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Evaluation of The Best-Fit Statistical Models for Distribution of Number On Diameter Classes in The Natural Pure Beech Stands; Case Study Forest Park of Sefidab

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ABSTRACT

The pure beech stands of the studied forest are uneven-aged stands so that they cover a wide range of trees from low-diameter to high-diameter trees. There are many trees in low-diameter category the number of which decreases as the diameter increases. Statistical distributions have not the same fitness and suffer restricted applications in terms of the type of stand. In other words, some statistical functions are highly fit to some stands while they low fit to other ones at the same time. In the studied forest, beta, normal, exponential, power, quadratic and logarithm distribution models were used. With the minimum chi-square value, quadratic distribution was introduced as the best fit model and beta distribution was introduced as the least fit model for describing the studied forest.

Keywords*: beach, chi-square, forest park, Sefidab, statistical model*

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INTRODUCTION

The ecological value of touched under-exploitation forests and natural intact ones is not the same so that the latter is more sustainable as they have been adopted over longer periods of time. The best method of forest management is to rely on models which are more compatible with the nature of that region. Definitely, the sustainable development of forests depends on the adherence to the specific nature of that forest because considering available capabilities the nature of each region selects a model and structure which is more compatible with the surrounding environment. The evaluation of natural stands makes it possible to identify the desirable factors available in sites, to study the natural evolution cycle of a forest evolved over long periods and to adopt natural models to manage forest resources.

Materials and methods

This study evaluates the pure beech forests of Sefidab Forest Park. This region is located in the eastern side of Gilan Province in the watershed no. 28. Regarding natural resources classification, it lies inside Roodsar forestry region subsidiary to the Natural Resource Management Organization of Gilan Province [Fig. 1]. The area of this region is 3943 ha. the majority of it has an altitude of >600m. The minimum altitude of the studied region is 150m located in the start point of the zone with a negligible area as compared to the total area of the studied region. The maximum altitude of the studied region is 3200m including the pasture heights of Shirekesh. Pedologically, this region is in regional soil category in terms of climate classification and in forest brown category in terms of European classification. Regarding Iranian soil classifications, it is classified in Khazar foothill soils and in forest brown to bleached brown soil sub-category. Regarding climate conditions, the annual precipitation of the studied region exceeds 2000mm with an annual mean temperature of 15.46^{oc} [Fig. 1].

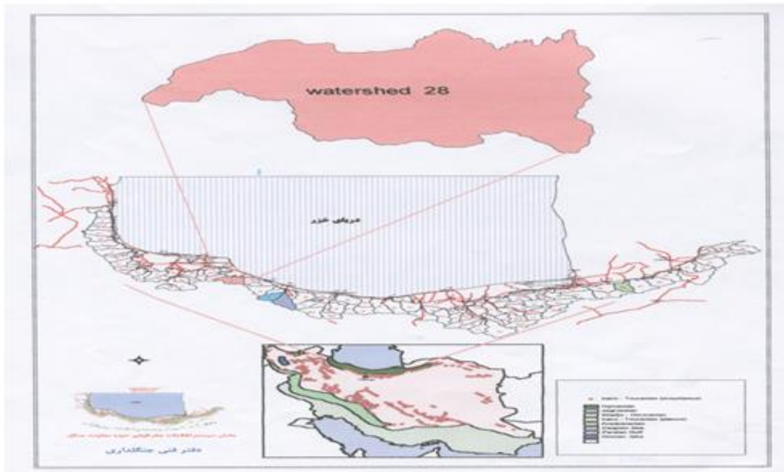

Fig. 1- position of watershed no. 28 located in the watersheds the north of Iran

This study was conducted on four sample plots with an area of 1 hectare. In the selection of the human intervention was kept in a minimum possible level and attempts were done to select the best possible plots representing the pure beeches of the studied region from stand status point of view. Then, inventory (100 percent inventory) was practiced in the plots where all trees with a dbh (diameter at breast height) of >7.5cm were measured (with cm accuracy) from the lower side of the steep. The graph of mean diameter distribution of the region was derived by averaging the graphs of the four studied sample plots and it had a decreasing shape but the decreasing trend was not sharp. However, it covers a wide range of trees with different diameters and clearly shows the uneven-aged structure of the stand. The existence of thick trees and the wide distribution of diameters may indicate that the studied region is natural. In the graph of mean diameter distribution, there are many low-diameter trees where as diameter increases, the number of such trees decreases. As it was mentioned before, this decreasing trend is not sharp [Fig. 2].

