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The Application of Statistical Distributions to Fit the Diameter and Height of a Species of Broad Leaf in Hirkanian Forests

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ABSTRACT: In order to Study the fit quality of some of the important quantitative characteristics of Fagus species such as diameter at breast height (D.B.H) and total height with the use of statistical distribution sparcel 751 in Siyahkal forests in north of Iran with a measurement of 68 hectares was selected containing Fagus stands in all- age and height levels and non-interference stand health. In this parcel net a vector statistics with dimensions 100 × 200 meters has been accomplished through a Random-systematic method, and 20 circle-shape pieces with 10R (1000m^2) measurements were made. In each sample piece, the diameter and height of all trees thicker than 7.5cm were measured. In order to fit these characteristics Beta, Weibull, Gamma, Normal, Log normal and Exponential statistical distributions were used. The results obtained from Kolmogrof-smirnov (K.S.) showed that the Normal distribution has caused a good fit for Fagus trees diameter distribution and the Beta distribution has the potential to explain the trees height.

Keywords: Fit, Statistical distributions, Fagus, Iran's north forests

INTRODUCTION

Iran's north Fagus forests are considered as one of the most valuable forest types in a way that this species alone forms 23.63 percent of number and 29.96 percent of volume of Iran's commercial and industrial forests. The continual decrease of these forest areas due to different reasons has made performing research regarding this valuable species necessary. This research too have been performed with the purpose of obtaining a better recognition of Fagus trees stands and the fitting of some of their important quantitative characteristics by the use of statistical distributions, so by applying these findings a better management would be performed for forests. The communities' individual statistical parameters change during time, so recognizing the quality of these changes helps the researcher a lot in comparing the present and the ideal situation. The study of trees' diameter at breast height in a forest stand has a very important role in the growth and production of stands (Burnhan, 2002; Lu *et al.*, 2003; Li-feng and Xin-nian, 2010). In this study too based on the existing studies and experiences for fitting the diameter and height, the Beta, Weibull, Gamma, Exponential, Normal and Log normal distributions were used. In one of the studies in this realm in order to consider the quality of trees' diameter at breast height and their fit with the use of statistical distributions, four one-hectare sample pieces in northern, southern, eastern and western directions of southern slope of Iran's northern Fagus forests were randomly selected.

In order to fit the data, the Beta, Gamma, Power, Exponential, Weibull, Normal and Log normal distributions were used. The results obtained from the χ^2 test showed that the Beta distribution in southern, western, and eastern directions and the Exponential distribution in western direction have provided a good fit for trees' diameter distribution (Fallahchai, 2011). In another study Nord-Larson and Cao (2006) in order to present a model for diameter distribution of even-aged Fagus trees in Denmark considered the Weibull distribution and realized that the application of this distribution was appropriate. Cao (2004) in a study on Pinusteada, used collected data from twenty 0.6 hectare sample pieces. The description of trees' diameter distribution was done by the help of three- parameter Weibull distribution, and for predicting the distribution parameters he used variables such as number in hectare, dominant height, age of the stand trees and the relative distance between trees. Nanang (1998) in a study on *Azadirachta indica* in Ghana used the three Weibull, Normal and log normal distributions. The K.S-test result showed that from the evaluation done in different age groups, the Log normal distribution had a desirable fit. In another study in natural forests of the Jian province of China Li-feng and Xin-nian (2010) by applying the Weibull, Beta, Gamma, and Exponential statistical models concluded that the Weibull distribution model compared to the other models had a better fit potential for trees' diameter in different accumulations.

Also, Zhang and Lei (2010) used collected data from the permanent 0.067 hectare plots of *Pinus tabulaeformis* during 5 years in north western forests of Beijing province in China and concluded that among the applied statistical models the Weibull distribution had more power deter mining the diameter distribution of *Pinus tabulaeformis* infixed sample pieces.

MATERIALS AND METHODS

The studied area with (68 hectares) is located in the western part of Siyahkal Shenroud forests of Guilan province in north of Iran. The series total area is 3077 hectares and includes 56 parcels. Its dimensions according to the UTM system is located among 50'' 47' 49° longitude and 30'' 35' 36° latitude. The studied piece is located among the height domains of 850 to 1000 meters above the sea level, and its general slope is towards north. The average slope is about 10 to 40 percent. From the penology point of view the soil type is acidic forest brown with argillaceous loam average tissue and its *p*H is acidic. The annual average precipitation is 1266.5 millimeters, and its annual average heat is 16° centigrade.

