SPATIAL ANALYSIS IN THE STRUCTURE OF PINE AND OAK TREES

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Abstract

This study was conducted in Zawita and Atrush in Dohuk governorate in northern Iraq and on the trees of the pine (*Pinus brutia* Ten.) and the oak (*Quercus spp*.) trees growing naturally in the study site and on an area of (495.47 km2), located between two longitudes (43° 2' 30"), (43° 25' 0") East, and two latitudes (36° 47' 30"), (37° 0' 0") North, at an altitude ranging between (542 - 1603) meters, and these trees are among the naturally renewable natural resources and must Maintaining and managing them efficiently requires the preparation of primary baseline data on what exists of these resources and how they interact with each other in the ecosystem. Field data were collected from (24) circular samples with a radius of (17.9) m, and the area of one sample was (1006) m^2, and field measurements included the variables of one tree, namely (geographical coordinates, diameter at breast height, crown center height, crown width). Soil samples were also taken from the centers of those samples and the necessary analyzes were conducted on them.

Geographical statistics were also applied to show the spatial correlation of pine trees in the study site using the (Isotropic Variogram) analysis for the large diameters trees correlation with site in this samples (1, 3, 7, 10, 11, 15, 19, 24) and with lower correlation rates in the samples (5, 6, 8, 9, 12, 13, 14, 16, 17, 18, 20, 22, 23), while no correlation was shown between the diameter variable and their locations in the two samples (2, 21). And the low values of the coefficient of determination (R^2) that appeared in the less correlated samples is due to the conducting of (Variogram) analysis on all the sample trees (Seedling, Sapling, Trees).

To determine the distribution of trees and their trends, the analysis of Kriging for mapping two and three dimensional maps, and from the analysis of two- dimensional maps variations in the distribution of big diameter were noticed in samples randomly while the rest of the samples showed aggregated, The rest of the samples are in the center or one of the directions of the sample. Three-dimensional maps were also used and the results of the analysis and for the various study samples showed that eight of these samples had a direction of the phenomenon in them towards the northeast, seven samples towards the north and northwest, seven samples towards the south, southeast and southwest, and two samples towards the west.

Introduction

Forests play an important role in addressing the crises of environmental degradation, biodiversity loss and climate change, as forests contain (662) billion tons of carbon, and this is equal to more than half of the global carbon stock in soil and plants (FAO, 2022), and forests cover (31 %) of the total land area (4.06) billion hectares, in other words about (0.52) hectares of forests for every person on the planet, but they are distributed unevenly all over the world, as more than half of the forest area (54%) is concentrated in Five countries (Russian Federation 20%, Brazil 12%, Canada 9%, USA 8% and China 5%) of the total area of forests in the world, and the rest of the world constitutes a percentage (46%), and the difference is due to the geographical distribution of forests To the environmental factors, as tropical forests (45%) and boreal (27%), as for temperate (16%) and semi-tropical (11%), and that (93%) of the forest area is naturally renewable forests and (7%) are Artificial trees (FAO, 2020).

The spatial analysis takes into account the collection of data related to spatial phenomena by clarifying the spatial distribution and the extent of variation in the distribution through two types of analysis: Variogram analysis and Kriging analysis. (Dimov, 2004) and (Dovciak, 2001). The second analysis is the best because it takes the trend of phenomena into consideration, and gives the best regression range for the observations values around the phenomena points (Bohling, 2005). The study site is one of the areas in which protean pine trees spread naturally, which is an extension of its natural spread places in the Mediterranean basin, as well as oak trees and other plant species and these types interact with each other to show a natural biodiversity in the site.

The aim of the study is

1- Use of Variocram analysis and Kriging analysis.

2- Determining spatial variance at different locations within the tree species distribution.

Materials and Method

1- Study Area

This study was conducted in Zawita and Atrush in Dohuk governorate in northern Iraq and on the trees of the pine (*Pinus brutia* Ten.) and the oak (*Quercus spp.*) trees growing naturally in the study site and on an area of (495.47 km2), located between two longitudes (43° 2' 30"), (43° 25' 0") East, and two latitudes (36° 47' 30"), (37° 0' 0") North, at an altitude ranging between (542 - 1603) meters, and these trees are among the naturally renewable natural resources and must Maintaining and managing them efficiently requires the preparation of primary baseline data on what exists of these resources and how they interact with each other in the ecosystem.

