Pattern of Distribution of Spatial Phenomena to Communities Prevailing in Mount Gara Using Function L(r)

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Abstract

The spatial pattern of species is an important feature to understand why these species coexist and remain in position or not, and using the single Ripley function and the L(r) function, we analyzed the spatial pattern of types of broad-leaf tree and tree covers and the needles for mixed brawls in the forests of Mount Gara, using PASSAGE V.2. L(r) analysis of the species under study showed a variation in the pattern distribution of trees and gave the highest percentage of random form distribution pattern with a cluster pattern of 11.25\%. Through the ratios and forms of distribution of the L(r) function of the various samples of the study, we find that these stands generally tend to be regular, indicating that these species remain at the end of the life cycle in the structure of a more stable stand.

Keywords: Pattern analysis, L(r) function, Mount Gara, Geostatistical Biodiversity.

1. Introduction

Biodiversity conservation is one of the major challenges facing forest management workers around the world today, with multiple forest use involving the conservation of natural resources, timber production, recreational and tourism services, the management of natural pastures and wildlife, and the maintenance of such coexistence within these forest communities in a usually very complex system.[1] Over the past century, intensive human exploitation has caused logging and loss of biodiversity in forests as well as the impact of climate change on the loss and destruction of many of the world's existing ecosystems[2]. These spatial compositions can be clearly studied using spatial analysis and geostatistical methods, and spatial analysis of point models is one of the most important pillars of geographical analysis because of its flexibility and high accuracy in interpreting many phenomena that it is unable to analyze clearly traditional statistical analysis[3] and analysis or geographical statistics can be carried out by turning the phenomenon into a point read through coordinates (X,Y), in forest studies the phenomenon is the tree. Altitude above sea level, aspects, temperatures and humidity are among the most important factors influencing the growth of tree presence in the study area.

The pattern of distribution of spatial phenomena of the dominant trees communities can be analyzed after they have been converted into sensors for many interactions within the stand, and what the composition of the stand will come to later, Researchers believe today that pattern analysis is one of the best ways to manage stands down to targets and to take appropriate management measures to preserve biodiversity.

This topic has been therefore gained by many researchers, and in a study conducted [4] that ecology recently initiated the implementation of two techniques of geographical statistics, (Variography) and (Kriging), the first of which is a graph of a scale called (Variogram) and is the first method that gave explanations Convincing and good for environmental impacts, but still unable to explain the pattern of distribution of geographical phenomena, the use of Covariance and Correlogram scales using functions such as Ripley's K (r), to illustrate spatial variations gives us A clear picture of the pattern of distribution of geographical phenomena, the Kriging scale provides us with unregistered site estimates, which is the best downward range of variable values around geographical phenomena based on Covariance values. These techniques are one of the best measures recently used in the study of spatial analysis of phenomena.

In another study of [5] it examined the pattern analysis of forests in dry areas of north-western Peru, and four characteristics were studied through six samples taken from the forest in dimensions (100x100) meaning that the sample area is one hectare, all trees with diameters greater than 10 cm.
[6], they showed that the spatial composition of genetic diversity from the perspective of geographical statistics could be illustrated by guessing the spatial distribution pattern. In their study, the researchers used Variogram analysis to (derive partial location variability and genetic diversity, prepare balanced units that reflect the multiple form of genetic distribution of different plant species, and see how spatial genetic composition in isolated communities is summarized on the basis of distances), the variogram analysis does not avoid deviation that It occurs from the disparity in societies because of a spatial subjective correlation, but it can provide us with estimates of the biodiversity of society and the degree of prevalence of spatial structure calculated through association.

The aim of this study is to determine the spatial pattern of the distribution of trees in the forests of Mount Gara and to study the overlapping effects among themselves and the stability of this pattern or not in the study area.

2. Materials and Methods

This study was conducted in Mount Gara, located within the border of Jamanki district, Imadiya district in Dohuk province in northern Iraq, located between lines of length (43°16'52" - 43°21'56") to the east and latitudes (36°58'48" - 37°01'27") north, and its height ranges from (1200-2150) m above sea level, the forest area in this area is estimated at (964720) acres (General Directorate of Tourism in Dohuk 2014). After identifying the study samples, the diameter measurements, Diameter at breast height (DBH), for all trees within and from samples by basal area (BA) and for all trees, which can be defined as the base of the cross section of the tree's leg at the height of the chest, and calculated according to the following relationship:

\[ BA = 0.00007854 \text{ di}^2 \]

