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Araştırma Makalesi

A Statistical Alternative Approach Study in Measuring the Distance of the Determinants of Inter-Species Interaction

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Abstract

A healthy measurement of the distances observed between plant species and varieties in ecological studies can increase the chance of success in identification studies. However, researchers working on the subject for a long time use classical methods and prefer to express the distance approximately. An approximate definition is insufficient to fully define the area where the data is located. Of course, this may vary according to the locations, as well as according to the spread of the species. In this study, distance measurements were made using Euclid, Chebyshev, Manhattan, Minkowski and Lorentzian distances. In the study conducted with 10 different species in Kırşehir conditions, the distance that best describes the distances between species was tried to be determined. In the study, it was determined that the success of the definition of Euclidean distance was statistically significant and distinctly separated from the others. In future studies, it is suggested that the measurement should be done carefully, and the Euclidean distance should be used to reduce the error variance and not to repeat it.

Key words: Distance Measurement, Ecology, Pasture, Kırşehir

Türler Arası Etkileşimin Belirleyicilerinden Mesafenin Ölçülmesinde İstatistiksel Açıdan Alternatif Bir Yaklaşım Çalışması

Öz

Ekolojik çalışmalarda bitki tür ve çeşitleri arasında gözlenen mesafelerin sağlıklı bir şekilde ölçülmesi yapılacak tanımlama çalışmalarında başarı şansını artırabilmektedir. Ancak uzun zamandır konu ile ilgili çalışan araştırmacılar klasik yöntemleri kullanmakta ve mesafeyi yaklaşık olarak ifade etmeyi tercih etmektedirler. Yaklaşık olarak tanımlamak verilerin bulunduğu alanın tam olarak tanımlanmasını yapmakta yetersiz kalmaktadır. Elbette bu lokasyonlara göre değişebildiği gibi türlerin yayılımlarına göre de değişiklik göstermektedir. Bu çalışmada uzaklık ölçümlerinden Öklid, Chebyshev, Manhattan, Minkowski ve Lorentzian uzaklıkları kullanılarak çalışmada yapılmıştır. Kırşehir koşullarında 10 farklı tür ile yapılan çalışmada türler arasındaki mesafeleri en iyi tanımlayan uzaklık belirlenmeye çalışılmıştır. Yapılan çalışmada Öklid uzaklığının tanımlama başarısının diğerlerine göre istatistiksel olarak önemli ve belirgin şekilde ayrıldığı tespit edilmiştir. Yapılacak çalışmalarda hata varyansının azaltılabilmesi ve tekrar edilmemesi için ölçümün dikkatli yapılması ve Öklid uzaklığının kullanılması önerilmiştir.

Anahtar Kelimeler: Uzaklık Ölçümü, Ekoloji, Mera, Kırşehir

Introduction

In ecological studies, very different data are obtained. Accordingly, it is expected that the analyzes to be made will differ. Because ecology is controlled by many factors and it is very difficult to know how much effect each factor has. Of course, the large number of variables also necessitates their analysis in different ways. For this reason, multivariate analyzes come into play. Gotelli and Elison (2004; Kabak and Akçura, 2017) stated that it is necessary to analyze the distances or differences that occur in ecological studies and that the distance matrix should be created first. It is known that measuring distances will be easier and more meaningful after the distance matrix is created. Wark and Warner (1981) stated that the environment has a great influence on dispersal and will be in a constant state of flux in their dispersal as the environmental impact is constantly changing.

There are many different sources of change. These can be natural disasters such as fire, flood, severe storm and earthquake, as well as pollutants released into the atmosphere as a result of human-induced industrial activities, constructions, polluted waters that are insufficiently treated or left to nature without any treatment, similarly affect the spread significantly. Continuous monitoring is necessary to obtain information about how the change in the spread is, its speed and direction. Wilson et al. (2002) stated that while determining the change in dispersion today, the important thing is not natural changes but human-induced changes, and that the threshold values that will affect the spread of pollutant species should be determined exactly. Ecologically negative effects of negative effects can negatively affect the development of plant species and varieties. Thus, it is desired to see how the selected places will affect the structure of the plant to be grown and direct the spread. Breeders are doing great work on this issue and are focusing on high yielding genotypes that are resistant to stress conditions. Sözen and Karadavut (2019) stated in their study that the most important feature in breeding studies is that genotypes should be grown in different environments in terms of quantitative characteristics. The use of distance measurement studies in the agricultural field is very limited. The studies carried out are for classification in general and have been made for fruit trees in general. Sert et al. (2010) in the classification of peach trees, Sofu et al. (2013) used image processing techniques to measure the frequency of disease symptoms in apple trees and distance measurements. However, the source could not be reached regarding the use of these methods in pasture classification.