2- Data collection

A survey of the study area was conducted to obtain data for the period from (1/9/2021 to 1/1/2022), showing that the forest has different densities and is distributed over a different topography of different interfaces, heights, and slopes, and (24) sites were randomly selected within the forests. To represent all densities and distributions, they were projected onto the satellite data and ground maps to conduct the survey process on the various sites. Data were collected from the locations of the samples that were determined by geographical coordinates using a GPS device, and the following table shows the distribution of samples in the study area.

In order to obtain the field inventory data, a circular sample was taken that is more accurate in representing the forest community from different sites than the previously mentioned sites with a radius of (17.9m) and this diameter is considered the minimum recommended for the study of mature trees. Before conducting field measurements, the center of the samples was determined by geographical coordinates (latitude and longitude).

3- Geographical statistics and programs

The traditional statistics does not take into account the spatial information, as the geographical distribution of the trees of the pine and oak was used to know and understand better about the spatial distribution and study the composition of the tree and the changes that occur in it as a result of topographical factors or environmental factors such as the influence of soil, temperature or rain or as a result of interactions between individuals The community is growing and competing for sites.

Therefore, we resort to geographical statistics to give a picture of the biological and environmental characteristics that affect the behavior of species, and relying on this type of statistics is one of the basics in conducting spatial analysis, through some branches of geographical statistics such as (Variogram) (Kriging) analysis. which depends in the analysis on the values of variables with spatial correlation, and spatial analysis in geographic information systems means the processes of spatial linking of digital geographic data elements, which is known as Topology.

4- GS + Version. 10

It is one of the modern geographic information systems software used in spatial analysis and is known as (Geostatistics for The Environmental Sciences), and it has many uses of two- or three-dimensional maps, and to use the program the data is written in Excel after converting the geographical coordinates from the (Degree Minute Second) system to Decimal Degree system, i.e. the degree and its parts, and it is written with geographical coordinates, for example, the diameter at the chest level of trees or the area of coronal coverage, then these data are transferred to the program and each column is named for the variables included in the analysis process, and the following analyzes were carried out through this program:

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a- Variogram analysis

It is one of the geographical statistics methods that can be used in spatial analysis, which is the measure of variance for a variable within the distance and it can be calculated through the following relationship:

$$\hat{y}(h) = \frac{1}{2n(h)} * \sum_{si-sj=h}(yi - yj)^2$$

Since:

y^(h) = The estimated Variogram value
n(h) = The number of point pairs of the vector h.
si-sj = The locations of the points i, j.
y = a variable (the diameter variable in this study)
yi = the value of the variable y at position i.
yj = the value of the variable y at position j. (Dimov, 2004) (Dovčiak, 2001).

Variogram analysis is used as an Isotropic Variogram, and this type of analysis ignores trends when performing the analysis process, and the outputs of this analysis are in the form of an image of the Variogram curve and as in Figure (1).