BA: basal area (m²)

di: Diameter at breast height

The geographical coordinates of all trees were then determined using the Global Positioning System (GPS), where readings were taken at each sample tree to stabilize their geographical coordinates (latitude intersection with longitude), the pattern analysis test for the L(r) function was conducted and this function tests the gathering points of the tree community, and the pattern analysis is intended as the pattern distribution pattern of a particular geographical phenomenon, which can be used in most biological studies, whether spatially fixed as trees or moving such as wild animals and bird migration [7] This analysis enables us to analyze, see and link early in a less complex way than traditional statistical methods, and the pattern is analyzed to obtain a better understanding of a phenomenon and is used as a sophisticated measure to develop models that can be used for sustainable development and forest management, and this analysis was carried out using field-taken data from study samples using Ripley's function K(r) method calculated according to the following relationship [8]:

\[ \hat{R}(r) = \frac{1}{\lambda} \cdot \frac{1}{N} \sum_{i=1}^{n} \sum_{j \neq i} K_{ij} \quad \hat{\lambda} = \frac{N}{S} \]

N: Preparing points in the sample

S: Sample area

Kij: Its value is (1) if the distance i and j is less than the radius (r), and equal (0) to other.

Another function of the K (r) function called the L (r) function was derived, and the values of this function are tested by Monte Carlo values to show the limits of confidence in the model to give us an idea of the shape of the distribution of geographical phenomena, and the L(r) function can be calculated through the next relationship [9]:

\[ \hat{L}(r) = \sqrt[\frac{R(r)}{\pi r^2}} \]
So: L(r) = 0, for the full random pattern and for all (r) values, this occurs when readings of values (r) fall within the confidence limits of Monte Carlo test, L(r) values are < 0 for regular patterns, when r values fall below Monte Carlo test confidence limits, L(r) values are > 0 for cluster or cluster pattern and this occurs when values are (r) Higher than the confidence limits of Monte Carlo testing, it should be noted that the combined pattern (r positive values) is evidence that the society under study is in turmoil and that this pattern may change in later periods of time, while the random pattern and the regular pattern indicate that the communities under study are more stable and will remain the same for later periods of time as regular growth is the result of biological and ecological processes that have led to what is the case [13].

The pattern analysis test was conducted using (PASSaGE V.2), an abbreviation for (Pattern Analysis, Spatial Statistics and Geographic Exegesis) and prepared by [10] University of Arizona School of Life Sciences, USA, pattern analysis test for L(r) function values and using the above program, we converted the geographical coordinates of trees that were taken field by GPS into UTM coordinates, according to the program’s requirements.

3. Results

In this study, we try to shed light on the dominant species of broad-leaf and wild trees that live in the study area alongside each other in the mixed melee of the forests of Mount Gara. The aspects were determined using the Digital Elevation Model (DEM) of the study area at 12.5 m above sea level, and through surface analysis aspects map was prepared and by dropping study samples on the aspects map the aspect was accurately identified for each sample. Although some of the environmental requirements of these species vary, these trees have been sorted by species and number of individuals as in table (1).