Pastures are special places in terms of structure. Plant communities in pastures have been formed in a long period with the effects of soil, topography and climatic factors. For this reason, the vegetative existence of each pasture is unique to itself. However, this specificity changes over time due to changes in ecology. In this process, there will be changes in the number of species forming the vegetation, the ratio of each species in the botanical composition or the soil cover ratio of the vegetation (İspirli ve ark., 2016). The direction of this change may be in a more desirable or more productive direction, or it may be in an undesirable or less productive direction (Curtis ve Wright, 1993). As a result, plant communities are not static as in every living community, on the contrary, they are in a continuous dynamism. This structure can cause its distances to change over time. The change in the distances between the plants over time may cause the health status of the pastures to change (Loughran ve ark., 2004). In such a case, when early intervention is not possible, pastures may deteriorate faster than expected and bare areas may ocur (Sun ve Liddle, 1993). Bare areas will mean zero feed production, as well as an increase in soil losses.

It will be important to determine how ecologically spread genetically susceptibility will be affected by the environment and how the amount of impact changes according to distance. Of course, analysis methods based on distance come into play here, and it is tried to determine how one variable affects the other variable or variables (Gobelle ve Gure, 2018). In terms of interaction, the general point of view is the relationship between the mean and the variance (Warton et al., 2012). Especially in some studies, results similar to the Poisson distribution can be obtained. In cases where the density increases too much, $Var(X) = \mu$ may occur (McArdle and Anderson, 2004). However, this is often misleading. It is seen that this structure, which seems to have been predicted very well, actually cannot be predicted very well. Because the mean and variance relations are examined, it will be seen that the variance works as a function of the mean and the distribution parameter (Routledge & Swartz, 1991). The direction of the mean-variance relationship is generally decisive in the definition. If the distribution becomes linear with a tendency towards a certain direction, the idea that the relationship is high occurs. If there is no linearity, if the data has a wide dispersion gap, then we think that the relationship between the mean and the

variance is low. Anderson et al. (2008) examined this issue in detail in their study.

In this study, our aim will be to compare the distance measurement methods that can help us to make healthier decisions in order to explain the effects of the changes that will occur accordingly, since the distribution of plant species according to the locations is affected by the distances between the plants. Because this will give us valuable information on how to distinguish between distributions and how to define the resulting distribution. It is known that there are difficulties in making decisions due to the inability to clearly determine the distances between plants, especially in studies with pastures. It is known that the environment has an effect on high productivity in a multivariate study.

Material and Method

In this study, there are hesitations as to whether the wheeled loop method, which is used to determine the distances on pasture plants and to determine ecologically communities, is a healthy measurement. By using distance measurement methods, distances between communities and between species whose communities are formed can be determined much more clearly. In this study, it was aimed to determine the distances between some plant species that dominate the pastures of the material in the areas between Karaarkaç and Bazlamaç villages of Kırşehir Province Mucur district. It was desired to determine the distances of 10 different species from each other. It is focused on the decreasing species in pastures. Because the decreasing species are very important in terms of animal husbandry and richness of botanical composition. The examined species are: *Agropyron cristatum, Dactylis glomerata, Koeleria cristata, Onobrychis armena, Phleum montanum, Sanguisorba minor, Trifolium hybridum, Trifolium pratense, Trifolium repens* and *Vicia cracca*. The rangelands in the study area are included in the problematic rangeland class (Koç et al., 2003).

