Measuring Spatial Change of Agricultural Land Uses in the Taza District, Kirkuk Governorate

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This study is on the measurement of spatial change of agricultural land uses in Taza District. It focuses on showing the importance of the spatial element in guiding all the phenomena that shape their behaviours through spatial variation in all its components. Then, it highlights spatial patterns by identifying the location and spatial distribution of the phenomenon. Therefore, it can be said that the multidimensional distribution is the reoccurrence of and variation in a particular phenomenon in a particular place. So, it is necessary to explain the process of activities taking place in a constant movement that expresses spatial differences. Hence, the identification of all potentials of any region gives an opportunity to know its reality in terms of limiting its exploited potentials and explaining the different relationships between all these elements and data. The problem of this study lies in the ability to develop a geographical database that enables the application of multiple criteria to measure spatial change, based on spatial competition between agricultural land uses, to show the best agricultural crop that can be grown in the study area. Accordingly, this study aims at using multivariate criteria in order to find the best agricultural crop that can be developed and relied upon. It is hypothesised that multiple criteria could be used to measure spatial change of agricultural land uses on the basis of spatial competition. It is concluded that there is a great competition between the uses of agricultural land in the study area. Also, the rate of spatial change in agricultural land uses varies in comparison with the uses of agricultural land for other crops through using several criteria of measurement.

Key words: *Variation of my location, Spatial change, Land uses, Spatial competition, Forecasting, Spatial extension.*

Introduction

Human knowledge represents an outcome that various sciences, such as mathematics, physics, engineering, economics, sociology, geography and other sciences contribute to. The nature of the contribution of any science is determined by the subject of and methodology of the study. The best way to achieve the goal of any study is to apply the quantitative method through the study of geographical systems. This system consists of a group of elements or components that are correlated so that they eventually lead to the formation of a specific system with distinct characteristics different from those of any elements forming it (Peter A. J. Attema and Others 2010). The most prominent elements of the system are the land on which the different geographical phenomena appear. These phenomena are called variables, elements or components, but it is preferable to use variables because it is the preferred concept in the statistical studies. The variable is a statistical term to name any phenomenon that takes different values. On the contrary, the constant refers to the value of only one phenomenon that never changes. The nature of the system is determined by the type of variables that form it and the nature of interactions between them on economic bases. These variables are spatial variables, i.e. within a spatial framework geographically known as the pattern. So, geography studies the spatial dimension of variables of all kinds. This is done only through applying quantitative method, which is called geo-theorisation, that is, seeking to develop geographical models and theories (Shahathah, 2002, p. 17).

Due to the predominance of natural distribution in the statistical methods of a variable, it is not surprising to discover that the natural multivariate distribution has a central position in the multivariate statistical methods which require data that follow the natural multivariate distribution (Henk C. van Latesteijn, 1999). The main objective of the multivariate analyses is to find variables that are indicators or standards for this purpose. This is done through the use of computer software designed specifically for these methods because of the presence of many variables. Here, it is necessary to standardise measurements to have equal scales in the analysis. The scale or the multidimensional measurement is a statistical technique designed to create a map that demonstrates the relationship between a numbers of things. The map could be of one, two or three dimensions. The important thing about the formation resulting from the multidimensional measurement is the relative location of the data under study (Manly, 2001).

Consequently, this study is on the use of multiple criteria in the measurement of spatial change of agricultural land uses in the Taza District. It focuses on showing the importance of the spatial element in guiding all the phenomena that shape their behaviours through spatial variation in all its components. Then, it highlights spatial patterns by identifying the location and spatial distribution of the phenomenon. Therefore, it can be said that the multidimensional distribution is the reoccurrence of and variation in a particular phenomenon in a particular place. So, it is necessary to explain the process of activities taking place in a constant movement that expresses spatial differences. Hence, the identification of all potentials of any region gives an opportunity to know its reality in terms of limiting its exploited potentials and explaining the different relationships between all these elements and data (Otto, J. M., Hoekema, A., & Bruce, J. W., 2012). The location is identified based on the behaviours of geographical phenomena. It must be emphasised that nothing is constant, as the phenomena are subject to change and modification. Phenomena are changing from time to time and the degree of change varies in its range and speed. The change is either causal or correlated, as it is not necessarily that relations among phenomena are of a causal type (Di Gregorio, A., 2005). This is because the location is not just a natural component, but it is formed by the interaction between people, time and space. Therefore, the location is the origin of the dynamic convergence between the relevant plans and concepts between temporal and spatial positions, and thus acquiring its cultural dimension (al-Musa, 2009, p. 21-39).

Research Problem

The problem lies in the ability to develop a geographical database that enables the application of multiple criteria to measure spatial change based on spatial competition between agricultural land uses, to show the best agricultural crop that can be grown in the study area.

Research Objective

The study aims to use multivariate criteria in order to find the best agricultural crop that can be developed and relied upon according to the available potentials. This is in addition to measuring the spatial change of agricultural land uses in the study area and then studying agricultural patterns.

Research Hypothesis

Multiple criteria can be used to measure spatial change of agricultural land uses on the basis of spatial competition that increases or decreases negatively or positively in agricultural efficiency, which represents problems or constraints in the agricultural process, in addition to studying spatial patterns of agricultural land uses in the study area.

Research Method

This study is based on the analytical approach, starting with collecting data through surveying the cultivated parts in the region and the use of special software in the processing of relevant data. It is concerned with developing databases in order to determine the best agricultural crop depending on special software to have accurate and reliable results, as well as measuring the spatial change of agricultural land uses in the study area.

Research Procedures

To achieve the research objectives, this study has followed several steps:

- Collecting data from the relevant departments, consisting of agricultural data on the basis of the districts in the study area.
- Obtaining a map of the study area from the Division of Agriculture in Taza with the distribution of districts.
- Measuring the spatial change of agricultural land uses in the study area through the use of simple linear regression technology.

