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The analysis of the spatial distribution of arboretum and its adaption to a series of stationary factors

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Abstract One of the most important structural parameters of a stand is its spatial distribution. Although there are many statistical techniques in terms of obtaining relevant data on different populations or samples, they were not sufficiently used in forestry to verify the accuracy and the theoretical results and it's applicability in the field.

According to research conducted in this study, it emerges the idea that statistical analysis of the spatial distribution of a secular stand is of great value and can lead to many close results.

On the other hand, the close bound between the purely statistic data and stationary vectors emerges.

Key words

coefficient of variation, statistical indicators, forest secular, stationary factors, number of trees, cluster analysis

During its evolution over the centuries and until now the forest was constantly searching for an ideal structural stability. This is why the information obtained from some analysis in detail over the natural processes from "the laboratory" of an ancient forest can have a significant importance to the design and implementation of appropriate technologies in the current forest management and fair assessment of the economic and productive forest ecosystem.

In the present study the spatial distribution of the stand that was take in consideration and the intensity of the influence from some stationary factors were monitored.

The multitude of data collected from the field gives the results of the research carried out a high precision, which can be used this way or in other similar situations.

Material and Method

In order to accomplish the present study, on the field were placed a number of 136 circular sample surfaces after a grid of 50m/50m, covering the 35B plot in UP Slătioara VIII, Stulpicani Forest.

Circular test surfaces were materialized in the field by a radius of 12,62m, covering 500 m2 each.

Within each sample area:

- the mother stand was inventoried by species, diameters and Kraft classes however nothing the existing defects and injuries;
- several heights were measured in a randomly mode, depending of the diametre class;
- one sample from the soil was taken, from the middle of the first existing horizon in order to determinate the pH. This was later determined in the laboratory through the electrometic method using a microprocessor pH metter.

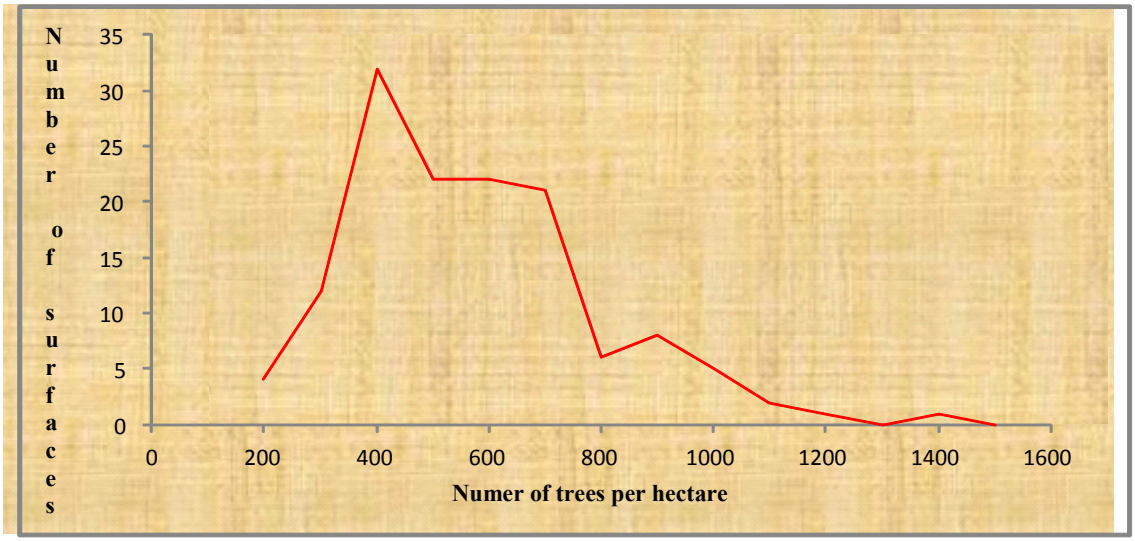
Results and Discussions

The number of trees represents on of the central parameters structure regarding the description and the study of the stands. The number per hectare varies depending on the stational conditions as well as according to the successional stage which the stand is.

In order to obtain these effects all trees were inventiored (with the exception of the dry ones) from all test areas conducted on the field.

The average number of trees per hectare was 576 and was established after determining the number of trees per hectare on each sample surface.

This number varies widely, ranging from 200 to 1460 trees per hectare with maximum surface category 400 trees per hectare.



Grafic. 1. - Variation in the average number of trees per hectare on studied surfaces.

To obtain an overview on the stand spreading area, the coefficients of variation of it were determined (Antonescu A., Constantin T., 2000; Opariuc C., 2009) and the result was a average of Cv = 38,51%. The high coefficient indicates a very wide spread in the terrain, with a high unevenness in their placement.