The fact that there is a lot of empty space in Central Anatolian pastures increases the error in determining the distance. The presence of a gap means an increase inspread. In studies based on distance, dispersion actually comes to the fore. An increase in diffusion means an increase in distance. If the distribution obtained in such studies is defined as a variability between the mean and variance, distance measures will come to the fore in the studies to be conducted based on distance. If a reliable measurement is made, the relationship between mean and variance will be revealed more clearly and location and distribution effects will be explained successfully. In case of different scaling, there will be changes in the relations between mean and variance. The distance measurement methods used in the study are as follows;

1. Euclidean distance; A standard distance measurement is required. The most convenient method here is to use the Euclidean distance. The Euclidean distance equation used in this study is as follows (Legendre and Legendre, 1998);

$$d(i,j)=\sqrt{\sum_{k=1}^{p}(X_{ik}-X_{jk})^2}$$

Euclidean distance can be defined as the straight line distance between two points. Euclidean distance is accepted as the most suitable distance measurement method that can be used when the variables have equal variance (Braak and Prentice, 1988). Here, the equal variance assumption is considered appropriate since the relationship between the mean and the variance is considered to be a horizontal line with a zero slope (Warton et al., 2012).

2. Chebyshev distance; The second distance measurement criterion is the Chebyshev distance. It expresses the highest absolute magnitude of the differences between two points or two vectors (Merigo & Casanovas, 2011). This equation can be represented as:

$$d_{Cheb}(p,q)=\max_{i}|p_i-q_i|$$

3. Manhattan distance; Manhattan Distance is another distance determination method. Euclidean distance is very successful from a theoretical point of view (Akpınar, 2014). It also performs distance measurements in small areas very successfully. However, as the area grows, for example, when it is desired to determine the distance between two cities, it becomes insufficient (Myatt and Johnson, 2009). In this case, Manhattan Distance is more appropriate and gives very valuable information. The Manhattan Distance can be represented by the following equation.

$$d_{Manh}(p,q)=\sum_{i=1}^{n}|x_i-x_i|$$

4. Minkowski Distance; Minkowski Distance expresses the distance between two

points in n-dimensional space (Lu et al., 2016). Actually, Manhattan is a generalization of Euclid and Chebyshev distances (Merigo and Casanovas, 2011). The main determinant is lambda. If the lambda is equal to 1, it will be the Manhattan Distance, if it is equal to 2, it will be the Euclidean Distance, and if it is equal to 3, it will be equal to the Chebyshev Distance. In studies, taking lambda as 1.5 is considered important for the subject.

$$d_{Mink}(q,p) = \sqrt[\lambda]{\sum_{i=1}^{n} (|q_i - p_i|)^{\lambda}}$$

5. Lorentzian distance; To determine the distance between two points, the logarithm of the difference between two points is taken. The issue to be considered here is that the result should not be negative (Tabucanon, 1988). For this, the number "1" is added to the equation. Thus, the results are greater than one and logarithms of large values are taken (Yoon & Hwang, 1995). The equation of the Lorentzian distance is as follows (Bilge and Kermibekov, 2016);

$$\mathrm{d}lorantzian = \sum_{i=1}^{n} |p\ i\ qi - pj\ qj|$$

In order to determine the estimation success of these distance measurement degrees obtained, the C value, which is accepted as the most appropriate solution value, was used. C value is calculated with the help of the equation given below (Kabak et al., 2017);

Ci = Si- / (Si+ + Si-)

Here;

Si-; The negative ideal value of the criterion,

Si+; It shows the positive ideal value of the criterion.

The C value takes a value between 0≤C≤1 and as it gets closer to one, it states that it makes the distance estimation successfully (Chen & Tzeng, 2004; Özdağoğlu, 2013).

Results and Discussion

Descriptive statistics of the botanical composition in the area are given in Table 1. When the table is examined, the variation width values that determine the difference between the highest and lowest values are seen as 30.99% in the planted area and 33.33% in the bare area. While the average of the area covered with vegetation was 44.59%, the average value of the area covered with vegetation was 55.41% in the bare area. When examined in terms of species, the variation width and mean value of the reducing species were significantly lower than the multiplier and invasive species.

Reducing species are the most nutritious and palatable plants in pastures and are primarily preferred by animals (Altın and Tuna, 1991). Because of these features, if the necessary care is not taken, they are quickly withdrawn from the pastures. Reproducing and invasive species begin to take their place (Altın et al., 2005). Considering that the average coverage rate of the reducing species is 12,68%, we can say that the reduction species have decreased a lot in the study area. The decrease of the declining plants in the pastures, both in terms of species and ratio, causes the classification of the rangeland to be classified as healthy, risky and problematic pastures (Aecher and Smeins, 1991). It would not be misleading to say that these areas are problematic areas. Working in problem areas and collecting data is quite difficult.