This technology studies the common distribution of two variables. One variable is constant at certain levels; in other words, it is measured without a line. The other variable is dependent and unrestricted, taking different values at each level of the independent variable. It is used as a functional relationship, namely, Y = X. This method can define the change in one variable on the basis of being affected by the other variable, in other words, expecting and predicting the behaviour of the dependent variable in the light of being affected by the independent variable or variables. In addition, it measures the extent of the correlation between the dependent and independent variables. Among the important things when studying the correlation or regression is the form of the spread of the phenomenon studied (Al-Ani, 2010, p. 379). This is done according to the following steps:

1. Measuring the rate of change in absolute materiality, as in the following formula:

$$\frac{S - K}{K} \times 100$$

Where S is the last year of study and K is the equivalent value in the first year of study. This difference is divided by the value of the first year in order to standardise the results, which are converted into a percentage by multiplying the result by 100.

2. The time rate of change in the rate of land uses in the cultivation of different crops: This measurement is based on the change in the rate of land uses in the cultivation of all the different crops in each years of the study period. Using this measurement, the rate of this

change for years of the study period is obtained. This is achieved by the technology of regression formulated as:

$$Y = A X + B$$

Where Y is the dependent variable (the ratio of areas occupied by land uses in the cultivation of a particular crop out of the total of cultivated area of different crops), X is the independent variable; A is constant and B is the regression coefficient (this is the measurement of the time rate of change in the rate of land uses in the cultivation of different crops).

3. The data processed are the original data, i.e. data of the absolute materiality of land uses in the cultivation of different crops after placing them in a standardised scale, which is a relative scale, using the following formula:

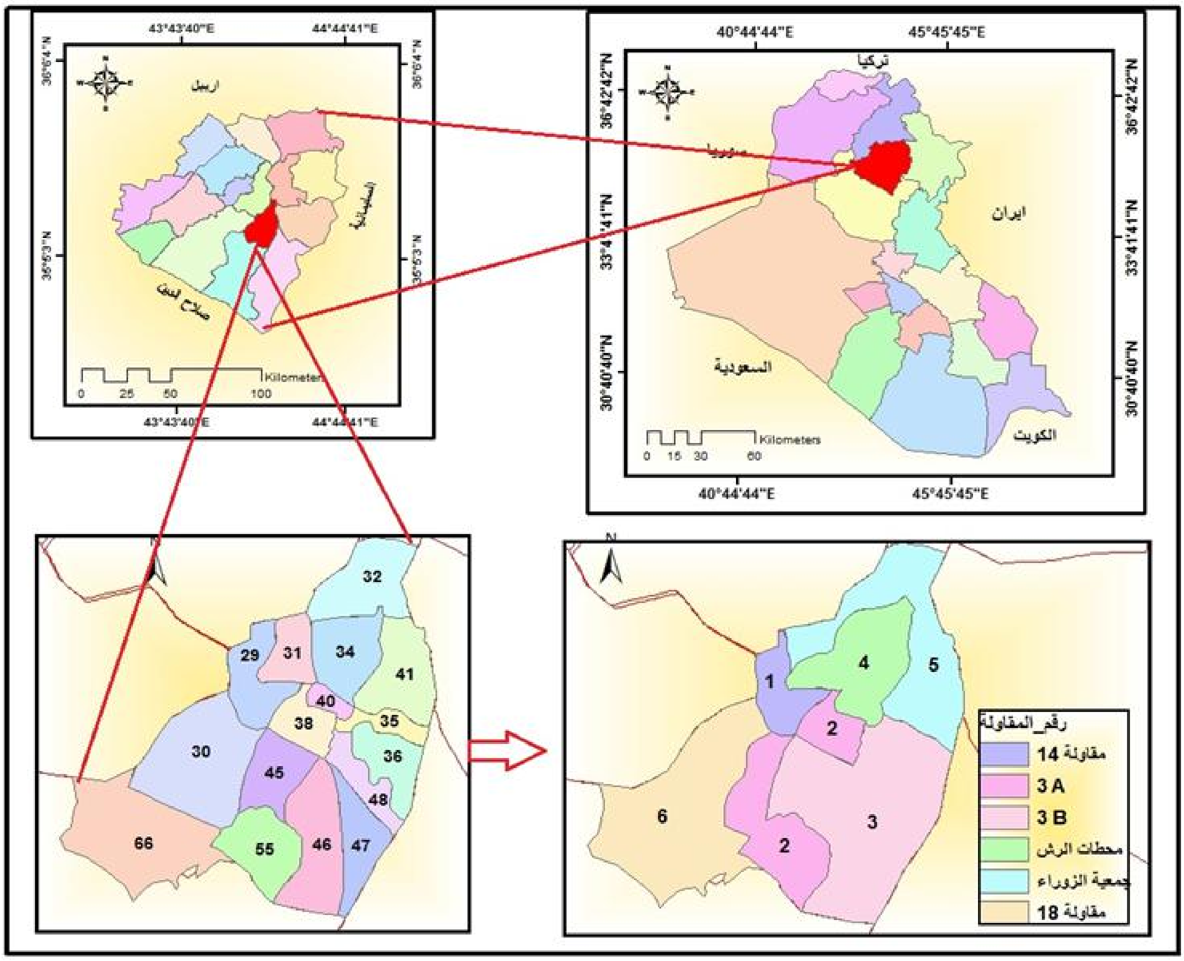
$$\frac{M}{L} \times 100$$

Where M refers to areas occupied by land uses in the cultivation of a particular crop in a specific district for a specific year and L is the total of the cultivated area occupied by land uses in the cultivation of different crops in that district and for the same year.

Research Scope

Concerning the spatial limits, this study is confined to the Taza district, which lies between longitudes 20′44° and 17′44° and latitudes 19′35° and 17′35°. It is bordered by the Yaiji district to the north, Al-Rashad to the south, Lailan to the east and Al-Riyadh to the west, as illustrated in figure (1). As for the temporal limits, it is confined to the period from 1998 to 2010 based on data collected from the Agriculture Division of the Taza District.

Figure 1. The location of the Taza District and its administrative units.