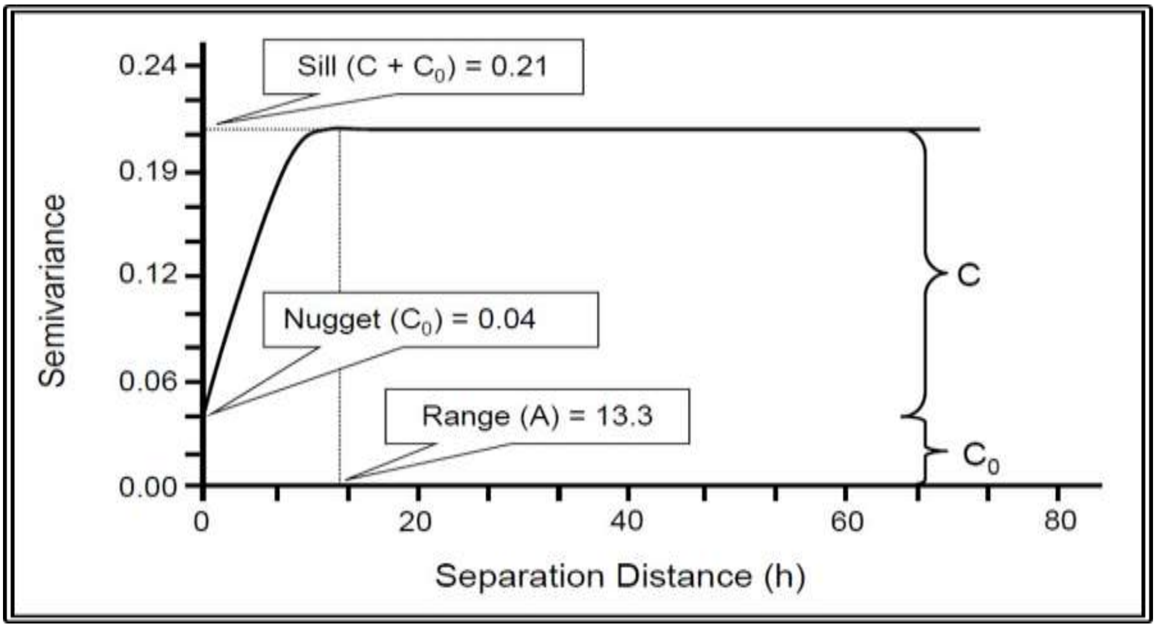

Figure (1) Isotropic variogram outputs

b- Kriging Analysis

It is the analysis that gives the best regression range for the values of observations around the points of the phenomena, and through the Variogram scale we draw two- and three-dimensional maps for Kriging's test. Dimensions for Kriging test By the command Draw we get the two-dimensional and three-dimensional maps and from the two commands (D-2) or (D-3) respectively, then the data (output) of the analysis is saved in the form of an image (Bohling, 2005).

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Results and Discussion

To study the spatial analysis in the study site of the pine trees, Variogram analysis and Kriging analysis were used to show the spatial correlation of the distribution of diameters using the (GS+) program. It clearly showed a discrepancy in the distribution of large diameters, so it showed two groups of distribution forms, a group that was randomly distributed in the rows of large diameters in the samples (1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 13, 14, 15, 16, 18, 19, 20, 23, 24) and as in the figure (2).

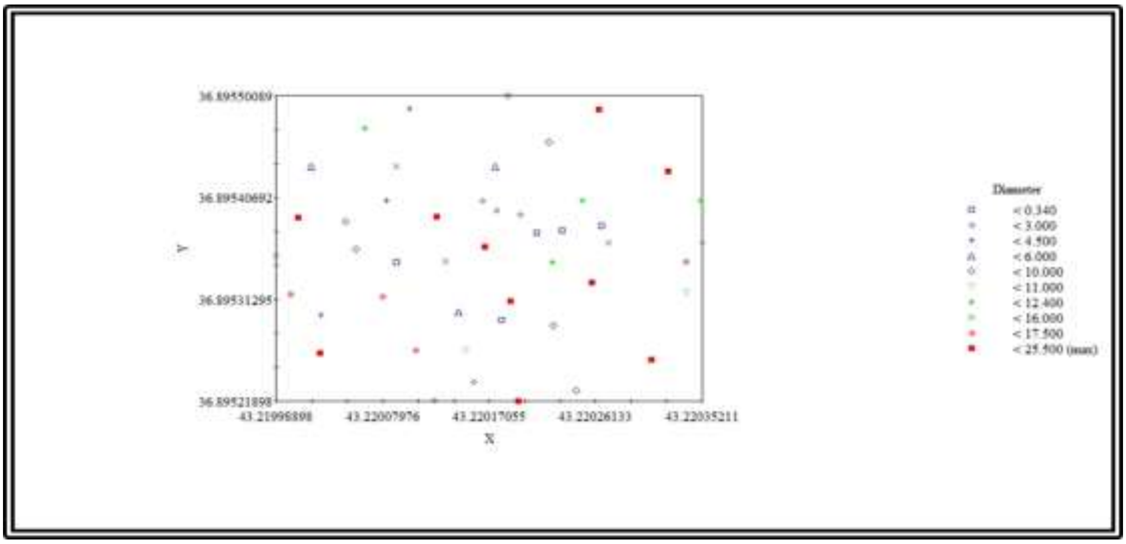

Figure (2) Random distribution of large diameter for sample No. (18)

As it turns out that the large diameters, which appear in red, were randomly distributed for sample No. (18), and this applies to the aforementioned samples.

As for the other group of samples, it showed a different spatial distribution from the first group in the distribution of rows of large diameters, as the diameters gathered in one part of the sample and were represented in the samples (5, 12, 17, 21, 22) and as in Figure (3).