When we look at the replicating species, it is seen that they have an average spread value of 25.40% and a variation width of 55.41. The height of the spread indicates that the probability of showing different characteristics in different areas is high (Bedell et al., 1981). Invasive species, on the other hand, constitute the last phase of the pasture. It is now a period in which diminishing and multiplying species are completely withdrawn. Invasive species found in the pasture have invaded the pasture. These types of pastures do not have any importance in terms of productivity and productivity (Mathews, 1994). It is seen that the invasive species has the highest value with the change width of 75.9%. The average was determined as 63.49%. The fact that the width of change is high is accepted as an indicator that the heterogeneous structure is dominant. The height in the width of variation observed especially in invasive and reproductive species shows that they are widespread in the area and they are now starting to dominate the pasture. We can say that if the pasture is not supported in terms of decreasing plants by intervening in this period, the pasture will become unusable very soon (Gökkuş and Koç, 2001).

Table 1. The characteristics and descriptive statistics of the rangelands studied

Descriptive Statistics	Plant Covered Area (%)	Bare Area (%)	Reducing Species (%)	Increasing Species (%)	Invasive Species (%)
Minimum	27,14	43,78	1,14	5,13	12,81
Maximum	58,13	77,11	33,26	60,54	88,17
Range	30,99	33,33	32,12	55,41	75.99
Means	44,59	55,41	12,68	25,40	63,49
Standart Deviation	6,72	5,92	10,24	15,29	17,12
Değişim Katsayısı	12,63	10,70	48,41	51,08	30,31

The collective representation of the distance measurement methods applied in the areas where distance measurement is made is shown in Figure 1. When the figure is examined, it is seen that the Chebishev and Euclidean distance measurements are the most stable measurements and there are no serious changes between the measurements according to the species. On the other hand, Lorantzian distance measurement method has been used for unstable measurement. This was followed by the Manhattan and Minkowsky method. The stability of the methods can be accepted as an indication that they can successfully measure the distance between the plants in the study area. The instability shows that they could not measure the distance measurements, which vary according to the species, and the deviation value increased. Lorentzian, Minkowsky and Manhattan distances had a serious decrease in measuring the distances between *Phleum montanum species*, especially the 5th species. However, Euclid and Chebishev methods have done more successful measurement.

Central Anatolia Region is the second largest region of our country. Due to this feature, its biological richness is quite high. Because the region is located in the largest phytogeographical region in our country (Yıldırım and October, 2003). Although there is a rapid disappearance of biological riches due to the dereliction of pastures, they still continue to exist in a certain amount. Çetik (1985) stated in his study that some of the species distributed in the region exist in the natural flora of this region, but some of them cannot fully adapt due to their cosmopolitan structure and have variability. Care was taken to ensure that the species used in the study are part of the natural flora of the region. It is thought that being a natural or cosmopolitan species has an effect on these differences between measurements. The fact that *Onobrychis armena, Onobrychis armena, Trifolium hybridum* and *Vicia cracca* are native species of the region may have caused a certain stability in the measurement values.

The C values used in the evaluation of distance measurement success were calculated according to the distance measurement methods and are shown in Figure 2. C value When the general success situation of Euclidean distance is evaluated, it is observed that the average distance is 0.16054, while the success situation has a value of 0.7994. It can be said that Euclidean distance is generally successful in determining distance.

When the success status of the Chebyshev distance values is examined, it is seen that there is no stable structure and serious changes are experienced. On the average, the Chebyshev distance value was determined as 0.1301, while the success status was determined as 0.7214. When the success status of the Manhattan distance values is examined, it is seen that there are no significant changes. Although significant decreases were observed especially in T3 and T8, it was determined that they were not statistically significant. Success statuses varied between 0.6719 and 0.8122 values. On average, the Manhattan distance value was determined as 0.12465, while the success status was determined as 0.7496. It is seen that the change in the Minkowski distance values is in a very wide range. Distance values were the lowest at T5 with a value of 0.09923 and the highest at T7 with a value of 0.18452. When the success statuses are examined, it is seen that the most commonly taken values are close to each other. In particular, the lowest value (0.7002) was taken in T7, while the highest value (0.7922) was taken in T5, but it was determined that these differences were not statistically significant. On average, the Minkowski distance value was determined as 0.13145, while the success status was determined as 0.7224. It is seen that the variation in the Lorentzian distance values takes place in a very wide range.

