Eco. Env. & Cons. 18 (1) : 2012; pp. (19-23)

The study of some statistical distributions in order to fit *Fagus orientalis* (Beech) trees diameter in Iran's north forests

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(Received 5 October, 2011; accepted 15 November, 2011)

ABSTRACT

The distribution of the number of trees in different diameter classes is not only needed in the study of the quality of the forest stand progress but also they are used to assign the worth and the quality of production and standing stand supply. Thus recognizing and evaluating the quantitative characteristics of these stands is one of the primary need in forest programming. Nowadays, since probability distributions are very important in forest researches their application in forecasting the future of the stands can't be ignored. This study is done in order to present the most suitable diameter classes in number distribution model in a natural and uneven aged forest in which the least interference has taken place in. For this reason the number of 238 *Fagus orientalis* trees from 20, 10 R (1000 m^2) sample pieces with a network dimensions of 100×200 meters were random _systematically selected in Iran's north Siyahkal forests. I all sample pieces the trees diameter were more than 7.5 centimeters and they were full callipering and they were written down in the special forms. In order to fit the data the statistical models (distributions) normal, lognormal, weibull, beta, gamma and exponential were used. The results obtained from kolmogrof_smirnof test (k.s) showed that in the under study arena in order to fit the diameter classes in number distribution fit, normal distribution is suitable for this purpose. And the other distributions don't have the explaining ability and are not appropriate for this purpose.

Key words : *Fit, Probability, Fagus orientalis diameter classes, Iran's north forests, Siyahkal*

Introduction

The first and simplest quality that can be measured in forest stand trees is diameter breast height feature. Nowadays the number of trees distribution in diameter classes is used in different forestation and silviculture researches. For example, the forest export by the help of this curve uses the quality of operation progress in thinning and leading the forest towards regulation.

With the help of these curves which nowadays with the help of probability_ statistical distributions can be demonstrated easily, the quality of stand progress or the quality of the supply in different diameter classes in future can be predicted and it can be used in the programming (Cao, 2004). The first study that was done in Iran in this field refers to the study of the trees diameter distribution in Noshah's forests. In this study the 3 beta, weibull and negative binominal distributions were used, the results obtained from goodness fit, chi_square and kolmogrof_smirnof (k.s) tests showed that the two beta and weibull distributions don't have the ability to describe the trees diameter distribution (Bihamta and Chahouki, 2008). Nowadays frequency distributions and probability distributions have important

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roles in scientific forestation and actually in forest measurement and statistics and also forest production, frequency and statistical distributions and their application are very important (Fallah *et al.*, 2005).

Also the diameter distribution and the statistical model related to it can have an important role in some forest sciences discussions such as silviculture; for example, in some growing models it is necessary to make the diameter distribution function type and other parameters clear so that the desired model could be known (Mohammad *et al.*, 2009). In using the frequency distributions for presenting the distribution manner of the desired parameters a distribution should be used that calculates the best index composition of skew ness and kurtosis of the community distribution or in a more clear expression, the best distribution, is the distribution that evaluates the amounts of the mean, standard of deviation distribution extent in the most exact aspect (Mataji *et al.*, 2000).

in this direction a study was done to consider the trees diameter distribution in uneven aged stands in Gorazbon area Khairoud forest near Noshahr in Iran. In this study the 3 distribution beta, weibull and normal were fit to the related data ,the results obtained from chi_ square and kolomogrof_smirnof showed that the beta and weibull distributions have the ability to explain the distribution of the diameters data but the normal distribution doesn't have this ability.

In another research Fallah and his colleagues (2006) in order to study the Fagus orientalis trees diameter structure in uneven aged stands used a few regression models. In this study also the statistical models (distribution) beta, gamma, power, exponential, weibull, normal and log normal in order to consider the trees diameter data were used so that the power and agreement of these distribution could be revealed for diameter data fit (Namiriyan, 2006). During some studies shiver (1988) used the three maximum likelihood, modified moments, percentile methods to fit weibull distribution to pinus elioty diameter data (Namiriyan, 1993). Cao (2007) in another study that was done on pinus teada, the collected data from 200.6 hectare sample pieces was used. In this study the description of the trees diameter distribution was done by the distribution parameters the variables number in hectare, dominant altitude, stand 's age and relative distance of the trees were used (Namiriyan, 1993).