| Sample | Height | Aspect | Scientific name       | Number of trees | Percentage | Sample trees |
|--------|--------|--------|-----------------------|-----------------|------------|--------------|
| 1      | 1265   | Northeast | Quercus aegilops     | 45              | 75.0%      | 60           |
|        |        |         | Prunus microcarpa     | 3               | 5.0%       |              |
|        |        |         | Crataegus azarolus    | 6               | 10.0%      |              |
|        |        |         | Pistacia khinjuk      | 3               | 5.0%       |              |
|        |        |         | Juniperus oxycedrus   | 3               | 5.0%       |              |
| 2      | 1270   | Southwest | Quercus aegilops      | 73              | 93.6%      | 78           |
|        |        |         | Crataegus azarolus    | 5               | 6.4%       |              |
|        |        |         | Quercus aegilops      | 15              | 17.6%      |              |
|        |        |         | Prunus amygdalus      | 3               | 3.5%       |              |
|        |        |         | Prunus microcarpa     | 7               | 8.2%       |              |
|        |        |         | Rhus coriaria         | 45              | 52.9%      | 85           |
|        |        |         | Crataegus azarolus    | 3               | 3.5%       |              |
|        |        |         | Pistacia khinjuk      | 8               | 9.4%       |              |
|        |        |         | Quercus infectoria    | 2               | 2.4%       |              |
|        |        |         | Juniperus oxycedrus   | 2               | 2.4%       |              |
|        |        |         | Quercus aegilops      | 37              | 60.7%      |              |
|        |        |         | Acer monspessulanum   | 1               | 1.6%       |              |
|        |        |         | Prunus amygdalus      | 1               | 1.6%       |              |
|        |        |         | Prunus microcarpa     | 6               | 9.8%       | 61           |
|        |        |         | Crataegus azarolus    | 7               | 11.5%      |              |
|        |        |         | Pistacia khinjuk      | 9               | 14.8%      |              |
|        |        |         | Quercus aegilops      | 29              | 49.2%      |              |
|        |        |         | Prunus microcarpa     | 3               | 5.1%       | 59           |
|        |        |         | Crataegus azarolus    | 3               | 5.1%       |              |
|        |        |         | Quercus infectoria    | 24              | 40.7%      |              |
|        |        |         | Quercus aegilops      | 18              | 60.0%      | 30           |
|        |        |         | Prunus microcarpa     | 3               | 10.3%      | 29           |
|        |        |         | Crataegus azarolus    | 5               | 17.2%      |              |
|        |        |         | Pistacia khinjuk      | 3               | 10.3%      |              |
|        |        |         | Quercus aegilops      | 41              | 69.5%      |              |
| 6      | 1500   | South   | Acer monspessulanum   | 8               | 13.6%      | 59           |
| 7      | 1480   | South   | Prunus microcarpa     | 6               | 10.2%      |              |
| Sample | Height | Aspect    | Scientific name       | Number of trees | Percentage | Sample trees |
|--------|--------|-----------|-----------------------|-----------------|------------|--------------|
| 9      | 1670   | North West| *Crataegus azarolus*  | 4               | 6.8%       | 64           |
|        |        |           | *Quercus aegilops*    | 18              | 28.1%      |              |
|        |        |           | *Acer monspessulanum* | 23              | 35.9%      |              |
|        |        |           | *Prunus amygdalus*    | 9               | 14.1%      |              |
|        |        |           | *Prunus microcarpa*   | 4               | 6.3%       | 64           |
|        |        |           | *Pistacia atlantica*  | 5               | 7.8%       |              |
|        |        |           | *Pistacia khinjuk*    | 1               | 1.6%       |              |
|        |        |           | *Quercus libani*      | 4               | 6.3%       |              |
|        |        |           | *Quercus aegilops*    | 4               | 7.4%       |              |
| 10     | 1680   | South     | *Acer monspessulanum* | 11              | 20.4%      |              |
|        |        |           | *Prunus amygdalus*    | 6               | 11.1%      |              |
|        |        |           | *Prunus microcarpa*   | 7               | 13.0%      |              |
|        |        |           | *Crataegus azarolus*  | 4               | 7.4%       |              |
|        |        |           | *Pistacia atlantica*  | 14              | 25.9%      | 54           |
|        |        |           | *Pistacia khinjuk*    | 4               | 7.4%       |              |
|        |        |           | *Quercus libani*      | 1               | 1.9%       |              |
|        |        |           | *Tamarix L.*          | 1               | 1.9%       |              |
|        |        |           | *Corylus avellana*    | 1               | 1.9%       |              |
|        |        |           | *Ficus carica*        | 1               | 1.9%       |              |
|        |        |           | *Quercus aegilops*    | 13              | 14.3%      |              |
| 11     | 1650   | North West| *Acer monspessulanum* | 13              | 14.3%      |              |
|        |        |           | *Prunus amygdalus*    | 22              | 24.2%      |              |
|        |        |           | *Prunus microcarpa*   | 16              | 17.6%      |              |
|        |        |           | *Rhus coriaria*       | 13              | 14.3%      | 91           |
|        |        |           | *Crataegus azarolus*  | 2               | 2.2%       |              |
|        |        |           | *Pistacia atlantica*  | 9               | 9.9%       |              |
|        |        |           | *Pistacia khinjuk*    | 1               | 1.1%       |              |
|        |        |           | *Juniperus oxycedrus* | 1               | 1.1%       |              |
|        |        |           | *Tamarix L.*          | 1               | 1.1%       |              |
|        |        |           | *Quercus aegilops*    | 11              | 16.9%      |              |
| 12     | 1660   | North West| *Acer monspessulanum* | 25              | 38.5%      |              |
|        |        |           | *Prunus amygdalus*    | 16              | 24.6%      |              |
|        |        |           | *Prunus microcarpa*   | 4               | 6.2%       | 65           |
|        |        |           | *Pistacia atlantica*  | 2               | 3.1%       |              |
|        |        |           | *Pistacia khinjuk*    | 2               | 3.1%       |              |
|        |        |           | *Quercus libani*      | 4               | 6.2%       |              |
|        |        |           | *Pyrus syriaca*       | 1               | 1.5%       |              |
|        |        |           | *Quercus aegilops*    | 15              | 22.4%      |              |
| 13     | 1770   | West      | *Acer monspessulanum* | 28              | 41.8%      |              |
|        |        |           | *Prunus amygdalus*    | 18              | 26.9%      | 67           |
|        |        |           | *Prunus microcarpa*   | 3               | 4.5%       |              |
|        |        |           | *Pistacia atlantica*  | 3               | 4.5%       |              |
|        |        |           | *Quercus aegilops*    | 11              | 16.7%      |              |
|        |        |           | *Acer monspessulanum* | 9               | 13.6%      |              |
| 14     | 1820   | West      | *Prunus amygdalus*    | 28              | 42.4%      | 66           |
|        |        |           | *Prunus microcarpa*   | 13              | 19.7%      |              |
|        |        |           | *Pistacia atlantica*  | 5               | 7.6%       |              |
|        |        |           | *Quercus aegilops*    | 13              | 16.3%      |              |
|        |        |           | *Acer monspessulanum* | 8               | 10.0%      |              |
|        |        |           | *Prunus amygdalus*    | 5               | 6.3%       |              |
|        |        |           | *Prunus microcarpa*   | 32              | 40.0%      |              |
| 15     | 1730   | South     | *Rhus coriaria*       | 1               | 1.3%       | 80           |
|        |        |           | *Crataegus azarolus*  | 3               | 3.8%       |              |
|        |        |           | *Pistacia atlantica*  | 8               | 10.0%      |              |
|        |        |           | *Pistacia khinjuk*    | 7               | 8.8%       |              |
|        |        |           | *Pyrus syriaca*       | 3               | 3.8%       |              |
From our observation of table (1) we find that there are types of trees and shrubs spread in the study area and in varying numbers in terms of availability in the region, and in general the wide-leaf species dominated the region while the needle species receded on the Cedrus libani and Juniperus oxycedrus and formed 1% of the total number of trees scattered in the region, while the tree and tree species reached 99% of the total trees, indicating that the conditions of the environmental area supports the presence of broad-leaf species more than needle species. It can also be noted from table (1) that the dominant species in the study area were both Quercus aegilops and Acer monspessulanum because the study area is one of the areas of natural spread of these two species because of the suitability of environmental conditions for their development and prosperity as indicated [11], and the presence of these two species constitutes more than 51% of the vegetation in the study area as well as the rest of the species to different degrees, as they vary in proportions in each study sample site, although the appearance of some species in very small numbers, such as Tamarix spp., Cedrus libani, Ficus carica, Corylus avellana and Pyrus syriaca, are due to their spread of natural or abnormal causes, such as wind, man, animals and birds [12].