Distance values were the lowest at T5 with a value of 0.07021 and the highest at T10 with a value of 0.16883. When the success status is examined, it is seen that the values obtained are very far from each other. In particular, the lowest value (0.5599) was taken in T5, and the highest value (0.8281) was taken in T10, but these

differences were determined to be statistically significant. On average, the Lorentzian distance value was determined as 0.12363, while the success status was determined as 0.7376.

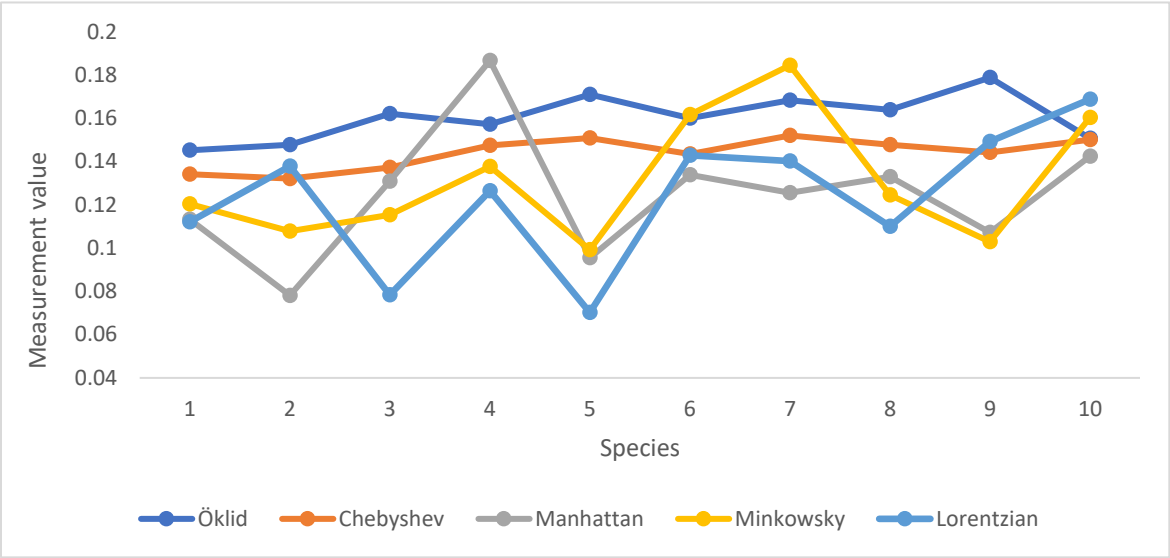

Figure 1. Distances calculated by distance measures

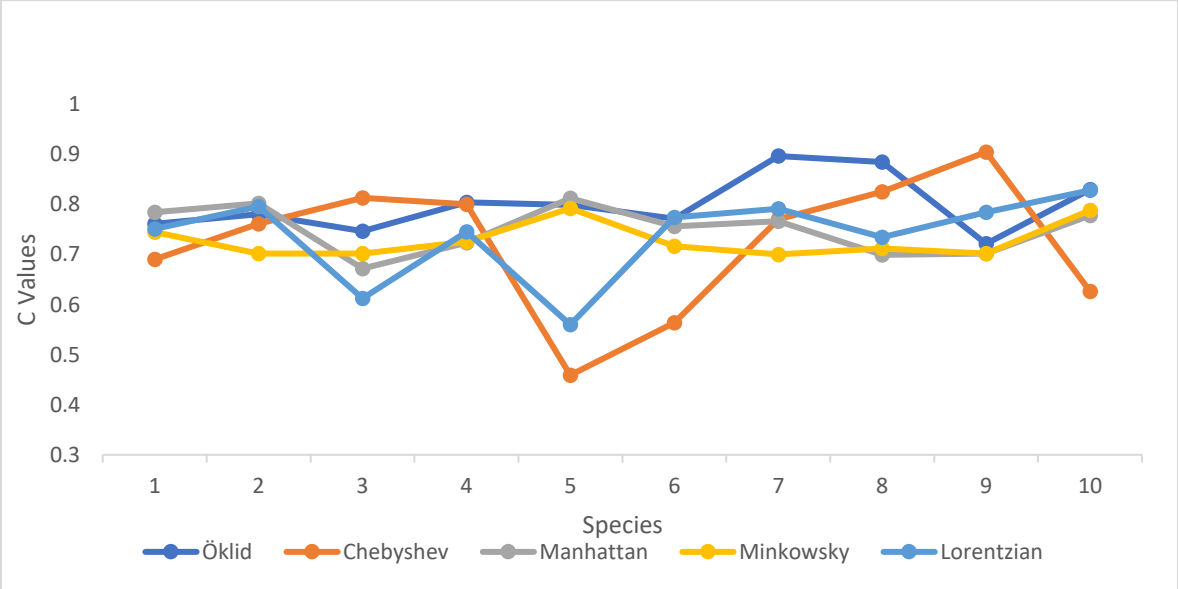

Figure 2. C values showing the distance measurement success of the methods according to the species

Ecologically, it is important to determine the botanical composition and to monitor the change over time. Thus, it will be possible to determine in time whether the critical threshold has been exceeded and to take early measures. However, methods such as the wheel loop method are generally used to determine the botanical composition. Such methods give approximate values in determining the distances between plants and cannot give a clear value. In this study, we focused on methods that can provide a healthier way of revealing distances, which are much stronger in terms of decision-making, and that can create alternatives. Decision making is one of the most difficult issues for researchers. It is especially difficult to make correct and valid decisions. When the results of the study are evaluated, it is thought that much more successful decisions can be made about the change of botanical composition. By determining the distance between the species in a healthy way, the area covered with vegetation and

the bare areas can get a proportionally clearer value (Ye, 2012).

