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Estimating the Accuracy of Transect Sampling Method in Preparing the Forest Type and Dense Forest Map of Lorestan Province, Iran

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ABSTRACT

The high importance of Zagros forests in terms of environmental values, soil preservation, un-woody products and supply of country water in semi-dried region of our country, necessitates the preparation of required maps to get information about their situation. Given the role of stand crown cover in estimating the main and expected performance of Zagros forests, it is worthy that the basis of sampling in these forests to be on the differences of stand crown cover.

In the present study, the forests of Lorestan Province were selected to investigate the accuracy of transect sampling method in the preparation of forest type and dense. To provide the dense map, aerial photographs in the scale of 1:40000 were interpreted to categorize the stand crown cover. Also, overcoming the species crown cover was considered as the basis for typification. So, forest types were identified in three forms, pure, combined and mixed and delimited on the study scale map (1:25000). Field sampling by transect method was conducted based on the theory of possibilities. Sampling network was designed on the map of 1:25000 based on UTM lines and with the distance of 4cm and in the area; transects were implemented from the place of UTM lines intersection (1km×1km).

Data was analyzed using Arc view software and the conformity rate of type resulted from transects has been shown with circulation forest operation called as a map type in the study. The results indicated that %59 of transects are consistent with the map type. In regard with density feature, the conformity rate is equal to 63% of transects.

KEYWORDS: Transect, Typification, crown cover, Aerial photograph, Arc view.

1. INTRODUCTION AND OBJECTIVE

Forest biometry (statistical study of environmental data in forest) includes methods and strategies for collecting, analyzing, evaluating and presenting the results of forest mass (Zubairi, 2007). To manage the forests of each area, using proper methods and suitable for specific objectives is one of the basic factors in providing statistic and planning for forest resources. Therefore, investigating various methods is required to identify proper methods (in terms of cost and accuracy) and apply them in forest sampling.

Forest performances are generally considered in terms of environmental and economic effects and in the studied area which is considered a part of Zagros eco-region forests, soil and water preservation- and creating environmental values performance are basically expected and stand crown cover has a particular importance in tackling the expectation.

Given that forests outside North have no commercial revenues, a statistical method is needed while it gives information with reasonable accuracy, and the cost would not be too much. In these forests, the forest divisions are based on the percentage of the crown cover.

So far, few studies have been done in the field of determining the accuracy of transect sampling method in providing forest type map.

Zohrevandy, AA. (2003), in his paper, examined the process of change in estimating mastics (pistacia atlantica) using two methods of transects sampling on the ground and aerial photography in Qalajeh forests.

In this study, transect sampling method was implemented on the aerial photos of area in 1955 and features of number per hectare and the distances between them for total species and also the number per hectare and two perpendicular diameters in the crown of mastics species were measured, then, the same transect sampling method was implemented on the ground and the above- mentioned features were measured. After the statistical analysis of data and estimating the number per hectare, the area of crown cover per hectare mastics in 1955, and the current status through both methods of the theory of probability and distances between trees, it was determined that number per hectare mastics was unchanged but the area of crown cover per hectare mastics in 1955 decreased. Meanwhile, the transect sampling method of studying the aerial photographs has been

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evaluated to estimate features of the number per hectare and the area of crown cover per hectare mastics through estimating taken accuracy and cost

Isaac Naimori, J. (2000), compared the random systematic sampling method with a circular sample plots and transect method in terms of accuracy and cost in west oak forests. The study was conducted with the aim of selecting the optimal sampling method in conformity with west forests in the Jegyn Sorkhe region in Kermanshah and the studied features of the area of crown cover per hectare and segment was equal to breast per hectare. Thus, random systematic method with circular sample plots (the usual method in region) and transects method were compared with each other in terms of accuracy and cost and finally transect method was introduced as an optimization method in the sampling from west oak forest.

In this study, it was attempted to study the issue that whether the forest cover maps resulted from the aerial photographs and field performances of studied area is obtainable using transects sampling method and this type of sampling method has the required accuracy in providing type and dense maps.

2 - MATERIALS AND METHODS

2-1 - studied area

Lorestan with an area of more than 2806400 hectares is located in west Iran and in Zagros growth region having about 1.78% of the extent of the whole country and 8.69% of Zagros area (Moradi, & Yeganeh. 2004). The approximated area of Lorestan forests is 1124000 hectare that given the area of more than 5 million hectares of Zagros forests (Jazireei, Ebrahimi Rastaghi, 2003), it covers 22.4% of Zagros forests.