Results and Discussion

The use of scientific and real methods of analysis requires advanced analytical methods through which realistic results can be achieved. This is done through the use of statistical methods, particularly the multi-analytical type which requires variant methods of analysis according to the research objective (al-Dulaimi, 2010). This is because there are constant geographical conditions, permanent distributions and continuous formations as a result of the spatial influence. Despite the integration of agricultural crops, there is competition among them influenced by the time through the development of geographical fields and human communities. The three concepts of structure, function and range are correlated, which requires special or objective studies on the land field in order to identify the factors of distribution, similarity and regularity which must be interpreted. The land field is characterised by dynamism as it is not objective or euclidean distances but human distances. It is a relative rather than an absolute field and is influenced by spatial competition. The place is measured through the passage of time. This method has helped to develop special laws to measure this change (Burgers, G. J., Attema, P., & van Leusen, M., 2010). According to Scheffer (1950), geography seems to be a field which tends towards producing laws that are formed rather than developing laws relating to operations in models of forms acting as laws that are formed. Consequently, the geographer must study spatial extension as geography invests the field and is based on interaction, taking into account adaptation and subject to distance (Mansour, 2010).

Spatial Change of Agricultural Land Uses in the Taza District for the Period (1998-2010)

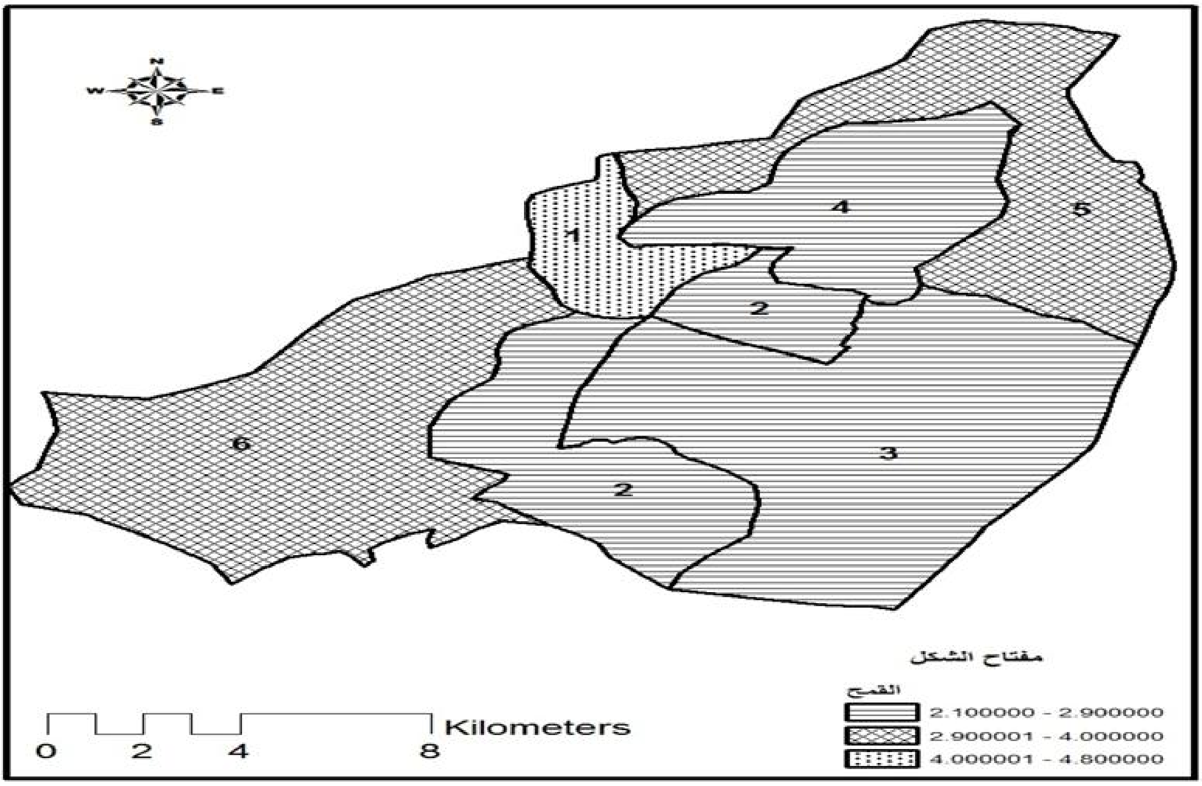
A. Time Rate of Spatial Change of Agricultural Land Use for Wheat Cultivation

The total area cultivated by the wheat crop in 1998 was 80,715 acres and its relative materiality was 11.2%; while in 2010, it was 36,085 acres with a relative materiality of 78.34%. The rate of change between the two years was -44,630. This means that the land use for wheat cultivation in the study area is decreasing, but the decrease varies from one region to another, especially after measuring the rate of time change of the wheat crop for the period 1998-2010. After classifying its data into categories, it is found that there are three categories as described in figure (2).

1. **2.1-2.9:** this category included three areas (enterprises 4, 2 and 3), whose spatial structure extended as a connected range from the north to the south-east of the study area. The rate of change in each was 2.95, 2.54 and 2.05, respectively.
2. **2.9001-4.000:** it comprised two regions whose spatial structure was not in the form of a connected range but as two separate areas, one in the north of the study area (enterprise 5) and the other in the south-west of the study area (enterprise 6). The rate of time change in each was 3.77 and 4.04.
3. **4.001-4.8:** it included only one area (enterprise 1) whose spatial structure appeared in the west-north of the study area. Its rate of time change was 4.88.

Based on the above, the rate of spatial change of agricultural land use for wheat cultivation in the study area was positive in comparison with other crops. This is attributed to that its spatial change was increasing as the highest rates of time change were recorded for wheat crop.

Figure 2. The rate of spatial change of agricultural land use for wheat cultivation in the study area for the years (1998-2010).