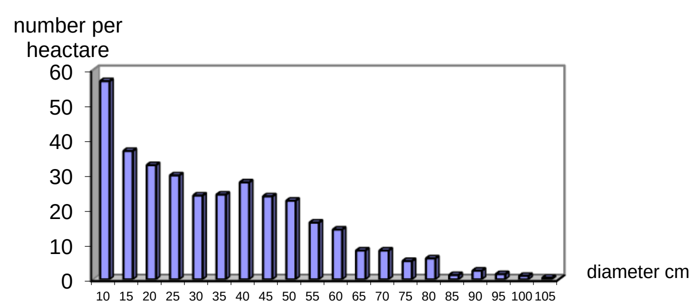

fig. 2: graph of mean diameter distribution per hectare in the pure beach area of ths tudied region

Then, suitable distributions for the stands were evaluated. Statistical distributions have not the same fitness and they have limited applications depending on the type of stands. In other words, some statistical functions show a higher fitness in some stands and a lower fitness in some others. To offer a model generating the best fitness in the cloud of diameter points, i.e. a model where the sum of estimations is less than the sum of observations, the frequency distribution graph was derived for different diameters of the studied stand. The distribution was compared with exponential, power, normal and beta distributions using chi-square test. It should be mentioned that such distributions are used only in the studied region. Table 1 shows the chi-square value of different distributions of the pure beech trees of the studied region.

Table 1: the chi-square value of different distributions of the pure beech trees of the studied region

Model type / Statistics	beta	normal	exponential	power
X^2	605.69	124.13	49.72	163.44

The chi-square value of beta, normal, exponential and power distributions is higher than the values mentioned in the table 1 in two probability levels of 5% and 1%. Exponential-estimated frequency better fits with the observed frequency while Beta-estimated frequency less fits with the observed frequency. By comparing the graphs of observed frequency with each distribution model it can be determined that which diameter distribution model best fits with the graphs of the diameter distribution of the studied forest. In addition, the graph derived from exponential distribution model overlaps with the observed distribution to a larger extent and exhibits a better fitness (figures 3, 4, 5 and 6).

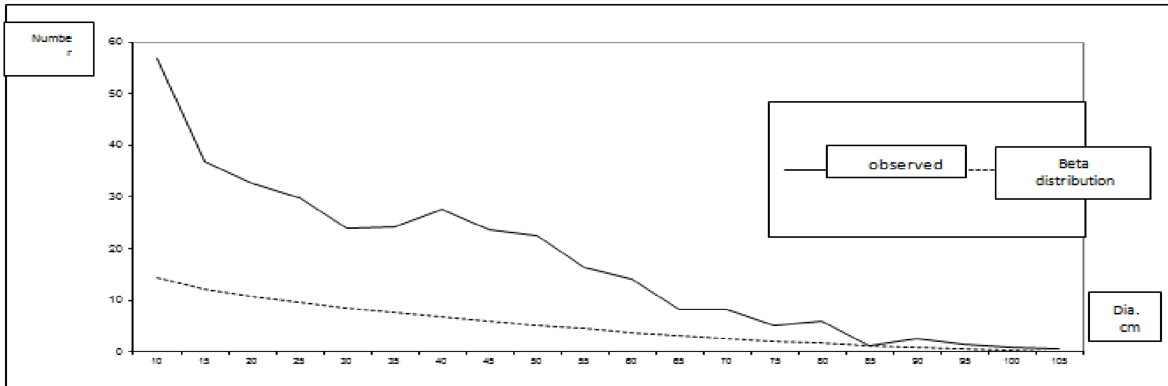

Fig. 3: observed frequency and beta-estimated frequency in the pure beech forest of the studied region