### 3.1 Spatial pattern analysis

This analysis was carried out using GPS data taken at each tree and using PASSaGE v.2 to extract the L (r) function, a form of geostatistical where this type of statistic is most capable of interpreting the interactions that occur in the melee.

### 3.2 L(r) function test

This type of test is conducted to draw the L (r) function through which the pattern of distribution of any geographical phenomenon of a community can be interpreted, and the confidence limits of Monte Carlo testing, and the test results were as in figures 1 and 2:

![Figure 1. L(r) test results for study samples (1-8).](image-url)
Figure 2. L(r) test results for study samples (9-16).

The L(r) function curve in the previous two forms is blue and the minimum confidence limits for Monte Carlo in red and the minimum confidence limits for the Monte Carlo test in green, the distribution is clustered when the L(r) curve passes over the red curve, when it passes between the curves the distribution is random, and the distribution is regular if it is under the green curve.

We note the variation in the shape of the L(r) function of the study samples where each sample showed a different shape from the other and for different distances, and to understand and interpret the results of this test we prepared table (2) as follows:

From the table above, the study samples showed different forms in the pattern of distribution of the phenomenon, with the three cluster (aggregate), random and regular phenomena appearing in different proportions, most samples had a random distribution pattern, followed by regular distribution and then cluster, and samples (1, 5, 8, 11) appeared. There are three patterns, the samples (2, 3, 6, 14, 15) showed a pattern of random distribution and regular distribution, while samples (4, 7, 9, 10, 12, 13, 16) showed a pattern of random and aggregation distribution, the following table shows the rate at which each phenomenon appears at the expense of the other:
Table 2. Results of the pattern analysis test for study samples.