Pan (1999) stated in his study that the effects of locations covering medium and small areas on species may have some effects that may arise from duplication in the estimation of error variance, and this may complicate the determination of the distribution. Similarly, although Henry and Laugin (2017) suggest the stochastic algorithm method to determine the distributions according to the locations in a healthy way, it seems that this will not give healthy results especially for botanical composition. Because as the number of locations increases, it becomes impossible to detect the spread. It is thought that our study was successful due to the low number of locations and species.

Kuncan et al. (2013) stated that it is appropriate to use Mahalonbis distance in the process of separating the olive plant according to its size in a healthy way and for real classification, while they stated that the Euclidean distance can also be used for successful classification. Akar et al. (2010) stated that the use of distance measures in the classification of lands is of great benefit and the use of Euclidean or Mahalanobis distances is important, especially in forest lands. Christian and Krishnayya (2009) stated that it facilitates the monitoring and protection of biological diversity in nature, while Huang and Fipps, (2006) stated that it is useful in classifying the land cover in pastures and forests.

The success of these methods is determined by the C value. C value decreases as it approaches zero and increases as it rises towards 1 (Chen & Tzeng, 2004; Özdağoğlu, 2013). According to the results obtained with the measurement methods used for this, it is seen that the Euclidean distance is generally more successful than other methods. While the average identification success of the Euclidean distance was 0.7994, the closest success was obtained at the Manhattan distance with a value of 0.7496. The lowest value was obtained from the Chebyshev distance with a value of 0.7214. Statistical differences between the distances are given in Figure 3. When the figure is examined, it is seen that the Euclidean distance differs statistically compared to the others, and the others are in the same group.