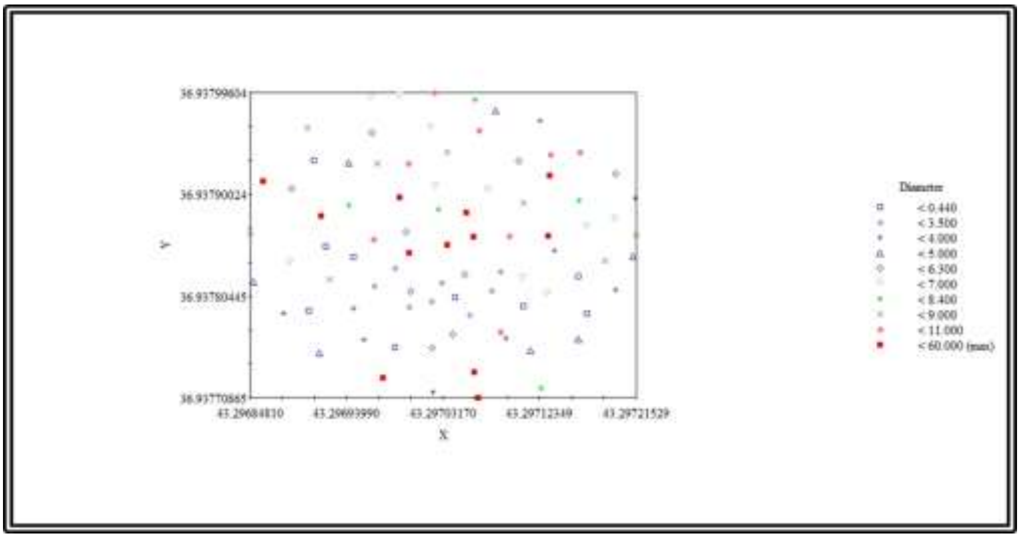

Figure (3) The aggregate distribution of large diameters for sample No. (12)

Variogram analysis

Isotropic Variogram analysis was performed for the diameter variable and for all study samples, using three models (Spherical, Gaussian, Exponential). 10, 11, 15, 19, 24), and with lower correlation rates in the samples (5, 6, 8, 9, 12, 13, 14, 16, 17, 18, 20, 22, 23), while there was no correlation between Diameter variable and its location in samples (2, 21), and Figure (4) shows the Variogram analysis form for sample No. (1)

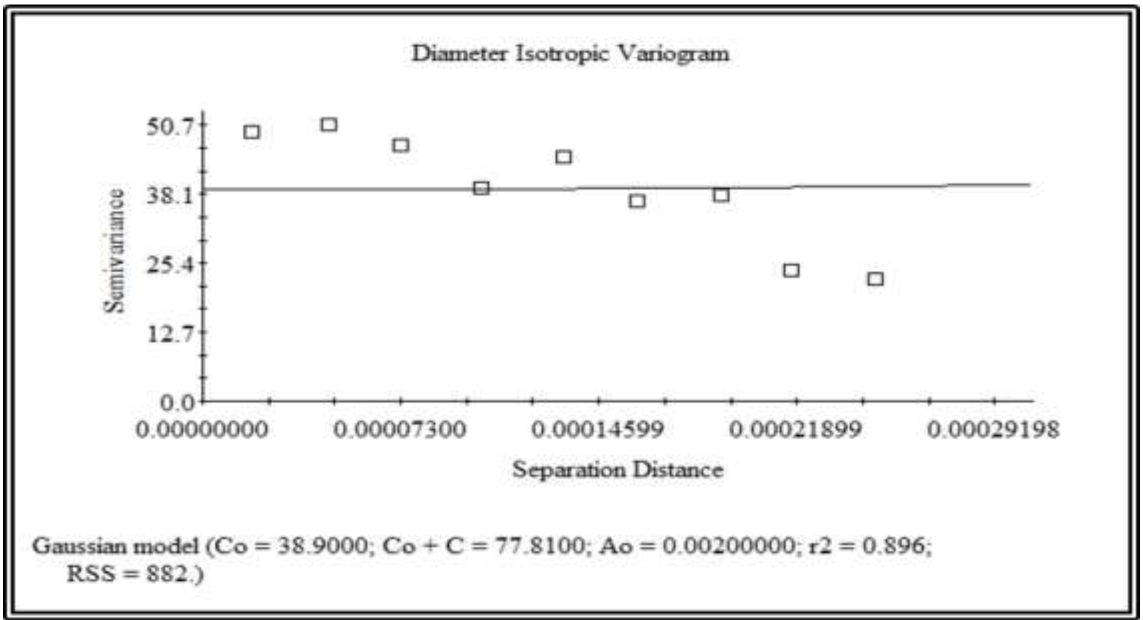

Figure (4) Isotropic Variogram Analysis Model for Diameter Variable for Sample No.