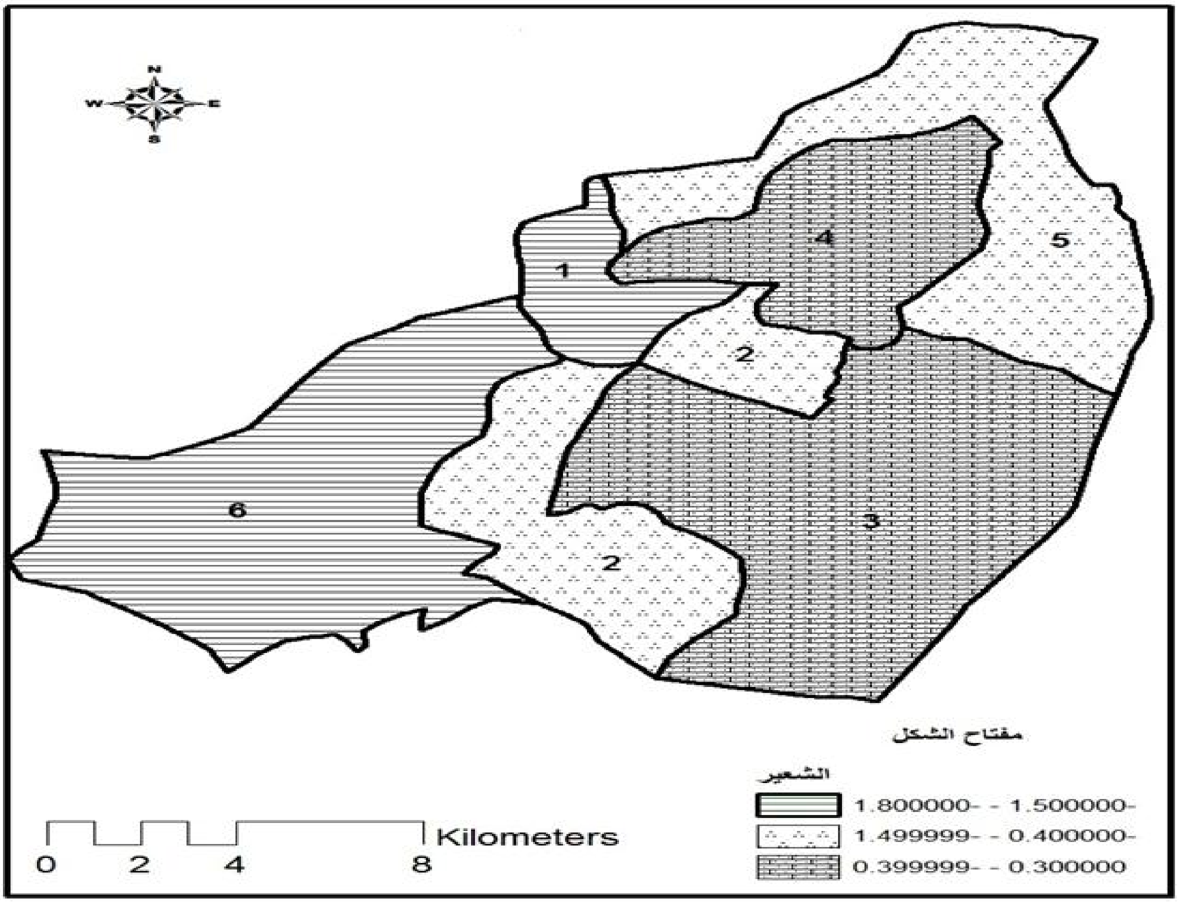
B. Time Rate of Spatial Change of Agricultural Land Use for Barley Cultivation

In 2010, the area planted with barley in the Taza district was 1775 acres, while in 1998 it was 13,000 acres with relative materiality of 4.92% and 23.7%, respectively. The rate of change for the two years was -11,225 acres. After classifying the rate of time change of the area cultivated by the barley crop for the years 1998-2010 into categories as described in figure 3, it is found that there is a clear spatial variation in its spatial extension as follows:

1. **1.5-¯1.8:** this category included two areas (enterprise 1 and 6), whose spatial structure appeared as a connected range extending from the west to the south of the study area with a change rate -1.83 and -1.56, respectively.
2. **1.4-¯0.4:** its geographical distribution appeared in two areas; the first area in the north of the study area (enterprise 5), while the second one appeared in the centre of the study area towards the south (enterprise 2) with the rate of change -0.44.
3. **0.39-0.3:** it included two areas (enterprise 4 and 3), with a spatial structure extended in the form of a connected range from the north centre to the south and southeast of the study area. Its time change rate was 0.18 and 0.28, respectively.

It is concluded that the agricultural land use for barley cultivation declined in comparison with other crops as the rates of temporal change were negative.

Figure 3. rate of spatial change of agricultural land use for barley cultivation for the period (1998-2010).



C. Time Rate of Spatial Change of Agricultural Land Use for Winter Vegetable Cultivation

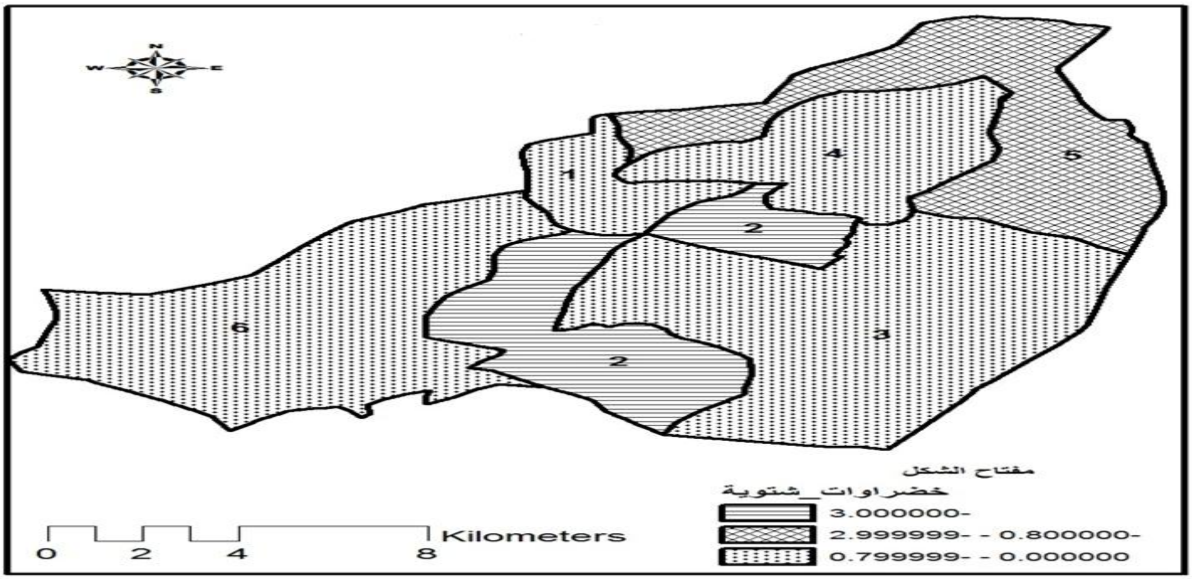
In 1998, the total area cultivated by the winter vegetable crop in the study area was 3350 acres by 52.53% of the total area cultivated by different crops. While in 2010, it was 340 acres by 0.94%. Thus, there is a clear change in the agricultural land use in the cultivation of winter vegetables in the study area. This change was negative, i.e., the cultivated area decreased by -3010 acres. After classifying the data of change rate for the study period into categories, there was a clear spatial variation shown in figure (4) as follows:

1. **3.0000:** it appeared in enterprise A3 and its spatial structure extended from the centre of the study area towards the southwest with the rate of change for the study period being 0.34.