Materials and Methods

The study area

The study area is located in the western part of Siyahkal Shenroud forests in north of Iran and regarding to the geographical position it is located between 49º 47´ 50? geographical longitude and 36º 55´ 30? geographical latitude and minimum altitude from the sea level is 70 meters and its maximum altitude from the sea level equals 2100 meters and it's general slope is towards north. By considering that the mentioned area has 56 parcelles, a parcelle was chosen which reaching the area was easier as well as it had in tacted and uneven aged Fagus orientalis natural stands. Therefore after several sprayer forests the parcelle 751 with a measurement of 68 hectares which was located in the altitude area of 850-1000 meters was selected. Pedagogically the soil is acidic forest brown type with an average loam and argillaceous tissue and its ph is acidic. The area's average annual precipitation is 1266.5 mm and its average annual temperature is about 16 °C. The area's climate type is humid and its relative annual humidity is 78 percent.

Study method

In order to study the quality of *Fagus orientalis* trees diameter distribution it was tried to select the areas with less interference and uneven aged forest stands. on this basis in the under study area the desired parcelle was selected and the number of 238 Fagus orientalis treed from 20 circle shape sample pieces that each of their measurement was 1000 square meters in an inventory network with the dimensions of 100×200 meters were measured. In these percales the diameter breast is recorded as 7.5 centimeters and for further calculation they were saved in mini tab and spss software's.

Statistical distributions

Beta distribution

$$f(x)=\frac{1}{B(\alpha_1,\alpha_2)}\frac{(x-a)^{\alpha_1-1}(b-x)^{\alpha_2-1}}{(b-a)^{\alpha_1+\alpha_2-1}}$$

In this formula is the considered characteristic and α_1 and α_2 are distribution parameters.

Weibull distribution

$$f(x)=\frac{\alpha}{\beta}\left(\frac{x-y}{\beta}\right)^{\alpha-1}\exp\left(-\left(\frac{\chi-\gamma}{\beta}\right)^{\alpha}\right)$$

In this formula γ is the beginning point and β shows the degree of the curve and is the factor form curve.

Normal distribution

$$f(x)=\frac{\exp\left(-\frac{1}{2}\left(\frac{\chi-\mu}{\sigma}\right)^2\right)}{\sigma\sqrt{2\pi}} \quad \delta>0, \qquad \mu \varepsilon R, \quad \infty- < x <+\infty$$

Log normal distribution

$$f(x)=\frac{\exp\left(-\frac{1}{2}\left(\frac{\ln(x-\gamma)-\mu}{\sigma}\right)^2\right)}{(\chi-\gamma)\sigma\sqrt{2\pi}} \quad \delta>0, \quad \mu>0, \quad 0< x <+\infty$$

Gamma distribution

$$f(x)=\frac{(x-\gamma)^{\alpha-1}}{\beta^{\alpha}\Gamma(\alpha)}\exp(-(\chi-\gamma)/\beta) \quad \alpha,\beta>0, \qquad 0< x <+\infty$$

Γ, the symbol of gamma

Exponential distribution

$f(x) = \lambda \exp(-\lambda(x-\gamma)) \qquad y>0, \qquad 0<x<+\infty$

Considering the goodness fit

In this study the non_ parametric kolmogrof_ smirnof test was used in order to select the best fit (9).

Results

As seen in figure 1 the distribution diagram of *Fagus orientalis* trees diagram in number has a decrescent form but it's decreasing process isn't fast.

Also wide extents of trees are seen in different diameter classes that demonstrates its uneven aged structure. The existence of thick trees and extended distribution in diameter classes can be a reason for the naturalist for the above stand. In the distribution curve in diameter classes the numbers of trees with inadequate diameter are a lot and while the diameter increases the number of them decreases.