Table (1). Variogram model constants for the diameter variable for the study site

No	Model	QMCR (m)	Diameter Variogram		
			Rang A (m)	C1/Co+C1	R^2
1	Gaussian	2.13	0.002	0.500	0.896
2	Spherical	2.35	0.002	0.500	0.067
3	Exponential	2.03	0.0002	0.500	0.630
4	Spherical	2.10	0.00012	0.838	0.766
5	Gaussian	2.32	0.002	0.500	0.149
6	Gaussian	2.30	0.002	0.500	0.217
7	Exponential	1.37	0.002	0.500	0.670
8	Spherical	2.16	0.002	0.500	0.189
9	Spherical	2.28	0.002	0.500	0.128
10	Spherical	2.57	0.0001	0.532	0.600
11	Spherical	2.38	0.0008	0.500	0.675

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12	Gaussian	1.74	0.002	0.500	0.462
13	Gaussian	1.84	0.002	0.500	0.263
14	Spherical	2.51	0.002	0.500	0.220
15	Exponential	2.76	0.002	0.500	0.518
16	Gaussian	2.04	0.002	0.500	0.292
17	Spherical	2.10	0.002	0.500	0.261
18	Gaussian	1.68	0.002	0.500	0.210
19	Spherical	2.37	0.002	0.500	0.796
20	Spherical	2.55	0.00005	0.999	0.434
21	Spherical	2.21	0.002	0.500	0.037
22	Spherical	1.53	0.002	0.500	0.247
23	Spherical	1.89	0.002	0.500	0.360
24	Spherical	2.35	0.0006	0.500	0.512
Mean		**2.148**	**0.0015**	**0.536**	**0.399**

Table (1) shows that the average of variations in the diameter variable for trees was (0.536) for the spatial structure of trees, depending on the model (C1/Co+C1), which represents the amount of variance of the model divided by the total variance, and when this value approaches the correct one, it indicates This indicates that the value of Co is close to zero, and this indicates that the model represents the community greatly, and that the spatial distances have a clear impact on the interpretation of the variable studied in the analysis process. We also find that the values of (C1/Co+C1) for the diameter variable reached (0.500) in all samples. This indicates that the Variogram model for the diameter variable for these samples did not represent the population well except for the sample (4, 20), which amounted to (0.838, 0.999), respectively, as in Figure (5).

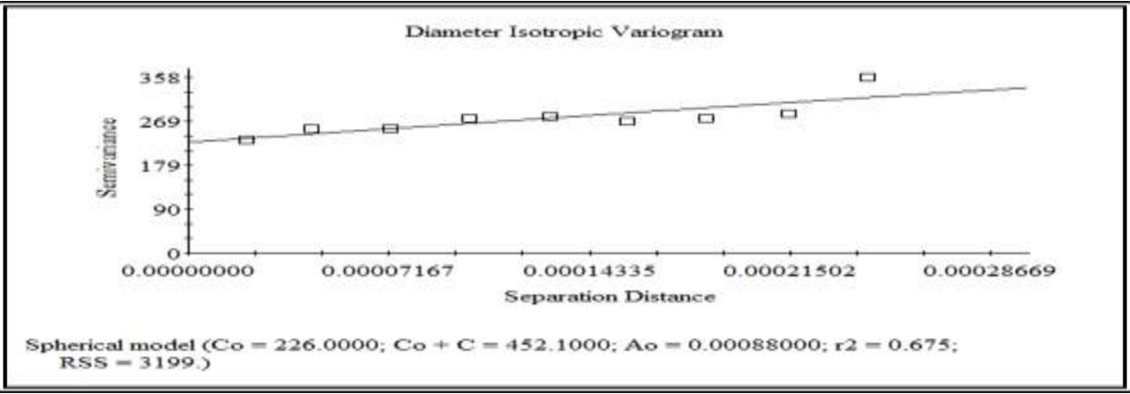

Figure (5) Isotropic Variogram Analysis Model for Diameter Variable for Sample No. (11)

Figure (6) shows that the nugget value (Co) for sample No. (11) amounted to (226), which represents the variances at distances less than the optimal sample distance with standard error, which is the amount that cuts the model curve from the y-axis, and this indicates that the model The community is not well represented based on the studied traits and distances.