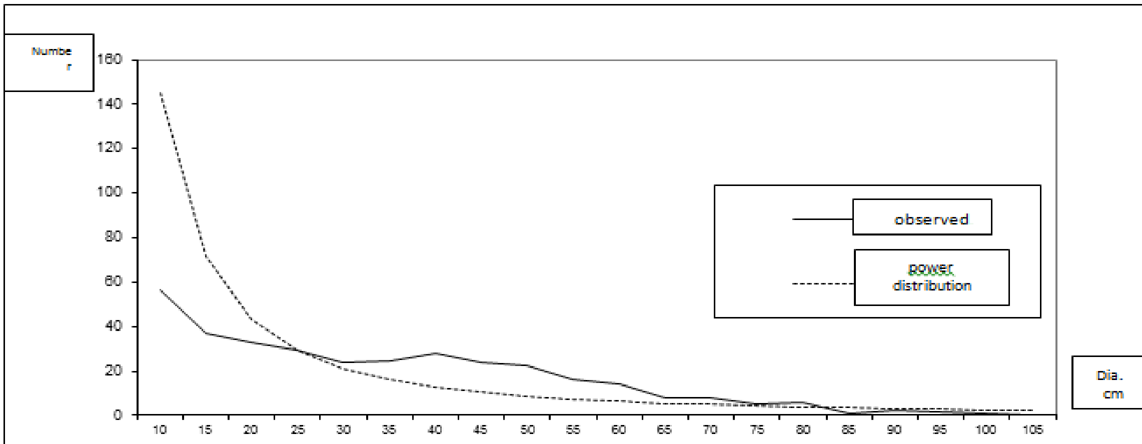

Fig. 4: observed frequency and power-estimated frequency in the pure beech forest of the studied region

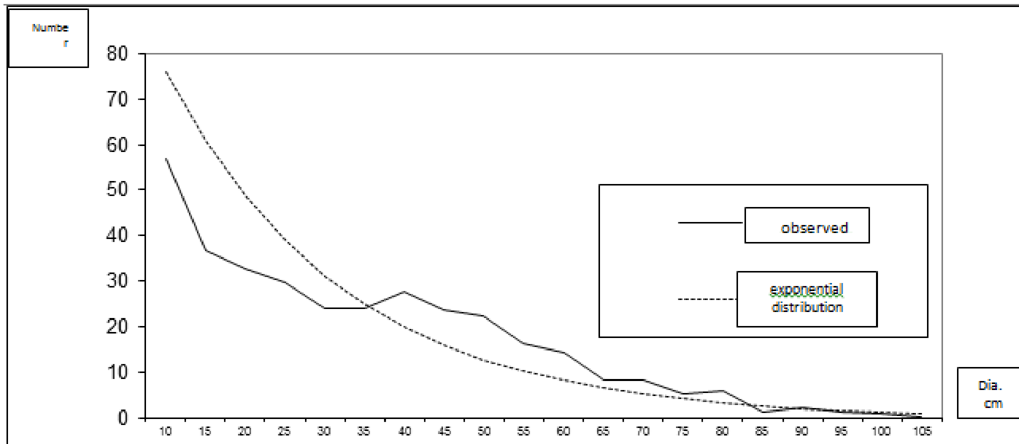

Fig. 5: observed frequency and exponential-estimated frequency in the pure beech forest of the studied region

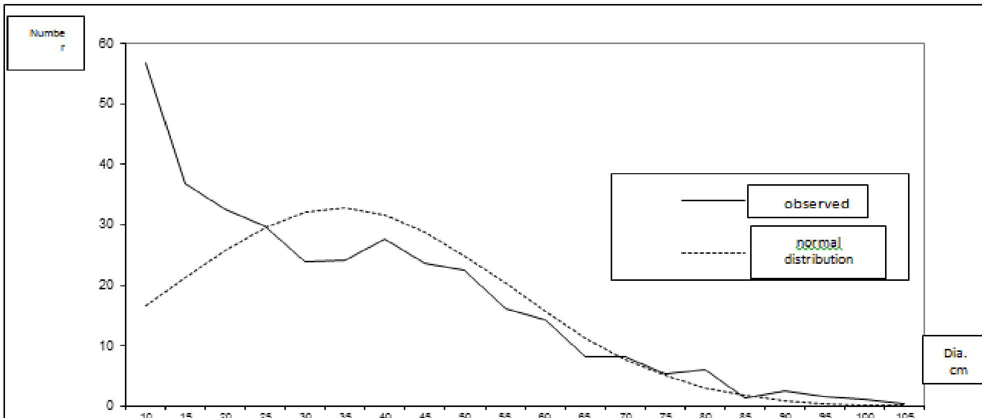

Fig. 6: observed frequency and normal-estimated frequency in the pure beech forest of the studied region

