is 31.712 m^2. Due to the existence of a lot of numbers, the young trees have the minimum volume in ha, while the Baseal area is seen in the other

Table 1. Condition of trees in number, Baseal area and volume / ha in separation of species and the total in sample plot.

Sample plot	Species	Volume		Baseal area		Number	
		%	M^3	%	M^2	%	N
Number1 (North aspect)	*Fagus orientalis*	92.56	147416	91.95	27136	95.17	453
	Carpinus betulus	5.55	24.966	5.99	2.365	3.78	18
	Alnus glutinosa	1.89	8.497	2.06	0.812	1.05	5
	Sum	100	610499	100	44839	100	476
Number2 (West aspect)	*Fagus orientalis*	97.55	495333	97.25	83930	98.05	403
	Carpinus betulus	2.45	8.33	2.75	0.873	1.95	8
	Alnus glutinosa	0	0	0	0	-	-
	Sum	100	883341	100	71231	100	411
Number3 (South aspect)	*Fagus orientalis*	95.97	591340	95.85	82530	98.06	454
	Carpinus betulus	4.03	14.32	4.15	1.336	1.94	9
	Alnus glutinosa	0	0	0	0	-	-
	Sum	100	911354	100	16132	100	463
Number4 (South aspect)	*Fagus orientalis*	93.09	608360	92.59	37932	98.89	433
	Carpinus betulus	6.91	26.788	7.41	2.592	2.11	19
	Alnus glutinosa	0	0	0	0	-	-
	- Sum	100	396387	100	97413	100	462

Table 2. Comparison of number, baseal area and volume /ha at harvested sample plot.

Sample plot/ number	Sample plot/ aspect	Number/ ha	Baseal area (M2 in ha)	Volume (M3)
1	Northern	476	39/448	449/69
2	Western	411	31/712	341/883
3	Southern	463	32/161	354/911
4	Eastern	462	34/971	387/396

sample plots. In the sample plots with the eastern and southern aspects, the number in ha is approximately similar, but in the sample plot with southern aspect, due to the fact that the presence of thick trees has more baseal area and volume in ha of the harvested sample plot, the separation of species individually and as a whole is shown in Table 1 and their comparison is shown in Table 2. The diameter classes of frequency in the table are shown in Figure 3, while the number average distribution of the diameter classes is shown in Figure 4.

According to the tables and Figure 3, the number of diameter classes decreased with the increasing diameter in the entire investigated aspects approximately, but this decrease was not similar in different areas. Although forest structure is uneven-aged in different aspects, in the western aspect, the middle size tree has considerable frequency in classes. On the other hand, the frequency of the very thick and thick trees in northern aspects was more than other aspects. Therefore, the structure of the forest was different in various areas and aspects. In order to estimate the number in various diameter classes, the number of diameter classes was calculated in different aspects by using the probable distributions dependencies Figure 5.

In order to select the best fitting, it is necessary that each one of the Beta, Normal, Exponential, Power, Gama, Viabol and Lognormal patterns should be tested in the best fitting; but when $N \geq 40$, the frequency of each class should not be less than 2, and in case the frequency of classes is less than 2, it should be integrated in each other, so that the minimum number in diameter classes can be procured for the test, even though some of the sources are determined as 5 for the minimum predictable frequency which is obtained from χ^2 (CHI – square) test Table 4.

Taking into consideration the performed CHI square test, it is specified that the estimated CHI statistic(x) of Beta distribution in three aspects, that is, western, southern and eastern aspects, is less than the amount of the table statistic x. It is seen subsequently that the distributions (Beta distribution and observed frequency)