Area studied in this research is the whole available sampling forest areas of the province.

2-2 – Method

2-2-1 – providing forest cover maps of Lorestan

Maps 1:25000 and aerial photos 1:40000 (photography year: 2007) were two main sources of data to study.

2-2-1-1 - aerial photos

Aerial photos were applied to classify forest cover density. To preliminarily prepare aerial photos using edge and corner signs, centers of all photos were determined and then, the photos' centers were transferred on adjacent photos and effective level was distinguished on odd photos. Then, to clarify the aerial photos, river paths and main and subsidiary waterways have been defined in blue color. Aerial photographs were visually interpreted to separate forest classes using a stereoscope with mirror.

Table 1. Dense percentage classes of crown cover of forest trees according to the instruction of the Iranian Organization of Forests- and Rangelands

Class codes	dense percentage (the percentage of trees crown cover)	forest classes
F1	75-100	Very dense forest
F2	50-75	dense forest
F3	25-50	Semi- dense forest
F4	10-25	Spare forest
F5	5-10	Very spare forest
NF	**1-5**	Forest lands

The minimum level of identification on photos is 1:40000, 5 mm × 5 mm (4 acres).

Forest and non-forest units were separated from each other on aerial photos having effective level by green color and parts where the determination of their forest classes have not been possible such as places being in shadow or under cloud cover, were classified through field operations.

2-2-1-2- Field Operations

All photos that their units of interpreted map had an unknown mark «×» have been identified through field operation of density of these units. Then, the interpreted photos were prepared for cartography operations. For a precise cartography of each photo, at least 30 points were determined between photo and topographic map to use the point for the georeference (georeferencing) of aerial photos. After coding the classes and final review, the generated data was transferred on base maps.

After identifying and eliminating all descriptive and spatial errors, a density layer was prepared for using in providing the final map by the use of specialized GIS software. Then, the type layer was interred into the computer. To provide the type map, initially, a color plot was provided from digital files of maps 1:25000 and was given to experts of cartography; next, the provided and studied map was depicted in the area on the plots. The maps became digital and georefrenced with appropriate format and separation ability and finally with

acceptable accuracy. After eliminating all descriptive and spatial errors and filling their information, the type map was provided and ready for providing the final map. Density layers, typification, network, range, controlling points, waterways, topography and utilities were accumulated to provide the final map.

2.2.2 – Field Sampling

To determine the status of forest density, the transect was used by the theory of probability according to the instruction of Iranian organization for forests and rangeland and watershed (2002-2003 years). In the theory of probability, the possibility percentage of omitting transect is determined by the tree. The transects were located on the UTM system of map 1:25000 and the sampling network was designed on the map 1:25000 based on geographical length and width lines of UTM with the distance of 4cm and then, they were implemented as a network of 1KM × 1KM in the area. The transects were measured from the intersection of UTM in the north or south direction in the length of 100m, 200m and 400m, in the crown cover density of (50%-75% and75%-100%), (10 %-25% and 25% -50%) and (1%-5% and 5%-10%), respectively in the way that all or part of trees and shrubs crowns cover that strike to these lines were measured (forests organization instruction).

Examining the quantitative features by transects sample method (the number of trees and crown cover rate) can be done in two ways:

1- Transect with fixed number of trees

2- Transect with fixed length

The second form is also possible in two modes:

1- Measuring the distance

2- The probability theory

In this study, field sampling has been done through probability theory. In total, 7739 transects were implemented in forests of Lorestan.

The length of transects has been considered from 100m to 400m depending on the density of woody species.

Example:

The application of transect sampling through probability theory for trees' crown cover in the forest

Region: Afrine located in Poldedokhtar, Lorestan

Transect length = 200m

the number of transects = 1

$$\overline{CD}_{ij} = \sqrt{CD_{1ij} \times CD_{2_{ij}}}$$

CD1 = the small diameter of sample tree crown (m)

CD2 = the major diameter of sample tree crown (m)