In order to obtain information about the dependency of the number of trees per hectare with several other stationary elements Cluster analysis was performed as follows:

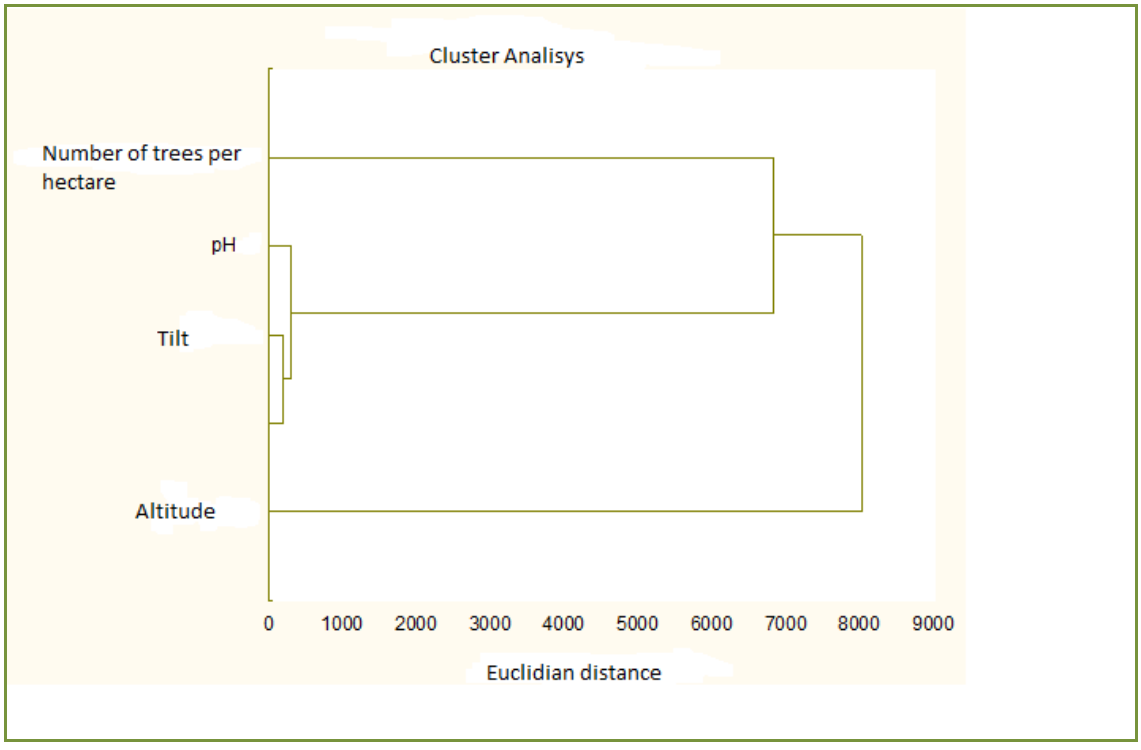


Fig.1 - Cluster analysis on the correlation between the number of trees per hectare, soil reaction, tilt and its altitude in 2011

Therefore, the number of trees per hectare depends directly on the slope and soil reaction which in turn depends on the altitude.

The surfaces with a maximum number of trees per hectare are S86, S89, S90, S92, s93, and S127, which are witnessing a large number of tree species. This fact can be attributed to the high atmospheric humidity from this areas, which plays a key role in the tree development, especially in this case where the average pH value easily exceeds 6,5 and the areas concerned are located on fields with very high slopes, above 50%, on the valley lines and shady slopes (Clinovschi F., 2005), general display being to the north.

Also in order to characterize the spatial distribution of the trees, the indicators Green and Morisita were determined, recommended by Botnariuc N. și Vădianu A., 1982, (după Cenușă R., 1996).

In order to calculate the Green coefficient the next formula was used (Zamfirescu R.S., Zamfirescu Oana, 2008):

$$I_G = \frac{\frac{s^2}{x_{med}} - 1}{x - 1}$$

where:

- s^2 = 11,0898 standard deviation;
- x_{med} = 28,7867 average number of trees
- n = 136 number of sample units
- x =3915 number of individuals in the sample

- **I_G = 0,0342**

Following the instructions given by the authors mentioned above, it can be concluded that the value of the index is close to zero, and the trees will show a random disperion to easily grouped.

The Morisita coefficient was calculated for a greater precision of spatial distribution of trees, because several authors claim that the value of this coefficient is less affected by the size of the sample (Malhado A.C.M., Petrere M., 2004).