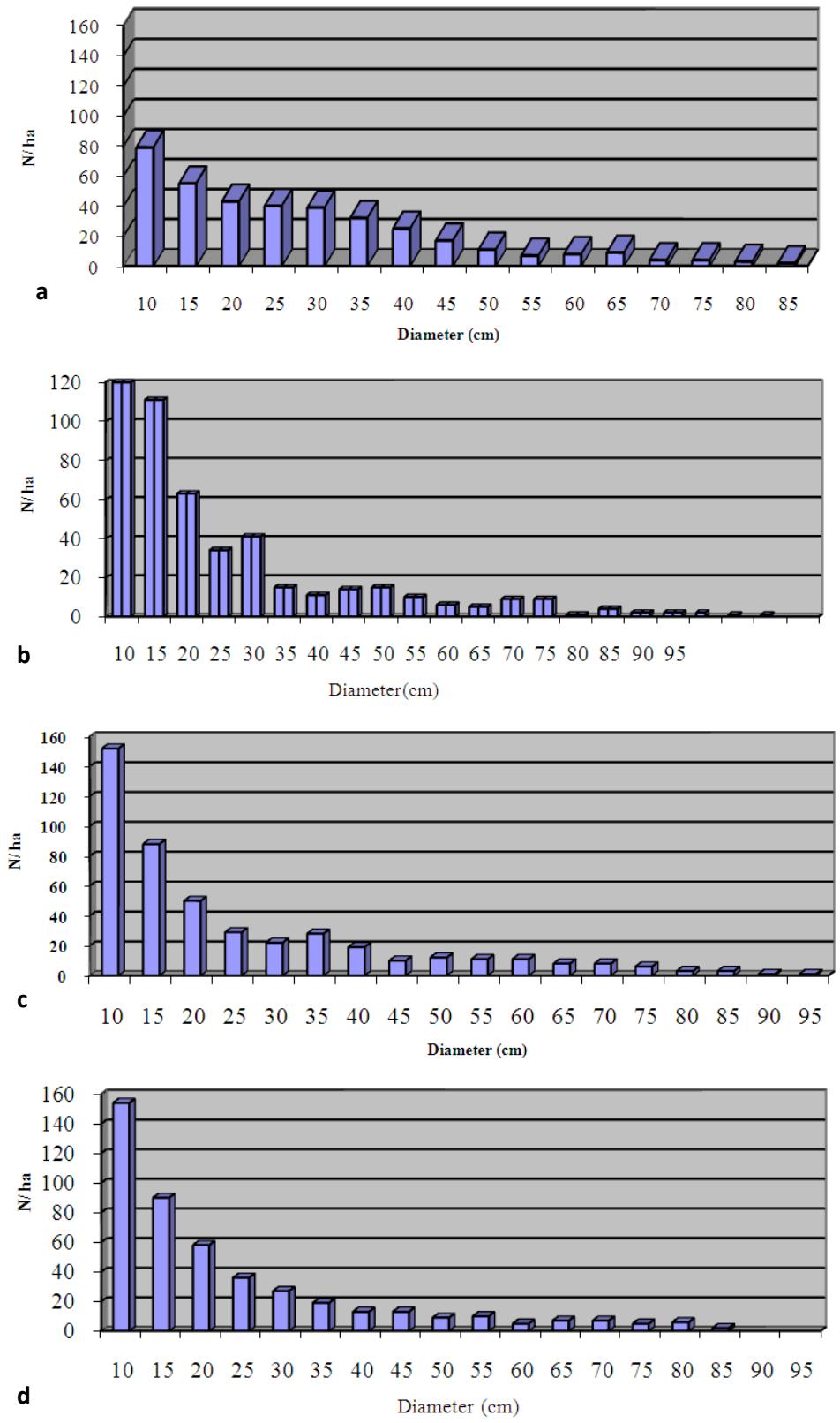

Figure 3. The number diagram of diameter classes at different aspects /ha. (a) The distribution number of diameter classes with west aspect in sample plot; (b) The distribution number of diameter classes with north aspect in sample plot: (c) The distribution number of diameter classes with east aspect in sample plot; (d) The distribution number of diameter classes with south aspect in sample plot.

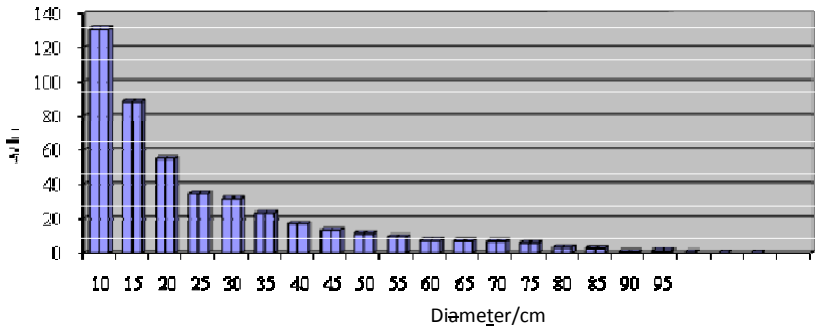

Figure 4. The number average distribution of diameter classes in the site of study.