2. **2.9-0.8:** it included the enterprise of the Al-Zawraa Association and its spatial structure extended in the form of a crescent to the north of the study area with rate of temporal change at -0.75.
3. **0.7-0.0:** its spatial structure extended as a connected range from the centre to the north then to the south and southeast of the study area. It included enterprises of spraying plants, B3, 14 and 18 with rate of change 0 for each.

This, in turn, indicates that the cultivation of winter vegetables declined in comparison with other crops, especially winter grains (wheat and barley).

Figure 4. The rate of spatial change of agricultural land use for winter vegetable cultivation for the years 1998-2010.



D. Time Rate of Spatial Change of Agricultural Land Use for Summer Vegetable Cultivation

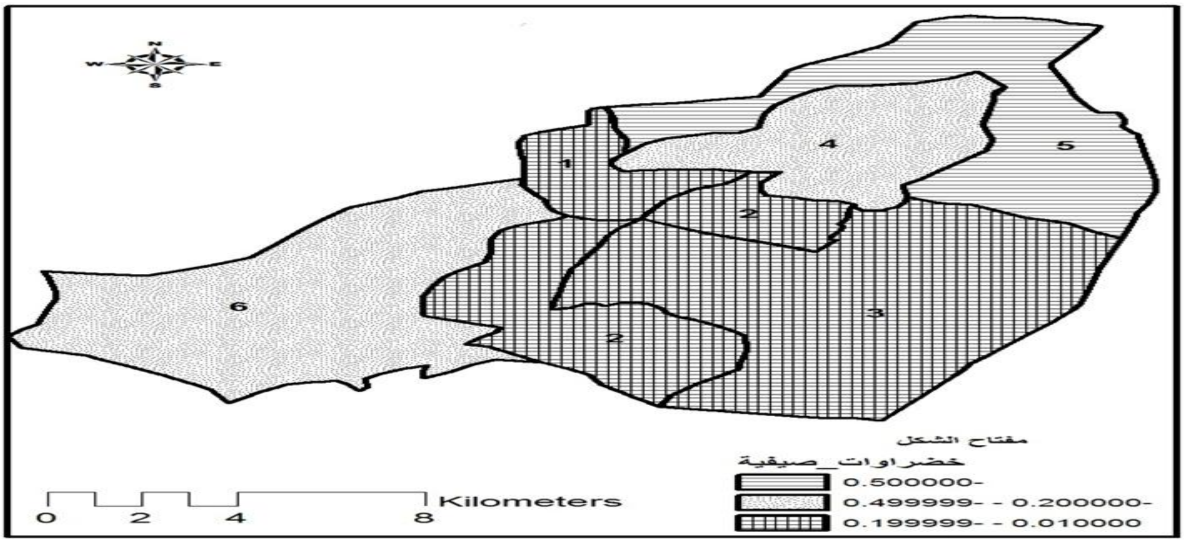
In 2010, the area cultivated by summer vegetables was 465 acres with 1.29%; while in 1998, it was 1,900 acres with 1.40%. The difference between the two years was -1,435 acres. Concerning the time rate of spatial change of agricultural land use for the cultivation of summer vegetables during the study period, it was classified into categories, and there was a clear spatial variation, as shown in figure 5, as follows:

1. **0- 0.5:** it appeared in the enterprise of the Al-Zawraa Association and is located to the north of the study area with rate of change at -0.54.

2. **0.4 -⁻0.20:** it appeared in the enterprise of spraying plants with a rate of temporal change of -0.18 for each. Its spatial structure extended to two separate areas, one in the centre to the north and the other to the west of the study area.
3. **0.19 - 0.01:** it appeared in three areas with a spatial structure extended in the form of a connected range from the centre to the west then to the south-east of the study area. The rate of change was -0.9, 0.01 and -0.13 for each.

Based on the above, the spatial competition of agricultural land use for the cultivation of summer vegetables declined in comparison with agricultural land use in the study area, in addition to the reluctance of farmers to cultivate this crop due to the scarcity of water resources.

Figure 5. The rate of spatial change of agricultural land use for summer vegetable cultivation for the years 1998-2010.



