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The Application of Some Probability distributions in Order to Fit the Trees Diameter in North of Iran

Miir Mozaffar Fallahchai [1], Seyed Armin Hashemi[2]

[1,2] Department of Forestry, Lahijan Branch, Islamic Azad University , Lahijan, Iran

ABSTRACT

Bafq- In order to consider the tree's distribution of diameter breast height and their fit through some probability distributions two accumulations two accumulations of natural forest and man - made forest each with a measurement of 30 hectares were select in the west forest of Guilan province . By the means of random – systematic counting in each accumulations 18.5 R (500 m^2) sample pieces were separated and in all of them the entries trees with 5 Cm diameter were measured . In order to fit the data normal and exponential distributions were used for both accumulations. The results obtained from the calculations reveal that the natural accumulations have a worthy fit distribution for the trees diameter distribution. Normal distribution has showed a good capability in explaining the trees diameter distribution. So the models can be used as the appropriate models for describing the forests.

Key words: probability, fit , trees diameter, north of Iran.

INTRODUCTION

Diameter at breast height is one of most fundamental external characteristics or measurements for forest trees which may be studied from various aspects. For example diameter distribution of trees in a stand or forest can be studied . This distribution represents the stand or forest's diameter structure(Mohammad etal.,2010). Evaluation of the numbers of trees distribution in diameter classes by using desirable probability theories is important not only for estimating major production type but also it may be useful in forest planning (Nanang ,1998) . First attempts to model diameter data was performed (Bailey ,1980). For this purpose he used terms of geometric progression with general term : $a_n = aq^{1-n}$ .Mayer (1933) used exponential function $y = Ke^{-ax}$ to model diameter data [6]. In years almost after 1360 , using nominal distribution in silviculture became usual(Namiranian , 1989) . During some studies , shiver used 3 methods including Maximum likelihood , modified moments and percentile to fit weibull distribution to diameter data of Eliot pine. in a study in Ghana to fit data related to species Azadirachta indica used three methods including weibull Log – normal and normal(Nanang ,1998) . distributions . Results of Kolmogrov – Smirnov test displayed preference of log – normal distribution. In another study on *pinus teada* data was collected from 20 sample plots with dimension of 0.62 hectares. In this study description of tree's diameter distribution was performed by using three – parameter weibull distribution. Variables including the number in hectare, dominant height, stand age and tree's relative interval were used to predict distribution parameters (Cao , 2004). In another study, a model was developed for diameter distribution of beech trees by using weibull distribution suggested model was developed based on distribution information parameters by using non – linear least square methods (Nord etal.,2008). First studies performed in this area in Iran were about study on tree's diameter distribution in forest (Shiver ,1988). In this study Beta, weibull and negative binominal distributions. Results indicated that both weibull and beta distributions have capability to describe tree's diameter distribution. In present study also normal and exponential distribution models were used to study distribution of tree's diameter data to reflex these distributions potence and compatibility to fit diameter data:

2. METHOD

To study distribution of tree's diameter at breast height and its fitness by using probability distributions, two natural and manmade forest stands each with dimension of 30 hectares were selected in western Guilan's forest in 350m altitude from sea level. 18 sample plots each with dimension of 500 m^2 area were selected by using random – systematic method and all tree's with up to 5 cm diameter were measured by tape gauge. 462 tree's in 10 – 60 cm diameter range were measured in natural stand and 715 trees in 15 – 45 cm diameter range were measured in

***Correspondence Author:** Mir Mozaffar Fallahchai, Department of Forestry, Lahijan Branch, Islamic Azad University , Lahijan, Iran. Email: mir_mzoaffar@yahoo.com

man – made stand. Vegetation of natural stand was including oak and with high quality and man – made stand was covered by *pinus teada* with average 30 years old.

3. Statistical Distribution

In present study normal and exponential probability distributions have been used that their density function will be introduced in this section.

