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Measuring Tree Height and Preparation Volume Table Using an Innovative Method

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Abstract: Zarbin (*Cupressus sempervirence* var. *horizontalis*) with its unique characteristics is one of the worthiest species which can be found in the central area of Alborz in the North of Iran. Especially in the Roodbar-manjil area, Chaloos-Hassanabad valley as well as it extends from Zarringol area to Gorgan. Although the distribution areas of this species have been protected, these forests have been invaded by the villagers who use this useful wood. For this reason in the Roodbar area, trees with DBH>30 cm are extremely rare. To recognize and to be aware of the stand quantity, the current research tries to calculate the species volume table in Roodbar area, to be the basis for any calculation of the volume of stand in the region. For this purpose, trees have been sampled using the line sampling method. After estimating the form factor, Tarif table have been prepared. In this study, a new method for measuring tree height is presented, in which, instead of measuring slope distance from observer to tree (which is difficult in young conifers because of existence branches in lower height) distance between the eye level of observer to tree butt is measured. Which doing of it is easier, time of field work is decreased and accuracy of measurement and calculation is increased.

Key words: Tarif, volume table, tree, Roodbar, innovative method

INTRODUCTION

Forest measurement and inventory is the science which expresses methods of sampling from forest and this information determines how the manager should decide if the forest is suitable for utilization or it should be reserved (Asli *et al.*, 2000; Sadeghian, 2002; Zobeiry, 2004, 2006). Iran is the country in south west of Asia and in FAO proclamation 1.5% of its area covered by forest (Heidari, 1995). This research was carried out in Roodbar area in the North of Iran. Roodbar area in Alborz mountain range including Chaloos-Hassanabad valley and Zarringol area to Gorgan was proclaimed as protected area because of this native and useful species and forestry office permission is needed for cutting the trees.

But in the period before enclosure, over harvesting and shifting cultivation changes the physiognomy of the forest, over mature and intact trees are observed only around the holly shrine. For example in Shahzade-abootaleb area 12 large diameter Zarbin trees are observed with the diameter ranging from 52.8 to 130 cm and maximum height of 22.3 m (Taheri, 1994). In spite of utilization prohibition, it's necessary to prepare Volume table of this species for doing different researches, increment estimation and studying of stand growth. Tarif table is a table in which a volume for each diameter class is presented (Zobeiry, 2004, 2005 and 2006).

For preparing Tarif table, measuring tree height and diameter is necessary, for measuring tree height, horizontal distance should be measured. For calculating horizontal distance, measuring slope distance and ground slope is common (Zobeiry, 2004). In this study for abbreviation in operation, instead of slope distance on the ground, slope distance from observer eye level to tree butt was measured. About preparing volume table some studies were done in Iran country which not about Zarbin.

For example, Ekhlesi (2000) has prepared Tarif table in Guilan area (North of Iran), the height of trees up to dm and diameter of them up to cm were measured and by form factor estimation, volume table obtained. Almost, 200 trees were measured for preparing beech species (*Fagus orientalis*) in Patom district in Kheirood-Kenar forest and for using this table, with DBH and height, exact volume is obtained by Heidari (1995).

Poorbeik (2000) chose 40 trees with random sampling method in pine compartment located in Fonton blue and cut them. He calculated the tree volume table in mathematic way. Pashayee (2006) have investigated precision of volume table (Tarif) for Hornbeam species (*Carpinus betulus*) in Konesrood forests (North of Iran). His research showed significant differences between volume table of calculated Tarif and existed Tarif, also, calculated Tarif is suitable and more precision by reason of haven't non-natural mutation in high diameter classes.

Also, volume table are well studied and results for models have been reported by Matis (2000), Leech *et al.* (2000), Pohjonen (2001), Wiant *et al.* (2002) and Maria Rita and Borders (2005).

MATERIALS AND METHODS

Study area: The study area was including public area of Roodbar with latitude 36°, 46' and the elevation between 450-650 m above sees level in North of Iran. All these Forests (Roodbar) are destructed because of traditional utilization and shifting cultivation which some scattered area of these forests is remained now. But this Species could survive its regeneration because of production a lot of stump sprout and high seed viability Zarbin was measured in different and sparse stands called Moshirabad, Mishinab valley, Saidan which are located in northern slopes.