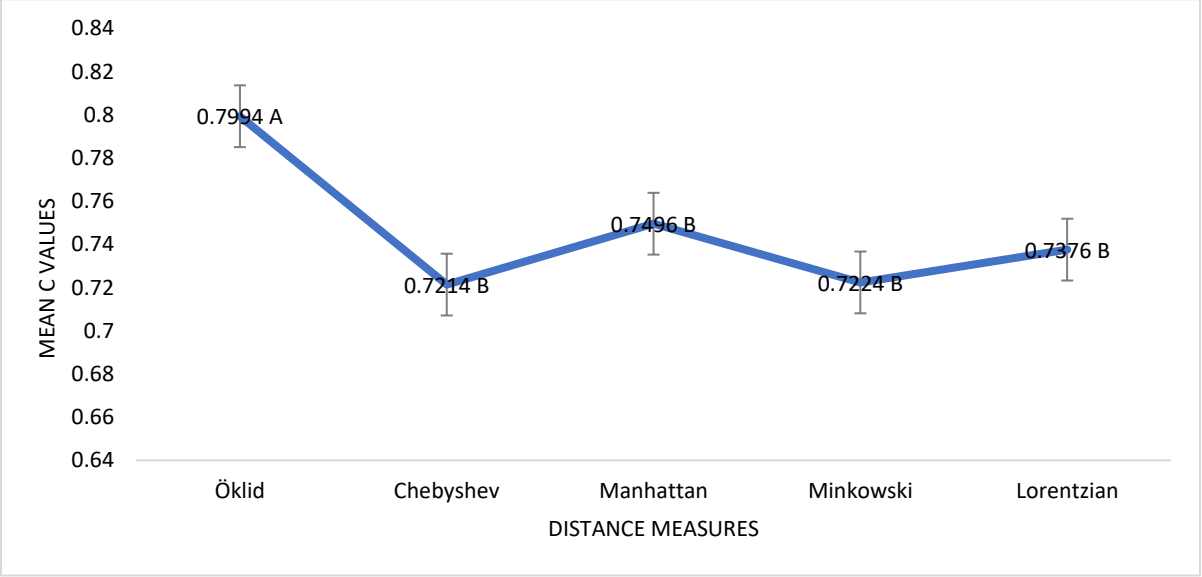

Figure 3. Average C values of the distance measurement methods used

Interactions are frequently observed depending on location and distance. However, it is important to clearly demonstrate the effects of location and distance in their formation. The difference between the distance determination methods actually depends on the proportional distances between the distance vectors. As the proximity to each other increases, there is a change in the distance identification successes. While the characteristics of the soils of the pastures are effective in this, the spatial differences of the pasture soils can directly affect the soil properties and the distance between the plants (Corwin and Lesch 2005). If the spatial changes of soils can be fully understood, the basis of the distribution of plant species and varieties

will be better understood. In this, it is necessary to know the pasture and the plants settled on the pasture very well (Dikmen, 2013).

It is important to know the average and standard milking of plant species and varieties in distance measurement. In addition to these, knowing the spatial structure is also important for the evaluations to be made (Isaak and Strivastava 1989). One of the important effects that determine the development of plants in the pasture is the wilting point. The amount of water in the soil can affect the development of plants and the distance between species (Yılmaz, 1977). If the wilting point changes greatly in small areas, there is an increase in the distance between species (Zhao et al. 2008). In the study, especially the large arid areas caused serious changes in the wilting points of the soil in small areas. Big changes cause the distance between plants to differ and the actual distance cannot be measured exactly. When determining the spread of plants in the pasture and the distance between species, information about the amount of water in the area and its use will need to be obtained.

Plants do not have problems in adaptation because they have existed for many years in the places where they are structurally located. In addition, as they adapt to the negativities seen periodically, they can easily overcome them. In fact, this feature is due to the special ability they have acquired over time for biotic and abiotic conditions. Pastures are places where natural conditions are effective and are areas where climatic conditions show their effects in every aspect. For this reason, it is easier for the plants in the pastures to interact with each other (Carlsson and Callaghan, 1991). While interaction is not allowed in agricultural areas, interaction is accepted as a part of the natural process for plants to survive.

The further away plant species and varieties are from each other, the more difficult it is for them to interact. This situation is more common in pastures where the number of plants decreases and the bare areas increase. Since there will be no plants, it is not possible to talk about the interaction between plants. Plants have a perception mechanism of their own, and in order for the mechanism to work, the roots must step in and present themselves with the secretions they produce (Pugnaire and Luque, 2001). Interactions occur as one of the forms of neutralism, commensalism, mutualism, parasitism, amensalism and competition (Bertness and Callaway, 1994; Lambers and Chapin Ш, 1998). Whether there is interaction and the amount of interaction is determined by the distances between the plants. Distances can be the main determinant, especially when determining the positions and movements of reducing, reproducing and invasive species. In this study, different distance measurement methods were used in order to help the distances between species to be made more accurately.

Conclusion

In this study, it was aimed to determine the most ideal distance between species. It was concluded that it would be appropriate to use the Euclidean distance in distance calculations. Although the most commonly used method in such studies is the Euclidean distance, some alternative methods were also included in the study but were not successful. It is suggested to continue to use the Euclidean distance to facilitate the work of researchers in terms of decision making and to make healthier decisions. It is expected that this study, which is the first in studies to be carried out for pastures, will be useful for application studies. In addition, when the findings are examined, it is seen that different distance calculation methods can create an alternative for decision-making experts.

Conflict of Interest: The authors declare no conflict of interest.

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