Since beta, normal, power and exponential models lack ideal overlap with the frequency graph of the studied pure beech, the other two models, i.e. logarithm and quadratic models, which better fit with the studied forest were selected. To select the best fit model, logarithm and quadratic distribution models were evaluated using chi-square test. Table 2 shows chi-square statistics for logarithm and quadratic model in the studied region.

Table 2: chi-square statistics of logarithm and quadratic models in the studied region

Type statistics	logarithm	quadratic
X^2	[illegible]	12.21

The obtained chi-square statistics for logarithm and quadratic distributions are less than the values of table 2 in two probability levels of 5% and 1% implying that the observed distribution is a random sample of the population and the specification of this population could be explained by quadratic and logarithm models. In addition, the selected distributions are applicable only in the studied regions. By comparing the graph of observed frequency with logarithm and quadratic distributions, one can know the fitness of the best dbh-based distribution model to some extent [figures 7 and 8].

DISCUSSION AND CONCLUSION

The review of the qualitative specifications of the studied pure beech stand shows the less contribution of alder species, which are occasionally observed in the stand, to the stand. Therefore, the studied stands can be called pure beech stands. The investigation of the dbh-based distribution range indicates the uneven-aged structure of the studied beech stands in normal condition. Korperl (1982) used 0.5 to 1 ha lands to study the growth, evolution and structural changes of stands in the natural forests of Slovakia. The number of such land differed from one region to another region in terms of stand status, mixture of species and their structural properties so that it ranged from 3 to 6 species. Vanderkerkove (1992) used 1 ha lands to study tree structure mix in the national park of Buycutt, Vietnam. In addition, he used rectangular sample plots (20m*50m) for profile representation purposes. Shaghaghi (1993) implemented single-tree selection on the forest ecology of beech species over a 10-year period (1981-1991) in the Jamand series of 500 sample plots of 10 ha. He drew dbh-based distribution graph of the early and end of the period and showed that the forests of this series have tend to change from abnormal uneven-aged regeneration to normal uneven-aged regeneration. In addition, he showed that dbh-based distribution graph is more uniform and normal in the last inventory compared with the inventory of previous period. This is held in all sample plots of Jamand series. However, he showed that aged and thick bases are still more uniform and are frequently observed across the sample plots. Namiranian (1990, 1993) introduced different theories for determining tree distribution in different dhb classes and suggested the creation of permanent and fix sample plots in order to derive their stand specifications and changes and apply them in the performance assessment of statistical-probability distribution theories. Kia Deliri (2003) studied the structure of the beech stands of Golband forestry project and stated that despite different large-scale change phases, the distribution of trees in dhb classes and the structure of the stands are irregular uneven-aged in normal condition and without human intervention. Fallah (2000) studied the structure of natural beech stands in Mazandaran and Golestan Provinces and stated that uneven-aged condition is clearly evident in the stands. The graph of the distribution of tress in different dbh classes of pure stands has a two-hump shape. Mataji (1999) studied the distribution of trees in dbh classes of the natural forest of Gorazbon region and illustrated a two-hump graph for whole the stand. Kia Daliri (2003) studied the structure of the natural beech stands in Golband forestry project and illustrated a two-hump graph for the distribution of trees in dhb classes.

Our study adopted exponential, power, normal, beta, quadratic and logarithm distribution models to evaluate the distribution of trees based on dbh classes. According to results, quadratic distribution and beta distribution models were introduced as the best and the worst fit models for describing the studied forest with a lower and higher chi-square statistics, respectively.

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