$\overline{CD}_{ij}$ = the average diameter of tree crown (i) in (j)m transect

For each species in each transect, crown cover is calculated per hectare:

$$CC_J = \frac{2500 \times \pi \times \sum_{i=1}^{ntj} \overline{CD}_{ij}}{L}$$

N_{tj} = the number of trees whose crown photos cut the transect

L = the length of transect (j) m

$\overline{CD}_{ij}$ = the average diameter of tree crown (i) in (j) m transect

CC_J = crown cover per hectare for the transect of (j) square meter

crown cover per hectare of oak species in 1 m transect

$$CC = \frac{2500 \times \pi \times 32/3}{200} = 1267/78$$

The crown cover per hectare of almound (Amygdalus scoparia) species in the transect in square meter

$$CC = \frac{2500 \times \pi \times 6/7}{200} = 263/98$$

The crown cover per hectare of transect in square meter

$$CC = \frac{2500 \times \pi \times 39}{200} = 1530/75$$

The percentage of crown cover per hectare of oak species in transect

$$CC\% = \frac{25 \times \pi \times 32/3}{200} = 12/68$$

The percentage of crown cover per hectare of almound (Amygdalus scoparia) species in the transect

$$CC\% = \frac{25 \times \pi \times 6/7}{200} = 2/63$$

The percentage of crown cover per hectare transect

$$CC\% = \frac{25 \times \pi \times 39}{200} = 15/31$$

Table 2. Sampling by the method of (200 meters) transect in Afrineh, Poldokhtar, Lorestan

Tree number	Species	The diameter of crown perpendicular to the path (m)
1	oak	5.2
2	mountain almound	1.5
3	oak	2.8
4	oak	3.3
5	oak	2.5
6	oak	2.6
7	oak	5.1
8	mountain almound	1.2
9	mountain almound	4
10	oak	3.1
11	oak	3.7
12	oak	4

2-2-3- Method of Typification

In forests of Lorestan located in the vegetative zone of Zagros Mountains that the main and expected performance is soil and water conservation and to achieve the aim, the crown cover role of forest density is more important than two other factors i. e. density and segment level and on the other hand, given the lack of direct relationship between the density and crown cover, typification was implemented based on overcoming species crown cover. Forest types in accordance with above-mentioned principles are identified in three pure, combined and mixed types as following and have been delimited on the map of study scales (1:25000):

Pure type: it is the type that 90% or more of the crown cover belongs to one species.

Combined type: it is the type that the crown cover of no species reaches 90%. To typify, the species that have higher crown cover than that of the first species and the species that have at least 10% or more crown cover than that of the first species, have been placed in the second species.

Mixed type: it is the type that the crown covers of any species forming stand in its combination don't reach 50% or more. Therefore, the type known as mixed type was identified with the maximum of three species in order to crown cover abundance.

Given the heterogeneity of forest stands (require to sampling (field operation)) with high intensity and spending costs and labor, the combination of the two methods of sampling and circular forest have been used in typifying the forest stands in the studied area (forests of Lorestan). It means that while the sampling operation of the apparent stands composition or in other words, forest stands type is conducted by certified silvics experts through field gauging the whole forested areas with the apparent view and implementing the mentioned typification method; forest types were identified and delimitated on the map of studies scale1:25000 and then, the typification of operations were corrected using the sampling data of sampling part and the range of types was determined.

2 - 3 - Entering Data

The software 302 Arc view *a* was selected to do this. Among the field data included as 7739 plot forms in 113 maps, 5371 plot forms were randomly selected.

The number of transects (plot form) in 93 plans were coded for the data to be analyzed.

The type of codes initiated from 10 as a feature. To avoid mistakes that might occur while interring codes, at first, the types were divided into 8 categories as follows:

First category, pure type

Second category, the combined type associated with the first species of oak

Third category, mixed types with the first species of oak

Fourth category, combined types with the second species of oak

Fifth category, mixed types with the second species of oak

Sixth category, mixed types with the third species of oak

Seventh category, non-oak combined types

Eighth category, non-oak mixed types

According to the category, the basis is oak species because of the importance and high frequency of this species in the forests of Lorestan.

Finally, 236 types were coded and introduced into Arc view.

Code 1 to 6 were used for density:

Code 1 is equivalent of F1 that is density from75 to 100%

Code 2 is equivalent of F2 that is density from50 to 75%

Code 3 is equivalent with F3 that is density from25 to 50%

Code 4 is equivalent with F4 that is density from10 to 25%

Code 5 is equivalent with F5 that is density from5 to 10%

Code 6 is equivalent with F6 that is density from1to 5%

Code 7 was also applied for non-forested applications

4 - Analysis

4-1 - type

According to the Query taken in Arc view, 3170 transects out of 5371 transects had the code equal to those devoted to type related to maps. Review was done to find the non-conformity cause of 2201 transects. It was expected that Polygons small and diverse gameplay and as a result, the insufficient number of located transects line are the cause of non-conformity.