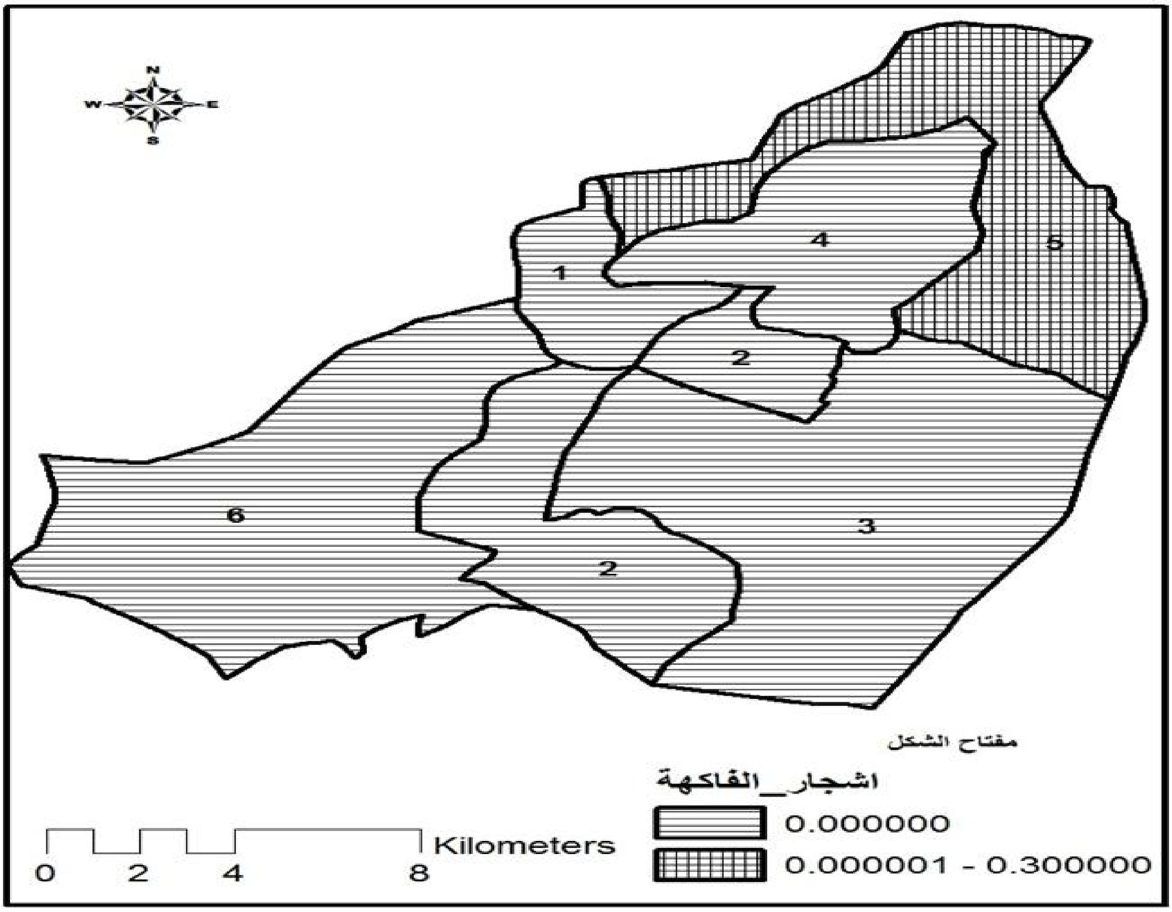
E. Time Rate of Spatial Change of Agricultural Land Use for Fruit Trees

The area invested for fruit trees in 1998 was 53 acres; while in 2010, it was 530 acres with relative materiality of 1.47% and 0.39%, respectively, and the rate of change was -477 acres for both years. When measuring this change as a percentage during the study period in the study area, there was a clear spatial variation as described in figure 6 after being classified into categories as follows:

1. **0:** this category showed no change in fruit trees in the study area as the rate of temporal change in it was zero. This means that it has retained its importance in the spatial competition compared to the agricultural land uses of other crops. It included enterprises of spraying plants, B3 and 3A, 14 and 18.

2. **0.01-0.3:** it emerged in one enterprise (Al-Zawraa Association) with a change rate of 0.30 and appeared in the north of the study area.

Figure 6. The rate of spatial change for agricultural land use for fruit trees for years 1998-2010.



F. Time Rate of Spatial Change of Agricultural Land Use for Cotton Cultivation

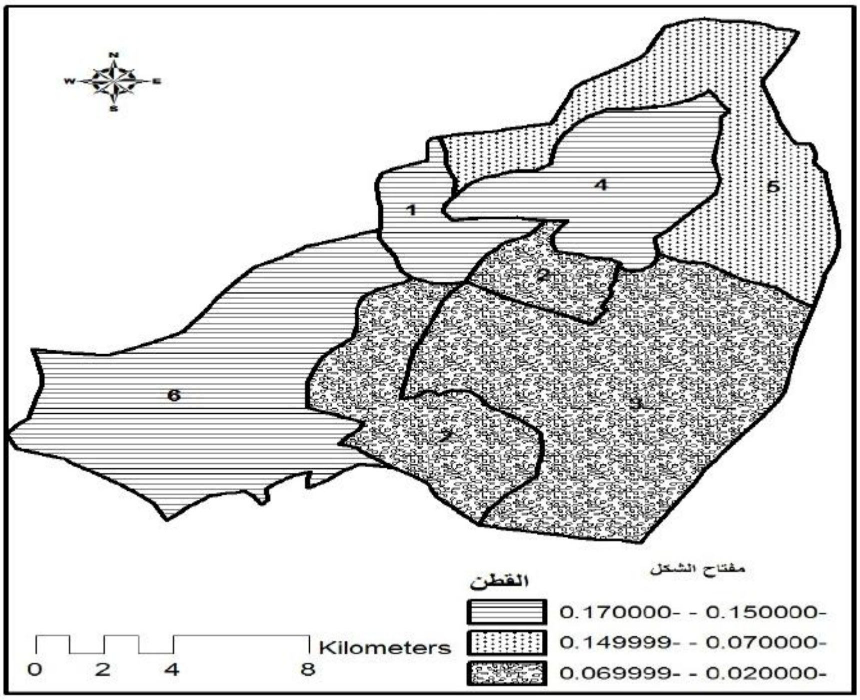
The area cultivated by the cotton crop in 2010 was 555 acres with a relative materiality of 1.54%; on the contrary, it was 1,140 acres in 1998 with a relative materiality of 0.84 %. The rate of change during these years was -585 acres. After measuring the rate of change during the study period (1998-2010), it was found that there was a clear spatial variation between enterprises of the study area, as described in figure 7, as follows:

1. **0.17 - 0.15:** the percentage change rate in this category appeared in three enterprises, namely, the spraying plants, 14 and 18, whose spatial structures appeared in the form of a connected range from the north to the south and southwest of the study area. The rate of change was -0.15, -0.17 and -0.18 for each.

2. **0.14-0.07:** its spatial structure extended from the north of the study area to the east within the enterprise of the al-Zawraa Association with a rate of -0.07.
3. **0.6-0.2:** it included two enterprises, 3A and 3B, whose spatial structure appeared in the form of a connected range to the east of the study area with a change rate of -0.04 and -0.02 for each.

This means that there was a decline in the areas invested in cotton cultivation in the study area in the face of spatial competition with the agricultural land use for other crops.

Figure 7: rate of spatial change of agricultural land use for cotton cultivation for the years 1998-2010.