3.1. Normal Distribution

Normal distribution is one of continuous distributions which most of natural events if measured will have distributions approximately near it. For example distribution of number of trees in various diameter classes in a seven – aged forest stand with an almost normal distribution . Density function in this distribution is as follows :

(1) $$F(x) = \frac{1}{6\sqrt{\pi 2}} \exp^{-\frac{1}{2}\left(\frac{x-\mu}{\delta}\right)^2} \quad \delta > \circ \quad ، \mu \in R \quad ، -\infty < x < +\infty$$

Where in present study following equation has been used to provide normal distribution model :

(2) $$F(X_i) = \frac{n \times b}{S_x (\pi 2)^{\frac{1}{2}}} e^{-\frac{\mu^2}{2}}$$

Where n is the number , b is width of diameter classes , φ is average and S_x is standard deviation.

Exponential Distribution

This distribution is also continuous and it is known as waiting time distribution. Whose density function is as follows:

(3) $F(x) = \lambda \exp(-\lambda x) \quad \lambda > 0 \quad , -\infty < x < +\infty$

And following equation is used to develop exponential distribution model :

(4) $F(d_i) = K e^{-adi}$

Where d is tree's diameter and (a , k) are coefficients relative to equation.

4. RESULTS AND DISCUSSION

4.1. Probability distributions calculation for man – made stand

Table (1) provides results of distribution calculation for 715 trees in 5 cm diameter classes along with estimates obtained from normal and exponential distribution for man – made stand. These figures have been obtained by using equations 2 and 4.

Table 1 : Distribution of number in observed diameter classes and its estimation using probability distribution in man – made stand. Values obtained in table 1 have been used to compare observed frequencies versus estimated frequencies using normal and exponential distributions in man – made stand.

Number of estimation s from exponential distribution	Number of estimation from normal distribution	Number of estimations from observation	Diameter in cm
365	92	128	15
194	190	233	20
103	215	167	25
55	134	117	30
29	46	50	35
15	9	17	40
8	1	3	45

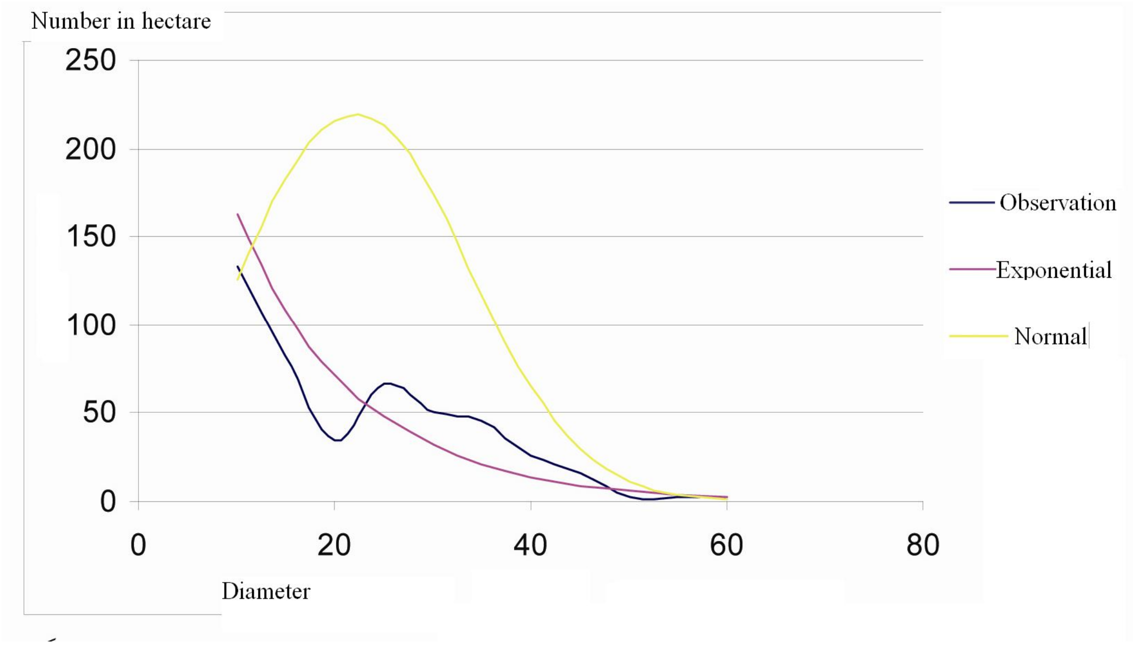

Figure 1 comparison between observed frequencies and estimated frequencies using probability distributions in man – made stand.