The classification was done as following:

The first category: transects which had oak type but had non-oak type on the map (the map of province forest cover resulted from aerial photos and field operations).

The second category: transects did not have the oak type but they had the oak type on map (the map of forest cover in Lorestan).

The number of 314 and 895 transects were placed in the first and second category, respectively. Types included 5 and more transects have been analyzed.

On each type, the selected transects were separately studied. Each transect were separately interred in the map file and the area of the polygon containing desired transect were recorded. Then, for each type, the number of polygons and the total area of its related transects were recorded. Also, for each type, the number of transects located in polygons containing 5 or more transects was determined.

Finally, a table was obtained with the following data:

Type in transect, type in map, the number of transect, the number of map, the number of polygon, the total of polygon areas and the number of transects that were located on the polygon containing 5 or more transects and it was seen that the majority of transects were located in polygons that their ranges (the type delimitated on the map) have more than one transect and generally more than 5 transects.

4-2 - Density

Out of 5371 studied transects, the number of 191 (3.5%), 723 (13.5%), 1047 (19.5%), 2748 (51.2%), 323 (6%) and 255 (4.7%) transects are located in very dense, dense, middle-dense and sparse forests and forest lands, respectively.

The maximum area of forest in the province has the density of F4 with the frequency of 2748 transect that 51.2% of whole transects are examined that is the density of about 10-25% of forest are covered by trees and shrubs crown cover.

Among 5371 transects, the number of 3383 (63%) transects are consistent with the map in terms of density.

Table 3. Analysis of the degree of density of forest based on the number of samples

Degree of density	The number of transects	The percentage of the whole transects
F1	191	%3.5
F2	723	%13.5
F3	1047	%19.5
F4	2748	%51.2
F5	323	%6
F6	255	%4.7
NF	84	%1.6
Total	5371	%100

6- DISCUSSION AND CONCLUSION

In adjusting the type resulted from transect with the type obtained from aerial photos and field operations called as a map type (forest cover map) in the study, it was revealed that among 3170 transects in the total of 5371 equivalent to 59% of transects), transects type have conformity with the map type. Given the area of sampling network which is equivalent to one hundred hectare in the study, this result is obtained that if the type resulted from each transect is the representative and agent of sampling network type i.e. one hundred area, in about 60% of the sampled level, the type of each transect can be consistent with the type of sampling network (100 hectares) or type resulted from map (the type resulted from circular forest). In about 40% of the sampled level, the transect type is not necessarily consistent with the map type. Therefore, according to the significant area of the network, the conformity of about 60% transects type with map type is considered satisfactory. Since, in various densities, each transect with the length of minimum 100m in 60% of cases can indicate the real type of each network of one hundred hectares. Experiences obtained from samplings through random systematic method with the sample plot of 1000 square meters and the network of 5 hectares in the forestry plans and detailed stage confirm the issue that types resulted from sampling are not consistent with real types in the forest (Ebrahimi Rastaghi, 1994). In 40% of the cases where the type resulted from transects is not consistent with the map type, the study results have indicated that the overwhelming transects are located in the Polygons that their limitations or in fact, the type delimitated on map (resulted from aerial photos and field operations) have been more than one transect and generally more than 5 transects and therefore, if the type resulted from the total of transects placed in Polygon is considered, it will generally show consistency with map type. Thus, if we accept the accuracy of typification more than one hundred hectare (transect with one hundred hectare network) in this method, the conformity accuracy of the type resulted from transect with the real type of studied area will be enhanced more than 60 percent.

In adjusting the density resulted from transect with density obtained from aerial photos and desert operations called as a pap density in this study, in 3383 transects from the total of 5371 transects, 63% of the transect was consistent with the map density of the plan and the remaining 37% was not consistent with the map in terms of density.

In providing the plan, FAO Mapping considers three categories to classify the degree of density.

F1 Class: the degree of density of more than 50%

F2 Class: the degree of density of 25%-50%

F3 Class: the degree of density of 10%-25%

In fact, the stand crown cover of higher than 10% is considered for defining a forest and therefore, it seems that the number of density classes (6 classes) and as a result, short class distances is the cause of the non-conformity. therefore, if the interval for density class is considered more, for example, instead of the interval of 1% - 5% and 5% - 10% and 10% - 25%, the class of 1% - 25% is accepted or the number of density classes are considered less, the density conformity resulted from transect with the density resulted from plan are improved more than 63% and also, the accuracy and precision of study will increase.

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