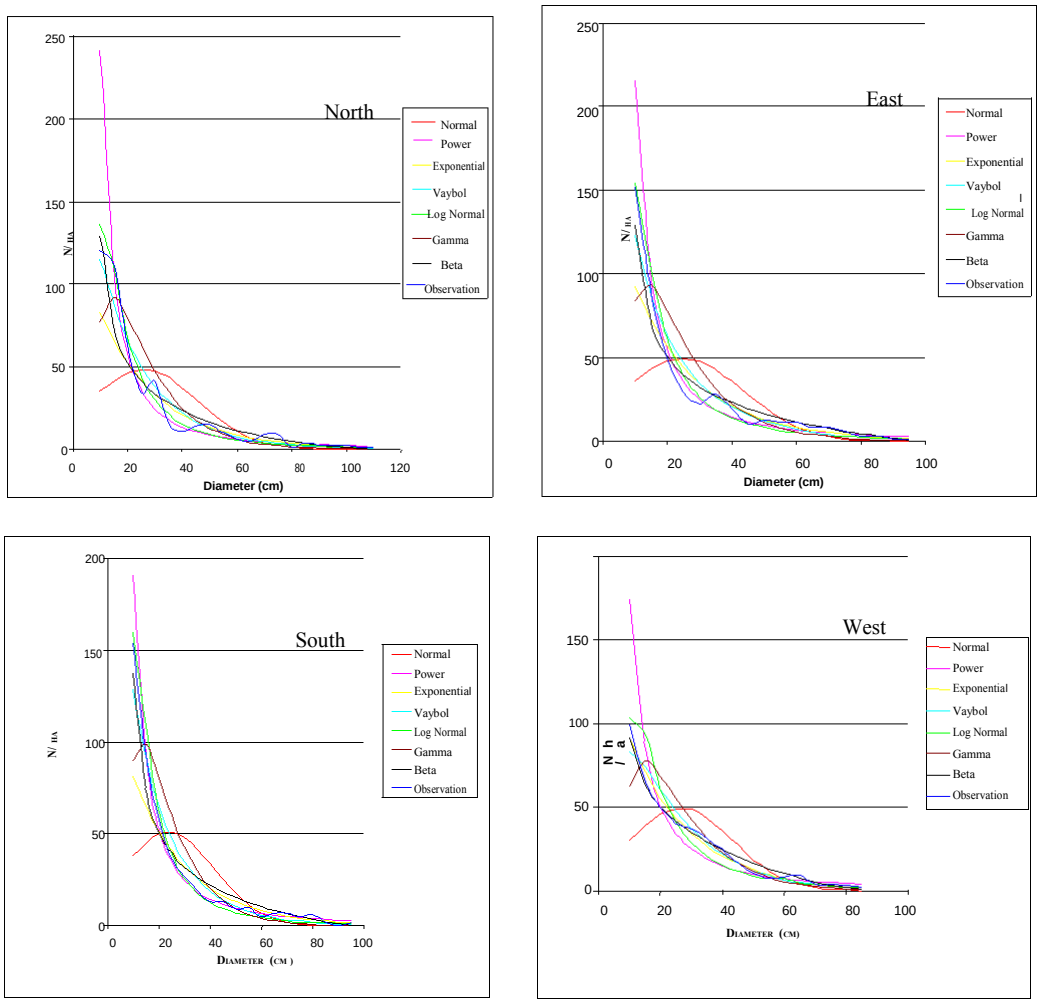

Figure 5. Comparison of the observed frequencies and estimation of the probable distributions in different aspects.

are not significantly different; and so it can be stated that if the estimated frequency of a community with observed and Beta distribution is taken into consideration, this community is distinguished by the Beta probability theory. This distribution (Beta) had the minimum of CHI statistic towards the predicted table in most of the aspects (except the northern aspect); therefore, it can be a pattern with better fitting for description of the forests of the region, and Beta model would create the good fitting in the distribution of the point cloud at different aspects (western, southern and eastern). Certainly, the Exponential and Vibol models (especially the Exponential

Table 3. Number frequency of diameter classes in sample plots and number average / ha.