As can be observed, according to the fact that studied stand is man – made and even – aged observed frequencies are almost in agreement to normal distribution.

2.4. Calculations of probability distributions for natural stand.

Table 2 gives results of calculations `on 462 trees in 5 cm diameter classes along with estimations obtained from normal and exponential distributions in natural stand. It suggests that these values are also obtained from equations (2) and (4). In this section as well, values obtained in table 2 were used to compare observed frequencies against estimated frequencies using normal and exponential distribution in natural stand (Table 2).

Table 2: Distribution of number in observed diameter classes and their estimation by using probability distribution in natural stand.

Estimated number form exponential distribution	**Estimated number from normal distribution**	**Number obtained from observations**	**Diameter in cm**
162	126	133	10
108	182	83	15
72	216	34	20
48	213	66	25
32	174	50	30
21	117	46	35
14	65	26	40
9	30	16	45
6	11	3	50
4	4	2	55
2	1	3	60

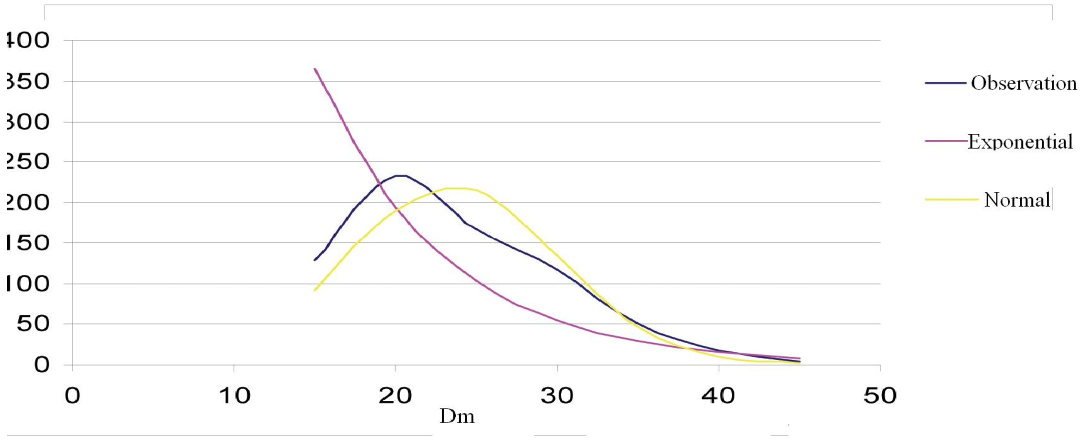

Figure 2 Comparison between observed and estimated frequencies using probability distribution in natural stand. According to Figure 2, it is observed that frequencies observed in natural stand follows exponential distribution and it can be considered as a pattern with better fit to describe natural forests.

Given the importance of diameter at breast height as most important biometric variable of forest trees, its study is of particular importance. On the other hand, frequency distribution for this variable is a subject using substantially to define diameter structure in stand or forest. But it can be useful in other cases such as growth models. Since using suitable probability theories to predict tree's distribution status in a forest stand is important (Nanang, 1998). According to these studies it could be suggested that various authors considered different results they obtained as convenient for conditions and characteristics of that given region which they will not be repeated necessarily in other forest regions. For example develop beta and weibull probability distribution to show trees distribution in various suitable diameter classes (Namiranian ,1989). Some researchers suggest that Beta , wiebull and normal probability distributions have greater capability to define tree's diameter distribution(Mataji et al .,1999) and also , during study on diameter data for *pinus teada* , defines weibull probability distribution as a suitable model(Cao , 2004). These comparisons indicate that ecologic characteristics of a forest must be in especial consideration to obtain a suitable model . Finally it is worth mentioning that results of this study are influenced by its data and it is likely that similar studies in different regions give different results.

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