| Sample | Number of trees | Random pattern | Regular pattern | Cluster pattern |
|--------|----------------|----------------|----------------|----------------|
|        |                | Range          | Total (m)       | Range          | Total (m)       | Range          | Total (m)       |
| 1      | 60             | 1 - 1.5        | 5.5            | 3.5 - 6        | 2.5            | 1.5 - 2.5      | 1              |
| 2      | 78             | 1 - 3.5        | 4              | 3.5 - 8.5      | 5              | -              | -              |
| 3      | 85             | 1.5 - 3.5      | 7              | 1 - 1.5        | 2              | -              | -              |
| 4      | 61             | 5 - 10         | 8              | -              | -              | 1 - 3          | 2              |
| 5      | 59             | 2.5 - 3.5      | 6              | 3.5 - 5        | 1.5            | 2 - 2.5        | 0.5            |
| 6      | 30             | 1.25 - 8       | 6.75           | 1 - 1.25       | 0.25           | -              | -              |
| 7      | 29             | 3 - 7          | 4              | -              | -              | 1 - 3          | 2              |
| 8      | 59             | 3 - 3.75       | 5              | 3.75 - 4.25    | 0.5            | 1.5 - 3        | 1.5            |
| 9      | 64             | 1 - 1.25       | 8.5            | -              | -              | 1.25 - 2.75    | 1.5            |
| 10     | 54             | 1 - 1.75       | 5.75           | -              | -              | 1.75 - 3       | 1.25           |
| 11     | 91             | 3 - 3.75       | 6              | 3.75 - 5       | 1.25           | 1.25 - 3       | 1.75           |
| 12     | 65             | 1 - 1.75       | 9.25           | -              | -              | 1.75 - 2.5     | 0.75           |
| 13     | 67             | 1 - 1.75       | 7.25           | -              | -              | 1.75 - 2.5     | 0.75           |
| 14     | 66             | 1.75 - 3       | 3.5            | 1 - 1.75       | 3.5            | -              | -              |
| 15     | 80             | 5.75 - 8       | 3 - 5.75       | -              | -              | -              | -              |
| 16     | 38             | 2.5 - 3.75     | 6              | 3.75 - 4.25    | 1              | -              | -              |
|        |                | 4.25 - 8       |                |                |                |                |                |
| Total  | 986            | 100.5 m        | 17.5 m         | 1 - 3          | 2              |                |                |

Table 3. Ratio of phenomenon distribution of pattern analysis test results in study samples.

| Sample | Random pattern | Regular pattern | Cluster pattern |
|--------|----------------|----------------|----------------|
| 1      | %61            | %28            | %11            |
| 2      | %44            | %56            | -              |
| 3      | %78            | %22            | -              |
| 4      | %80            | -              | %20            |
| 5      | %75            | %19            | %6             |
| 6      | %96            | %4             | -              |
| 7      | %67            | -              | %33            |
| 8      | %71            | %7             | %21            |
| 9      | %85            | -              | %15            |
| 10     | %82            | -              | %18            |
| 11     | %67            | %14            | %19            |
| 12     | %93            | -              | %8             |
| 13     | %91            | -              | %9             |
| 14     | %50            | %50            | -              |
| 15     | %86            | %14            | -              |
| 16     | %80            | -              | %20            |
| Average| 75.35          | 13.4           | 11.25          |
Table 3 shows that the percentage rate of tree distribution patterns showed a variation in the pattern and gave the highest 13.4%, while the cluster pattern showed the lowest rate at 11.25%. It should be noted that the pattern of combined distribution indicates that stands are at the beginning of the life cycle and that the species in this pattern will remain the same in the region until the end of the life cycle and that these forests are mature. The random pattern is the transitional situation between the turbulent situation and the more stable situation in the stands.

When returning to table (3), the percentage of random form gave the highest percentages (75.35%) and if we look at figures (1 and 2), the L(r) function curve for almost all samples was in random mode low, i.e. the curve was closest to the minimum confidence limits of the Monte Carlo test, which appears in green, i.e. the large randomness of the L(r) function is closer to regularity than the assembly situation and if we take into account that the ratio of 13.4% from the patterns of the regular pattern we find that these stands generally tend to be regular and this is evidence of the species within these stands in which the stands of biodiversity are more stable and that the probability of these species remaining until the end of the life cycle is very high in the possibility that the probability of other species appearing in the region is low under the installation of the stand more stable as it is.

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