Sample plot (1) (North aspect)	Sample plot (2) (West aspect)	Sample plot (3) (South aspect)	Sample plot (4) (East aspect)	Number Average /ha	Diameter classes (cm)
120	99	154	152	131.25	10
111	65	90	88	88.5	15
63	50	58	50	55.25	20
34	40	36	29	34.75	25
41	37	27	22	31.75	30
15	31	19	28	23.25	35
11	25	13	19	17	40
14	17	13	10	13.5	45
15	10	9	12	11.5	50
10	7	10	11	9.5	55
6	8	5	11	7.5	60
5	9	7	8	7.25	65
9	4	7	8	7	70
9	4	5	6	6	75
1	3	6	3	3.25	80
4	2	2	3	2.75	85
2			1	0.75	90
2		2	1	1.25	95
2				0.5	100
1				0.25	105
1				0.25	110
476	411	463	462	453	Sum

model) created more suitable fitting in distribution of the western aspect points, due to it having the less CHI Square which this fitting did not observe in other aspects. Also, the existing difference in the distributions of Power, Gama, Lognormal and normal in the whole aspects of the region, the Beta distribution in the northern aspect, and the Vibol and Exponential distribution in the northern, southern and eastern aspects, is significant with actual quantities. So, the mentioned models could not be indicative of the number link in diameter classes of the region.

DISCUSSION

The study of distribution slope and number in height and diameter classes indicated that beech stands structure, in quite large surfaces, is similar to the irregular uneven-aged in natural condition and without human interference in spite of having evolution in the various phases. It should be taken into consideration that this uneven-aged has been created by nature, because it does not carry out any interference on these stands. Therefore, by estimating the method of number distribution in the diameter classes of the studied stands, other methods can benefit from it as a pattern for guiding the other stands of this region with the method of uneven-aged high forest. According to Nanag (1998), the use of suitable probable theories for predicting the situation of distribution on the number of trees in a stand is not only important in estimating the type of production at different ages, but also in planning the method of thinning in forest, which can be useful and which will guarantee the economic production, resistance and optimum biologic of the stand. Table 3 and Figure 4 indicated that decreasing the number in the average diameter classes of the region had more regular condition towards the studied different aspects, while the observed fluctuations were not evident in the different aspects that were contrary to nature. Therefore, against some of the accomplished studies that put the average of number in diameter classes of the region based on the investigation of the natural stands' structure, the investigation of structure and number distribution models in diameter classes should be accomplished on the level of inventory plots which is indicative of the stands' situation. The assessment of CHI square statistics in the studied natural beech stands on the southern slopes of the Caspian forest indicated that in a way, the number distribution in diameter classes (investigation of different aspects) has the suitable fitting by Beta model and is not significantly different from the points of the cloud. The presented Beta model showed the best situation due to having the lowest amount of CHI square statistic in three aspects from the studied aspect

Table 4. CHI – square statistics for investigated probable distributions at different aspects in the site of study.

Model / Aspect	Observations	Normal	Log normal	Gama	Vibol	Power	Exponential	Beta
Northern	DF 18 K table 28.869	**761.378	**40.906	**36.005	**45.777	**94.563	**73.914	**55.230
Southern	DF 15 K table 24.966	**161.348	**32.809	**161.174	**38.04	**14.753	**89.941	ns 23.591
Western	DF 16 K table 26.296	**277.915	**36.231	**47.889	ns 14.413	**64.330	ns 6.899	ns 18.640
Eastern	DF 18 K table 26.296	**561.714	**45.951	**145.395	**37.444	**46.473	**63.127	ns 21.90

[1] Degrees of freedom. ** In the surface of %5 is significant. ns is not significant.

(eastern, southern and western aspects). So, this model can be used to guide the similar stands and the desired region in one selection of the forestry methods. The result of the present study has been accorded with the study of Kia (2003) in western Mazandaran (journal design) and the studies of Mataji and Namyranyan (2002) in Kheiroud kenar forest, but has been oppositely accorded to the studies which were carried along the presentation of normal curve based on Liokort de model to forestry design in Livan Banafshe Tapeh. Therefore, the statement of Housh et al. (1963) cannot be generalized for all the areas, as narrated by Meyer who stated that the presentation of the structure of uneven-aged forest was done by the Exponential model. The investigation of the result of this study and its comparison by Falah et al. (2005) was different from that stated by the model of regression; however, the Tavani model is indicative of suitable distribution in diameter classes in SangDeh and Shastkalateh area. Taking into consideration the fact that the studied forest has not been evaluated, the regression model does not express its view on this matter. Therefore, suitable achievement for the presentation of the uneven-aged structure in a forest will be different from taking into consideration the condition and its sites features. So, in the studied region, the southern slope sites can be used for the obtained distribution and model (Beta model) instead of the Meyer model, etc.

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