While we find that the nugget value (Co) for sample number (20) reached (0.1), which is a value close to zero, and this means that the model represents the community largely and that distances have an effect on the studied trait, as in Figure (6).

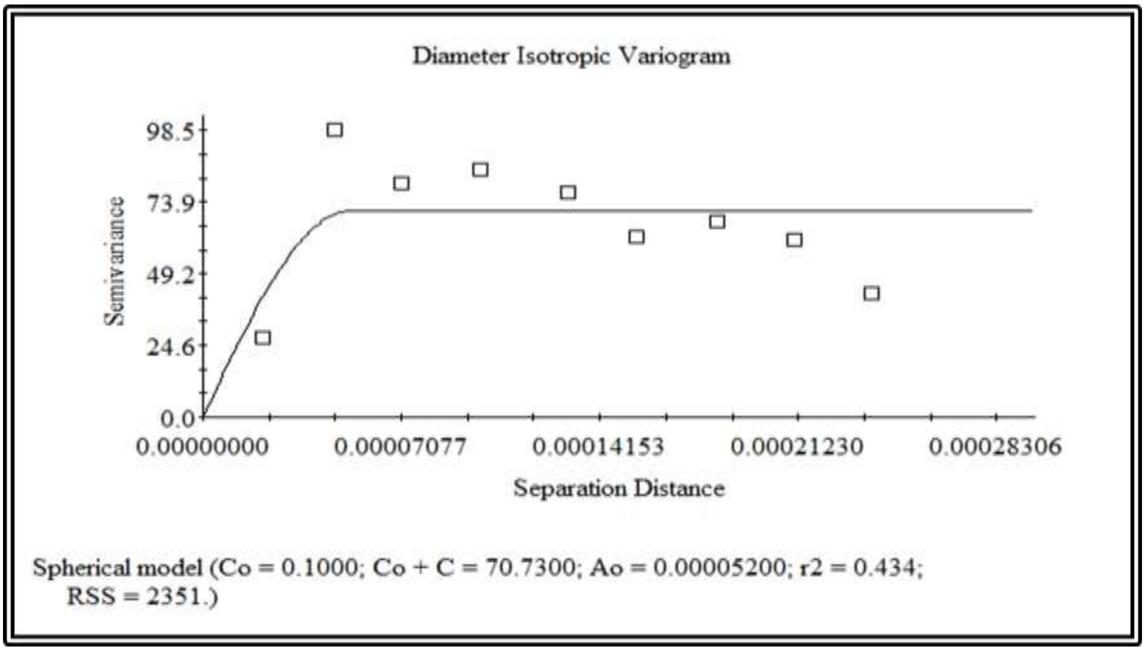

Figure (6) Isotropic Variogram Analysis Model for Diameter Variable for Sample No. (20)

It also appears from Table (1) that the values of the coefficient of determination for the Variogram analysis prepared for the variable diameter showed a significant correlation between the variable and its spatial space for trees in some samples.) In general, it is a low value and this is due to conducting this analysis on all sample trees and for all age groups (Tree, Sapling, Seedling).

Kriging Analysis

When performing a Variogram analysis, the results that we obtain in the study of any phenomenon differ according to the specific trends in the analysis process. Its use previously on the study samples, and to give a clear picture of the direction of the distribution of any spatial phenomenon in a location depends on determining the direction of that phenomenon (east, west, north, south ..... etc.), as we use Kriging analysis to find out the direction of those phenomena and they are clarified In the form of (two-dimensional, three-dimensional) maps, two-dimensional maps show the phenomena in the form of contour lines, taking into account the directions according to the geographical coordinate system in colors and according to the extents of the

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rows of the phenomenon, while the three-dimensional maps show the phenomena in a three-dimensional (XYZ) form.

In order to conduct Kriging's analysis using the data collected for the study's samples of (24) samples, the analysis was conducted using the (GS+) program, through which two- and three-dimensional maps were drawn, which gives the best regression range for the observations' values around the phenomena points and uses these maps to show up, By tracking the colors from the colors that indicate the lowest values of the phenomena classes towards the colors that indicate the highest values of the phenomena classes (Kushavand et al., 2007).