The formula used in this case was:

$$I_M = n \times x \times \frac{x^2 - x}{(x)^2 - x}$$

Where the unkown values are the same from the Green coefficient:

- **I_M = 1,1629**

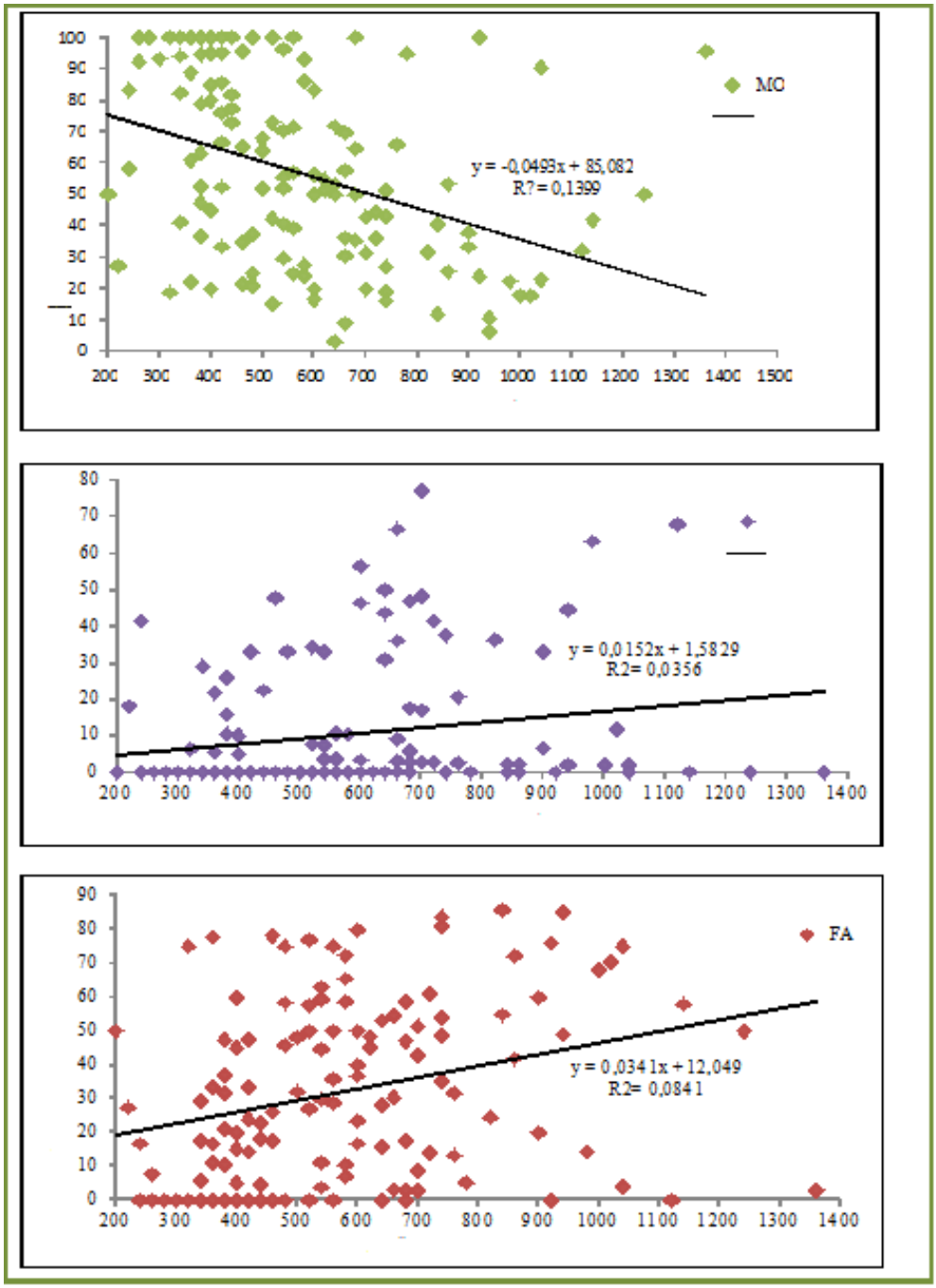
Because the index value is slightly above 1, very weak trends of tree grouping are confirmed.

In order to estimate the percentage of species in the composition of the stand, there were calculated based on the total base area of the diameters of all inventoried trees in the circular sample surfaces and the base areas of the key species.

The composition formula of the mother stand obtained was:

- **75Mo10Br13Fa2Dv – la 2011.**

The spruce trees and the downfall tendencies line highlights the tight dependencies of the number of trees per hectare. The number of beech trees form a positive correlation with the total number of trees per hectare and a weaker positive correlation is given by the fir trees.



Graphic 2- Correlative links between the distribution of the number of trees by species and number of trees per hectare.

We can also see a very close negative correlation between the spruce and the other two species.