G. Time Rate of Spatial Change of Agricultural Land Use for Sesame Cultivation

The area utilised in the cultivation of sesame crops in 2010 was 0 acres with a relative materiality of 0%; while it was 1,600 acres in 1998 with a relative materiality of 1.18%. This means that there was a clear decline in the cultivation of the sesame crop in the study area, but it was not in the same range as there was a clear spatial variation within enterprises of the study area after classifying the rate of temporal change into categories, as shown in figure 8, as follows:

1. **0.37-0.31:** it appeared in two enterprises, the al-Zawraa Association and 18, whose spatial structure appeared in the form of two connected ranges, the first in the north of the

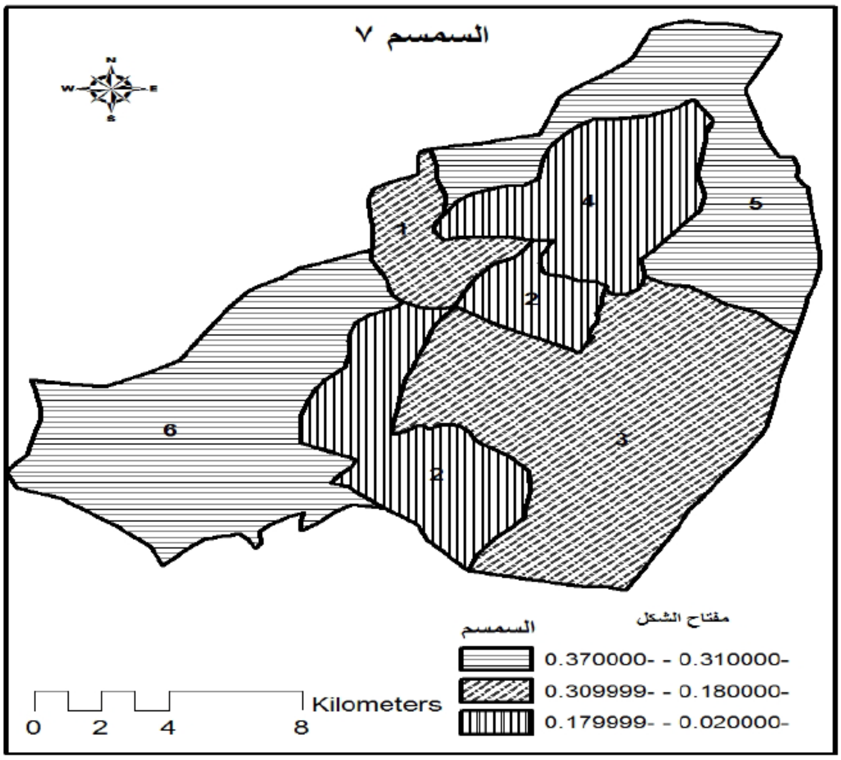
study area (the al-Zawraa Association) with the rate -0.31 and the second in the west (enterprise 18) with the percentage change rate of -0.37.

2. **0.30-0.18:** it included two areas (enterprises 14 and 3B), whose spatial structure extended from the west to the east of the study area towards the centre with a change rate of -0.24 and -0.18 for each.

3. **0.17-0.02:** the rate of change for this category appeared in two areas in the form of a connected range from the centre to the south of the study area. The rate of change was -0.10 and -0.02, respectively.

It was found that there was a clear spatial decline in the area planted with the sesame crop in the face of the spatial competition with other crops.

Figure 8. The rate of spatial change of the agricultural land use for sesame cultivation for the years 1998-2010.



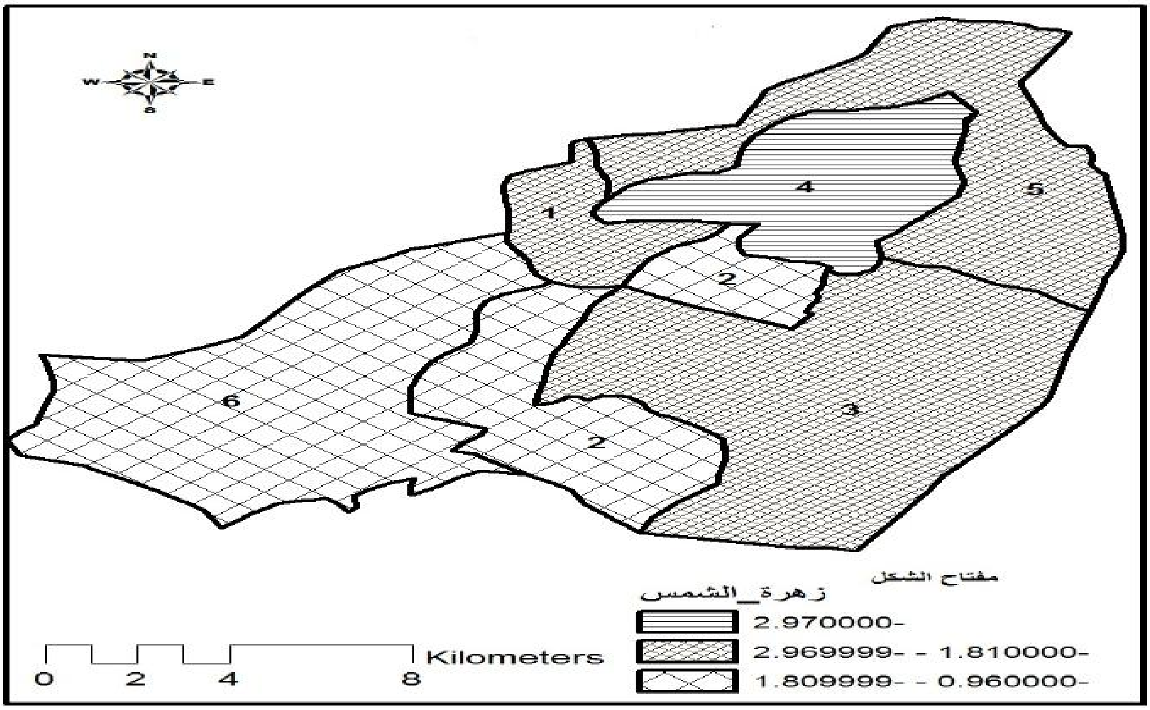
H. Time Rate of Spatial Change of Agricultural Land Use for Sunflower Cultivation

Through the study of the spatial change of the agricultural land use for sunflower cultivation in the study area for the years 1998-2010, it was found that there was a clear spatial variation between enterprises of the study area. After reaching 19,425 acres in 1998 by 14.32%, its area became 125 acres in 2010 by 11.15%. The rate of difference between the two years was

-19,300. The data of the temporal rate of the percentile change for the cultivation of the sunflower crop were classified into categories as described in figure 9:

1. **-2.97:** it appeared in the enterprise of spraying plants with a rate of change of -2.97 located in the centre of the study area.
2. **2.96-1.81:** it included three enterprises, namely, 14, the al-Zawraa Association and 3B. Their spatial structures appeared in the form of a connected range from the north to the south-east of the study area. The rate of change for the study period was -1.90, -1.91 and -1.81.
3. **1.80-0.96:** it included enterprises 3A and 18, whose spatial structure extended in the form of a connected range from the west of the study area towards the centre with change rate -0.96 and -1.37.