From the tree cover point of view, the studied area contains uneven aged stands of pure Fagus and accompanying species of Alnussubcordata, *Carpinusbetulus*, *Quereuscastaneifolia Area velutinum*, *Zelkovacarpinifolia*, *Sorbustorminalis* and *Tiliabegunifilia*. In this parcel 238 fagus trees from 20 circle- shape sample pieces with 10R area measurement in an inventory net with dimensions100 × 200 were measured. In these pieces diameter at breast height (D.B.H) and the total height of all trees thicker than 7.5cm were measured.

RESULTS

Fagus trees diameter fit. In Fig. 1 the curves related to the comparison between the observed frequencies and evaluated frequencies from Fagus species diameter probability distributions in the studied area are presented.

In order to study the fit power of applied probability distributions in this study, the KS- test was used, by considering the obtained results it has become clear that the Normal distribution having the least statistic has caused a good fit for Fagus trees diameter distributions (Table 1).

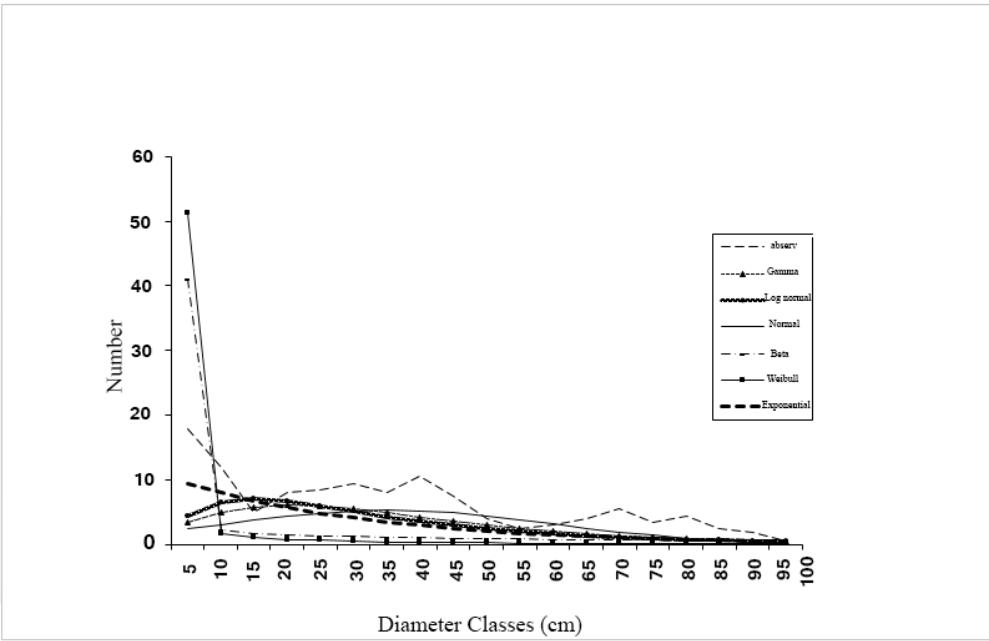

Fig.1. The comparison of observed frequencies and evaluated frequencies from Fagus species diameter probability distributions.

Table 1: KS amounts for Fagus trees diameter probability distributions.

Row	Distributions name	statistic
1	Beta	0.12126
2	Exponential	0.15126
3	Gamma	0.26695
4	Log normal	0.11729
5	Normal	0.10955*
6	Weibull	0.16939

*Significant at the level of 5 percent

Fagus trees height fit. The comparison of curves of observed frequencies with the evaluated frequencies from Fagus trees height probability distributions in the studied area (Fig. 2) and the K.S-test show that the Beta distribution having the least statistic has the capability to explain the Fagus trees' height (Table 2).