For a better determination of the spatial distribution of trees by species the coefficients of variation of the participation rated by species and the values of the Green coefficients were determined:

Table 1

Indicators of the spatial distribution of the number of trees by species:

Inventory time	*Number of trees*			*Coefficient of variation*			*Green Index*		
	Spruce	Fir tree	Beech	Spruce	Fir tree	Beech	Spruce	Fir tree	Beech
2011	2056	454	1358	59,21	198,35	100,47	0,028	0,435	0,073

We can see that the beech population as well as abies population are eterogeneous, the variation coefficient being high over 75% (Balint Ş., Tănasie Loredana, 2011). However the spruce strives for a relative homogeneity.

Regarding the Green index values, it shows a slight random dispersion of spruce in 2011. The beech shows some tendency to group. These groups of fir tree take place as said along the valleys and on the shadowed slopes.

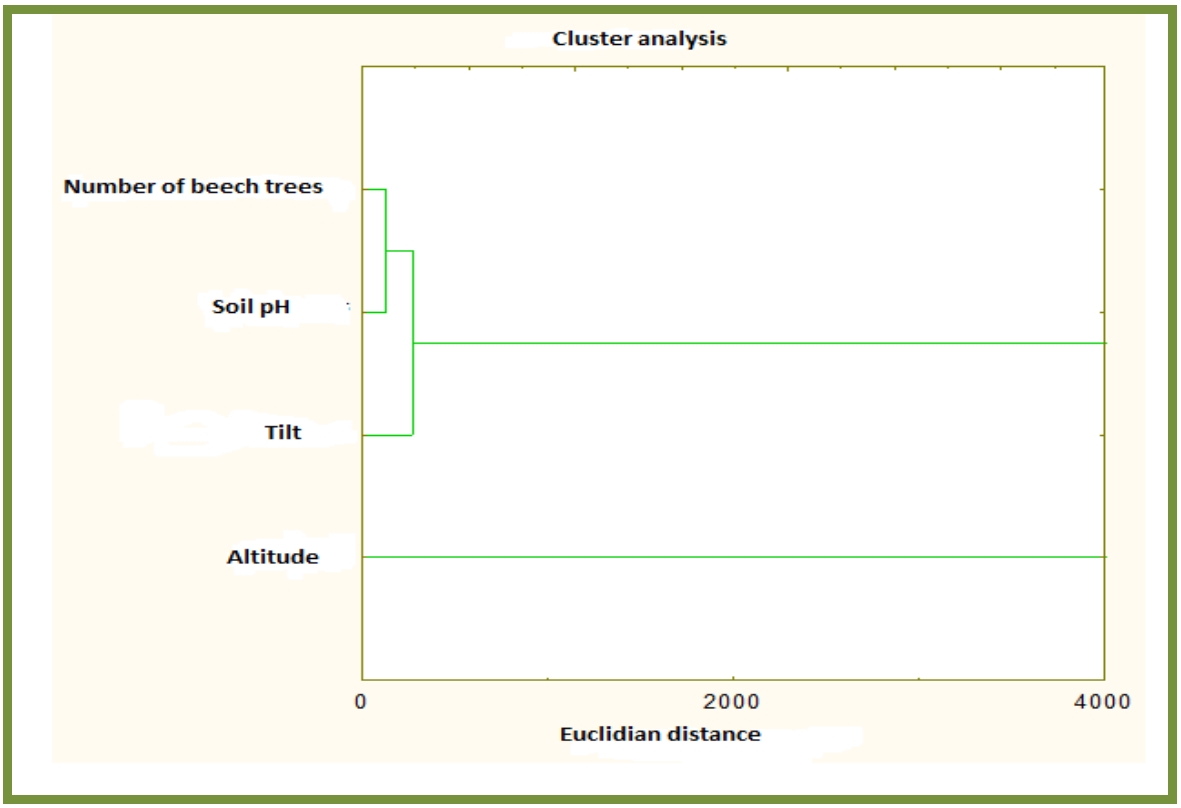


Fig 2- Cluster analysis concerning correlation between the number of beech trees on the sample surfaces with soil reaction, land slope and altitude.

The Cluster analysis shows a direct dependences of the number of beech trees regarding to the soil reaction, and afterwards regarding the land tild and finally to the altitude.

Indeed, some surfaces with the biggest proportions of species participation is located in the west of the amenajistic unit, where the altitude exceeds 1300 meters, and the beech trees has good conditions for growth, because of the acid soil but wet enough, permeable and airy (Clinovschi F., 2005).

Another series of ares represented by beech trees are those along the water lines, where beech trees found good conditions to develop, this time because the high content of humus and airy soil.

Conclusions

After these investigations, it was found out that the spatial distribution of the stand in the field is exactly true being seconded statistically by the results obtained according to the Morisita and Green coefficients and variation coefficients as well.

Also, the soil tilt and reaction have a significant importance in the settling and distribution of the constitutive species of stands.

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