The area of these stands was calculated from topographic maps (1:25000) which is about 670 hectare. Moshir-abad stand is young, pure and high density stand in some areas with height up to 12 m and diameter <18 cm. The soil is sufficient and compacted. The soil of Seidan is deep and little unstable which bed rock is not observed on it. The stand is relatively old growth with good regeneration and most of the trees do not have normal shape because of traditional utilization. In humid areas broad leaved trees such as oak (*Quercus* sp.) and hornbeam (*Carpinus betulus*) are more than Zarbin. This research was performed in the summer of 2006.

Data collections: It is necessary to measure the height, mid diameter and DBH of tree and the instruments were such as measuring tape, clinometers, diameter tape and compass. For researches and getting to this purpose several methods have been proposed for sampling in forest inventory. Among them random systematic sampling is preferred (Zobeiry, 2004, 2006). Since the area of each stand is not so much, small sampling plot should be selected. Totally, there are two methods a bout sampling plot: 1) Choosing small sampling plot and their number should be increased for proper distribution of samples, 2) Choosing sample trees instead of sampling plot which the second method is preferred because of better distribution of samples (Zobeiry, 2004).

For this purpose, after field inspection and mastering over them from mountains, some lines were chosen as sample line which indicates all variations of stand such as high and down altitudes, valleys, slopes with different aspects. Then the distance between samples were computed according to the number of required samples. In each diameter class, 2-3 samples were needed. The minimum and maximum limits of tables were 7 and 30-40 cm

so it was necessary to measure 50-100 samples. For example in every 50 m unconsidered azimuth, one tree was measured. For this purpose, we moved in specific azimuth in every line with a compass and after each 50 m one point was determined and the nearest tree to this point was chosen as a sample tree. It must be noted, most of samples were in small diameters because of the high density in smaller diameter classes. After measuring 3 samples in each diameter class other samples were ignored because in each class, 2-3 samples were required.

RESULTS

For measuring height and DBH, clinometers, measuring tape and diameter tape were used. For this purpose we must stand in a distance almost equal to tree height so that the butt and top of tree can be observed easily (Fig. 1). Horizontal distance to tree is required to compute the L for this purpose it is common to measure slope distance with two range poles.

Then the ground slope (the angle between horizontal line and parallel line to surface) was measured. Slope distance is measured too. Thus, horizontal distance = L = slope distance × cos (ground slope). For abbreviation in operations and reducing the mistakes (resulting in a lot of measurements) instead of slope distance on the ground, slope distance from observer eye level to tree butt is measured (OF). For measuring this angle Arctg of butt slope was calculated. Horizontal distance was obtained with Eq. 1.

$$L = \cos[\text{Arctg}(\text{tg}\beta)] \times \text{OF} \quad (1)$$

It is worth mentioning that this method is proposed for the first time and it is suitable for conifers with the height < 20 m in which measuring slope distance from observer to tree is very difficult because of many branches in lower height of tree and it is not very accurate. Height is calculated from Eq. 2.

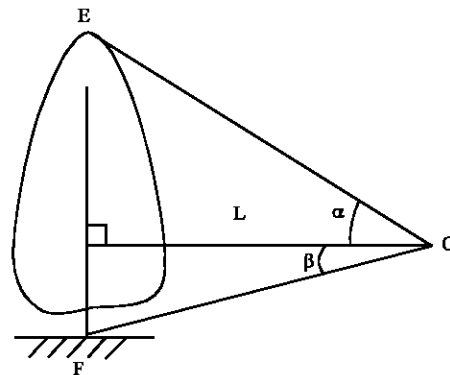


Fig. 1: How to measuring

$$h = EF = L \times (|\text{tg}\alpha| + |\text{tg}\beta|) \quad (2)$$

For measuring diameter in mid-height, diameter tape was used. For finding the place of mid-height, top and butt slopes were added up and divided by two (Eq. 3).