The results of the analysis and for all study samples showed that there is a discrepancy in the shape of the distribution of the phenomenon (diameter), and from the observation we find a discrepancy in the shape of the distribution of diameters, as the samples appeared (1, 2, 3, 4, 5, 7, 10, 13 , 15, 18, 21) were randomly assigned to the distribution of the phenomenon (that is, the distribution of large diameters of trees) as Figure (9), while the rest of the samples seemed to be aggregated in the distribution of large diameters. , 16, 24) cumulatively for the diameters in the northern part of the sample, while the two samples (12, 19) were distributed cumulatively in the center of the sample, and the diameters were distributed cumulatively in the two samples (17, 22) in the center and north of the sample, while the two samples (14, 23) were dispersed collectively in the east of the sample, and sample (6) gathered in the center and east of the sample, while the sample (9) was distributed in the southeast of the sample, while the two samples (11, 20) showed a congregate in the southwestern part of the sample.

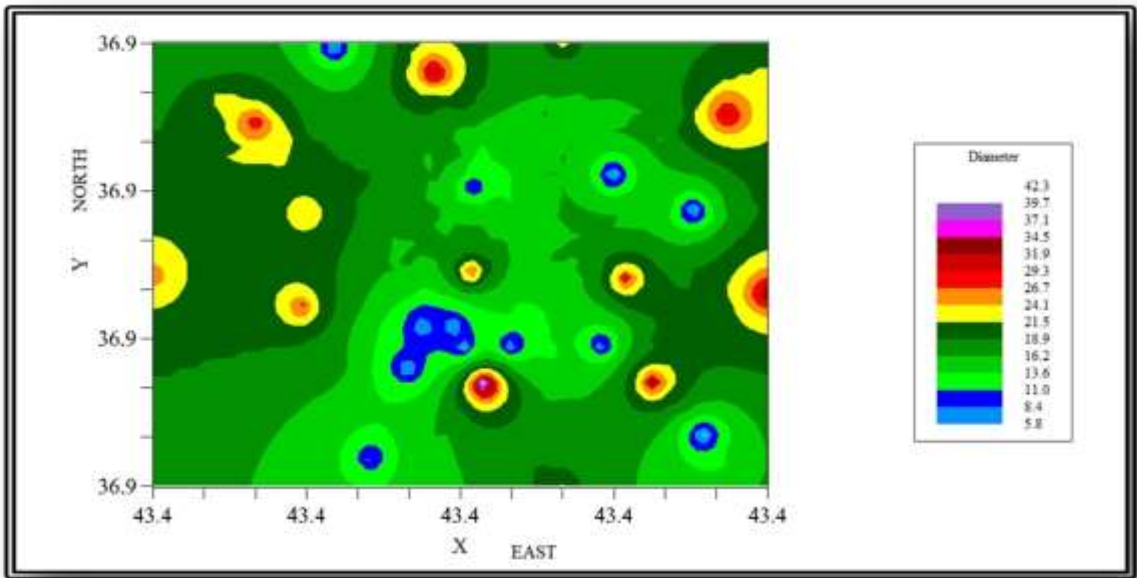

Figure (7) a two-dimensional map of the Kriging test for the variable diameter (sample 15)

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The discrepancy in the distribution of the large diameters of the samples from random to aggregate is attributed to the relative location of the trees, and this discrepancy occurred due to differences in growth, which are vital phenomena resulting from physiological processes taking place in the tree that lead to its development with time and that the presence of trees has no ability to grow And development because of its location in the lower layers within these trees, and the management of these trees requires mitigation operations to make room for the remaining trees to grow and develop in positive relationships as a result of eliminating competition between trees and reaching optimal growth and production.

From the foregoing, we see the existence of a gradient of the phenomenon in different directions, and to determine the trends of those phenomena, three-dimensional maps were used through Kriging analysis, which were applied to the various samples of the study site and as in Figure (9).