Table 1 also shows the results of the distribution calculation of 238 *Fagus orientalis* trees in 5 centimeters diameter classes that are measured in the present study stand along with the obtained evaluations from beta, weibull, exponential, gamma, lognormal evaluations from beta, weibull, exponential, gamma, lognormal and normal probable distributions.

In figure 2 the curves related to the observed frequencies of *Fagus orientalis* trees diameter in the study area and the evaluated frequencies from gamma, lognormal, normal, beta, weibull and exponential statistical distributions are shown.

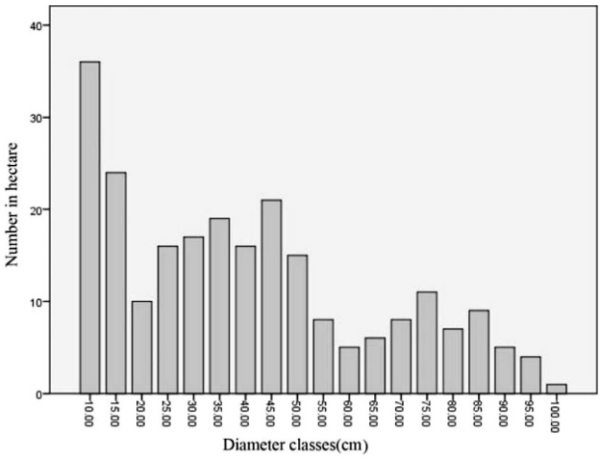

Fig 1. The diameter classes in hectare distribution of Fagus orientalis in the under study area.

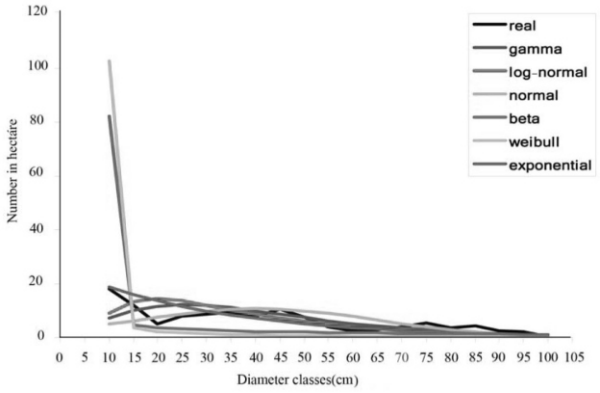

Fig 2. The comparison of the observed frequencies and the evaluated frequencies from probable distributions in the under study area.

According to the obtained results from kolmogrof_smirnof test the zero assumption from beta, weibull, exponential, gamma and log normal distributions are rejected with a 95% probability. And the only zero assumption is accepted for normal distribution (Table 2). Thus according to what has been said the normal distribution can be selected as a model with a better fit for *Fagus orientalis* trees in the study area.

Discussion

The consideration of the under study forest diam-

Table 1. The observed distribution of diameter classes in number and their evaluation with probable distributions

Diameter level	Observed quantity	Evaluated With gamma	Evaluated With log-normal	Evaluated With normal	Evaluated With beta	Evaluated With weibull	Evaluated With exponential
10	36	7.107	9.017	5.005	82.110	102.67	18.906
15	24	10.047	13.287	6.289	4.626	3.494	16.033
20	10	11.667	14.311	7.586	3.605	2.290	13.597
25	16	12.164	13.514	8.781	3.091	1.716	11.531
30	17	11.846	11.971	9.757	2.755	1.364	9.779
35	19	11.006	10.255	10.405	2.506	1.122	8.293
40	16	9.880	8.628	10.650	2.308	0.944	7.033
45	21	8.638	7.191	10.462	2.142	0.808	5.964
50	15	7.398	5.967	9.865	1.999	0.700	5.058
55	8	6.230	4.944	8.928	1.870	0.612	4.289
60	5	5.174	4.098	7.755	1.753	0.540	3.638
65	6	4.248	3.402	6.465	1.644	0.479	3.085
70	8	3.453	2.830	5.173	1.540	0.428	2.616
75	11	2.783	2.361	3.973	1.439	0.384	2.219
80	7	2.226	1.976	2.929	1.339	0.346	1.881
85	9	1.769	1.659	2.072	1.237	0.313	1.595
90	5	1.393	1.397	1.407	1.131	0.284	1.353
95	4	1.099	1.180	0.917	1.015	0.259	1.147
100	1	0.859	1.001	0.5773	0.879	0.236	0.973