Figure 9. rate of spatial change of the agricultural land use for sunflower cultivation for the years 1998-2010.

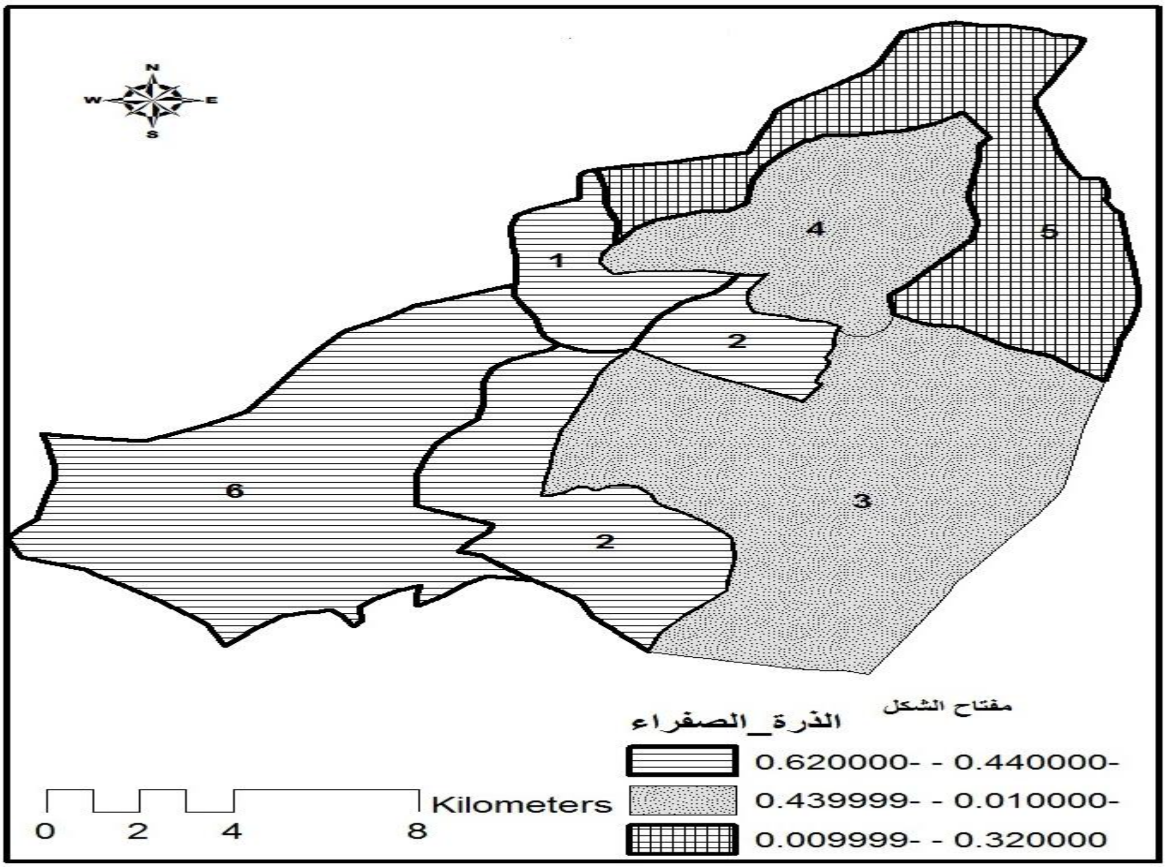


I. Time Rate of Spatial Change of Agricultural Land Use for Maize Cultivation

The total area cultivated by the maize crop in 1998 was 14,000 acres with a relative materiality of 6.43%. In 2010, it was 4,025 acres with a relative materiality of 11.15%. As for the rate of its spatial change, it reached -9975 acres. After classifying the rate of change for the study period into categories as described in figure 10, there was a clear spatial variation, as follows:

1. **0.62 - 0.44 :** its spatial structure appeared in three enterprises (1, 2 and 6) extended in the form of a connected range in the west of the study area with rate of change -0.1, -0.44 and -0.57 for each.
2. **0.43-0.01:** this category emerged in enterprises of spraying plants and 3B with a rate of change of -0.01 and -0.05 for each.
3. **0.009 - 0.32:** it emerged in one enterprise (the al-Zawraa Association) with rate of change 0.32.

Figure 10. rate of spatial change of the agricultural land use for maize cultivation for the years 1998-2010.



Conclusion

1. The use of multiple criteria has a role to play in highlighting the spatial change of agricultural land use in the study area.
2. There is a great competition between the agricultural land uses in the study area within its enterprises.

3. The rate of spatial change of the agricultural land use for wheat cultivation in the study area is positive in comparison with the agricultural land use for other crops, as the rate of its spatial change has increased, so that it has the highest rate of temporal change.
4. Agricultural land use for barley cultivation has declined compared to other crops as the rates of its temporal change is negative.
5. Cultivation of winter vegetables has declined compared to other crops, especially winter grains, namely, wheat and barley.
6. The spatial competition for agricultural land uses for the cultivation of summer vegetables is declining in the face of agricultural land use in the study area, in addition to the reluctance of farmers to cultivate this crop due to the scarcity of water resources.
7. The cultivation of fruit trees has retained its importance in spatial competition in the face of agricultural land uses for other crops.
8. There is a decline in the areas invested in cotton cultivation in the study area in comparison with the agricultural land use for other crops.
9. The difference rate for sunflower crop during the study period is negative compared to other crops.
10. The area cultivated by the maize crop declined during the study period in comparison with summer crops, especially sunflower and sesame.

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