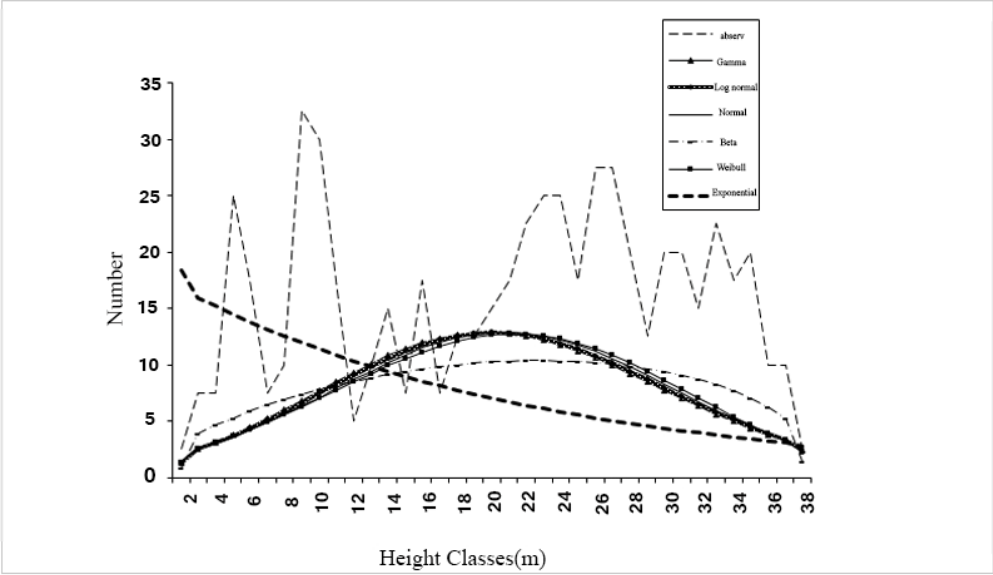

Fig. 2. The comparison of observed frequencies and evaluated frequencies from Fagus species height probability.

Table 2: The amounts of K.S for Fagus trees height probability distributions.

Row	Distributions name	statistic
1	Beta	0.075
2	Exponential	0.2209
3	Gamma	0.1011
4	Log normal	0.1023
5	Normal	0.1055
6	Weibull	0.10889

*Significant at the level of 5 percent

DISCUSSION

Evaluating the method of number distribution in forest stand diameter levels, it could be used as a pattern for leading other stands. The use of suitable statistical models for predicting the trees number distribution status in a forest stand is not only important estimating the production type inventory in different ages, but it could also be useful in the programming of forests and can guarantee an optimal biologic and economical production and the stability of the stand. According to the present study and other studies done in this field, we can reach the result that probability distributions are useful in estimation and manner of diameter, height and other quantitative characteristics of distribution patterns. Studies in the field of fitting trees diameter frequency by the use of probability distributions has begun recently in Iran, but it is at the beginning of its way. Studies of Namiranian (1990), Mataji *et al.* (2000) in Garazbonarea of khairoud kenar, Nowshahr, showed that the Weibull and Beta distributions were suitable for diameter at breast height.

Mohammad Alizadeh *et al.* (2009), in Garazbon area, have introduced the Gamma distribution with more capability for explaining diameter at breast height that is not compatible with the result of our study since among the applied distributions in our study the Normal one has caused a suitable fit for Fagus trees diameter distribution in the studied area. In another study performed by Fallahchai (2011) for the purpose of studying the procedure of the Fagus trees' diameter at breast height distribution and their fit by statistical distributions, it has been shown that the Beta distribution in eastern, western and southern directions, and the Exponential distributions in western direction have provided a good fit for trees diameter distribution. In comparing the results of this current study with other studies in other countries, as most of them have been performed in even-aged and conifer stands, the comparison would not be so desirable. As an example, Nord-Larson (2006) considered the Weibull distribution suitable for trees diameter distribution.

Cao (2004) introduced the three- parameter Weibull distribution for describing pinusteada trees diameter distribution. Li-feng and Xin-nian (2010) claimed that the Weibull distribution in comparison with other distributions has more fitting power for trees' diameter in different accumulations, and Zhang and Lei (2010) introduced the Weibull distribution with more fit power for explaining pinustabulae diameter distribution in north western forests of China. Regarding trees height frequency fit, since up to now similar studies have not been done, an appropriate comparison couldn't be performed with other researches. But this study showed that the Beta distribution in comparison with other distribution has the power to explain trees' height. According to the points mentioned, it seems that accessing a suitable model in a forest would be different noticing its site characteristics and conditions. So it has to be admitted that the results obtained here are influenced by this study's available data, and in other studies different results might be obtained.

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