Table 2. The results obtained from kolmogrof_smirnof test for the used statistical distributions

The distribution name	statistic	P-value
Beta	0.12126 $^{n.s}$	0.72239
Exponential	0.15126 $^{n.s}$	0.72232
Gamma	0.26695 $^{n.s}$	0.10997
Log-normal	0.11729 $^{n.s}$	0.9293
Normal	0.10955 **	0.95766
Weibull	0.16939 $^{n.s}$	0.58858

** Significant in 5%level n.s = non _significant

eter classes in number distribution diagram shows that the stand has a kind of uneven agedness. By considering the diameter classes wide slope and its decrescent from it can be said that studied stand is irregularly uneven aged. The present study shows that in order to fit the diameter data among beta normal, lognormal, weibull, exponential and gamma distributions only normal distribution is selected as a model with a better fit for Fagus orientalis stand in the under study area. Mataji and colleagues (2000) studies show that beta, weibull, normal probability distributions have more ability in order to explain the trees diameter distribution. Namiriyan (1990) after inventory from Garazban forests in north of Iran which is an uneven aged high forest seeding crop, accomplishing the statistical tests for determing the best probability distribution from the view point of its fitness in representing the trees number distribution method in different diameter classes, it became clear that the two distributions weibull and beta have high accuracy by considering kolmogrof_smirnof test's value, beta distribution showed that in has more fitness compared to weibull distribution. Also in Nord_larson and Cao studies in 2006 weibull distribution model was used for *Fagus orientalis* trees diameter distribution (Shiver, 1988). These studies express the power of statistical distributions in describing the important distribution variables especially diameter variable which the present study also proves this claim. For this it is suggested to repeat these type of researches several times so that a deeper knowledge could be gained about forest stands and this knowledge could be used for a better and more accurate programming. It is necessary to mention that the results obtained from this study is only true for the present study area and necessarily in other studies different results would be obtained.

References

Bihamta, M.R. Zare Chahouki, M.A. 2008. *Principles of Statistics for the Natural Resources Science*. University of Tehran press. 300.

Cao,Q.V. 2004. *Predicting Parameters of a Weibull Function for Modeling Diameter Distribution*. (translation).

Pergamon press, Oxford. 447.

Fallah, A., Zobeiry, M. and Marvi Mohajer, M.R. 2005. The presentation of the appropriate distribution diameter classes in number model Iran's north Fagus orientalis uneven aged and natural stands. *Iran's Natural Resources Journal.* 58 (4) : 813-821.

Mataji,A., Hojati, M. and Namiriyan, M. 2000. The study of diameter classes in number distribution in natural forests by the use of probability distributions. *Iran's Natural Resources Journal.* 53(2): 165-171.

Mohammad Alizadeh, Kh., Zobeiry, M., Namiriyan, M. Hourfar, A and Marvi Mohajer, M.R. 2009. The diameter breast height frequency distribution fit by the application of some statistical models (distribution), distribution forest and *Popular Research Journal.* 17(1): 116-124.

Namiriyan, M. 2006. Measuring the tree and biometry of the forest, Tehran University publication, 574.

Namiriyan, M. 1990. The application of probability theories in determining the trees distribution in different diameter classes. *Iran's Natural Resources Journal.* 44: 93-108.

Namiriyan, M. 1993. The practical application of beta frequency distribution, *Iran's Natural Resources Journal.* 46: 113-125.

Nord_larson, T. and Cao, Q.V. 2006. A diameter distribution model even aged beech in Denmark. *Forest Ecology and Management.* 231 : 218-225.

Shiver, B. D. 1988. Sample size and estimation method for the weibull distribution for unthinned slash pine plantation. *Forest Science.* 34(3) : 809-814.