$$h/2 = (|\text{tg}\alpha| + |\text{tg}\beta|) \times L/2 \quad (3)$$

For calculating the tree volume form factor was used. Form factor is ratio of real volume of tree to cylinder volume which its height equals to tree height and its base equals to basal area (Eq. 4).

$$f = \frac{v}{V} = \frac{\frac{\pi \times dm^2}{4} \times h}{\frac{\pi \times D^2}{4} \times h} = \frac{dm^2}{D^2} \quad (4)$$

where, v, real volume of tree is cylinder volume with height and base area equal to tree height and basal area; D, diameter at breast height; dm, mid-diameter ($d_{0.5}$). Tree volume is calculated with height and form factor (Eq. 5).

$$V = g \times f \times h \quad (5)$$

where, h, total height of tree; f, form factor; g, basal area that calculated from DBH (Eq. 6). Table 1 is prepared after above calculations.

$$g = \frac{d_{1.3}^2}{4} \times \pi \quad (6)$$

Analysis of data has showed that the correlation between height, form factor and volume with DBH are 0.721, -0.301 and 0.876, respectively. After data analysis, these regressions were obtained. For preparation of volume table, volume related to each diameter class was computed using regression and volume related to each diameter class was obtained from binomial equation (Eq. 7).

$$V = 0.0003367411D^2 - 0.000694928D - 0.00337732 \quad (7)$$

where:

V estimated volume (m^3); D, DBH (cm).

DISCUSSION

Zarbin Tarif in Roodbar area and the result of this study is presented in Table 2. This volume table is suitable for trees up to 30 cm. Because trees with more diameter have specific form and out of range volumes (because of villagers harvesting) and for this reason, samples with diameter >30 cm and sample 44 because of being forked stem are omitted. These samples in scatter gram are separated significantly and omission of them results in increasing correlation coefficient. Commonly diameter classes in volume tables of Northern forests of Iran are 5 cm but in this research volume table is classified to 1 cm because tree diameters are restricted to 30 cm.

Table 1: Characteristics volume of sample trees

No. of sample	DBH	Height	Mid-diameter	Form factor	Volume	Considerations
1	14.0	7.7	6.4	0.209	0.025	
2	9.4	4.9	5.6	0.355	0.012	
3	8.9	4.9	5.2	0.341	0.010	
4	13.0	6.5	8.5	0.427	0.037	
5	8.3	4.5	4.7	0.321	0.008	
6	13.0	5.4	10.8	0.690	0.049	
7	13.5	6.7	8.2	0.369	0.035	
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39	8.6	5.1	7.6	0.781	0.023	
40	17.5	6.1	12.7	0.527	0.077	
41	31.2	6.1	9.5	0.231	0.108	For samples 41 and 44 which were forked stem from below the mid-diameter, form factor and volume was calculated for each branch.
			15.0	0.093	0.043	
42	21.3	7.2	14.3	0.451	0.116	
43	15.9	10.0	8.6	0.292	0.058	
44	29.9	11.0	10.5	0.123	0.095	
			11.1	0.138	0.106	
45	20.7	15.0	11.1	0.287	0.145	
46	15.6	7.1	10.5	0.453	0.061	
47	26.4	11.2	12.1	0.210	0.129	
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Table 2: Zarbin Tarif in Roodbar area

DBH (cm)	Volume (m ³)	DBH (cm)	Volume (m ³)
7	0.008	19	0.105
8	0.013	20	0.117
9	0.018	21	0.130
10	0.023	22	0.144
11	0.030	23	0.159
12	0.037	24	0.174
13	0.044	25	0.190
14	0.053	26	0.206
15	0.062	27	0.223
16	0.072	28	0.241
17	0.082	29	0.260
18	0.093	30	0.279

Zarbin Tarif in Roodbar area which shows estimated volume of each tree with DBH. The result of this research is satisfactory and the time of field work is decreased to 2/3 common time. (Compared with previous measurements). One column of matrix is omitted and the result of is increasing accuracy.

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