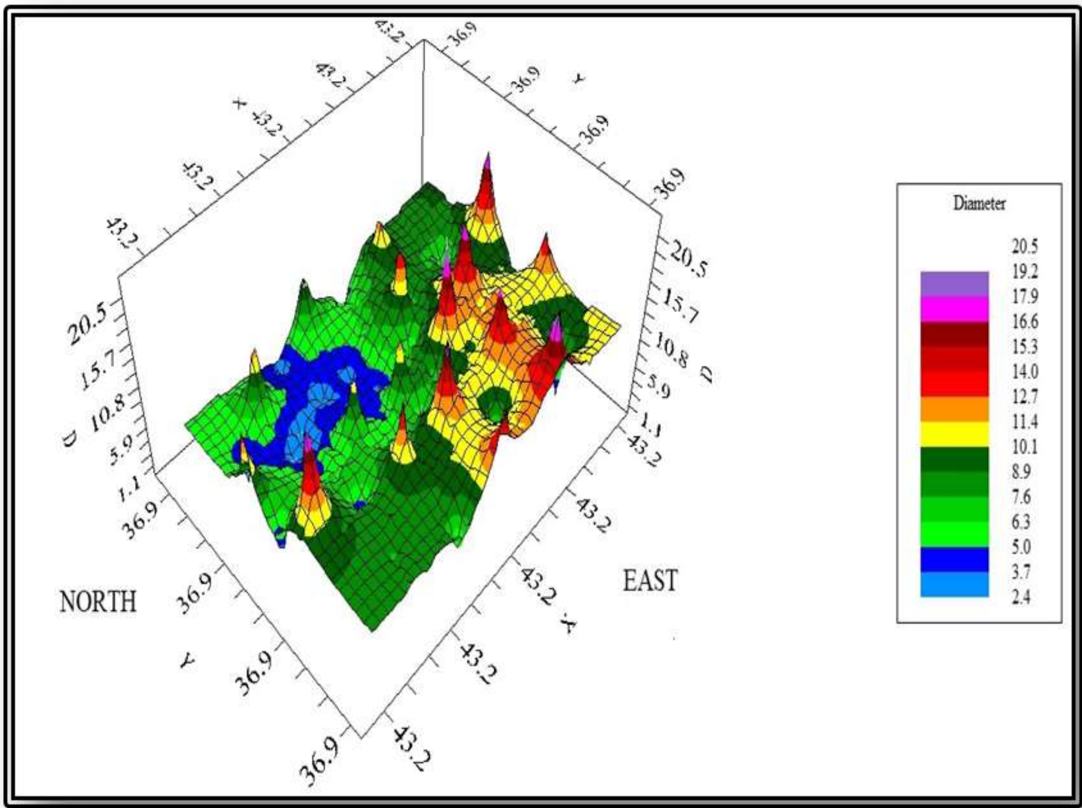

Figure (8) a three-dimensional map of the Kriging test for the variable diameter (sample 9)

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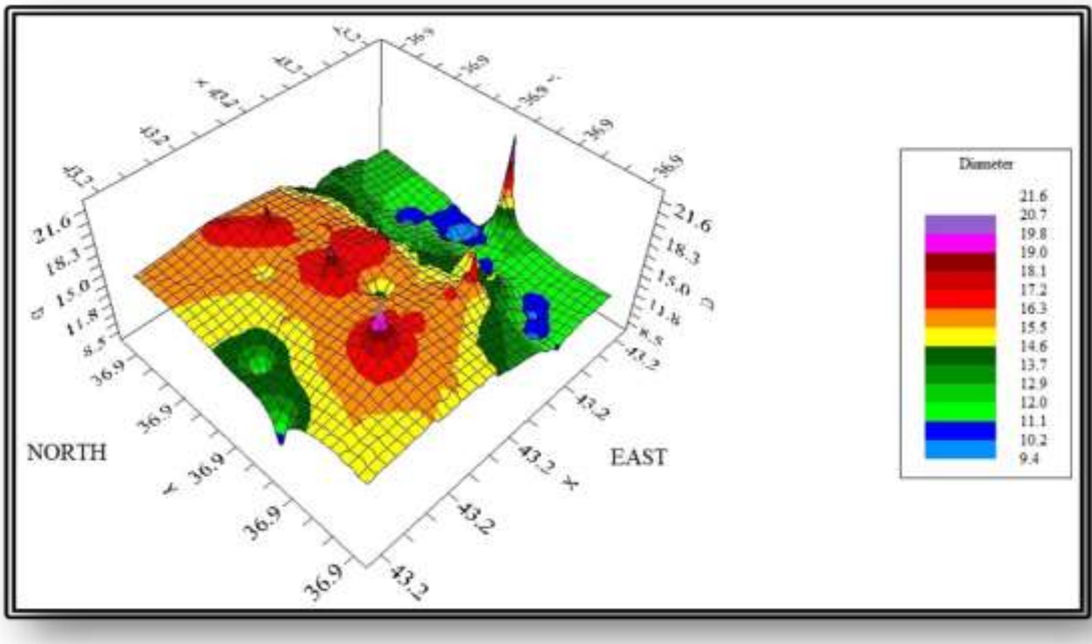

Figure (9) a three-dimensional map of the Kriging test for the variable diameter (sample 24)

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