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Geographical Analysis of the Urban Communitie's Distribution in Ma'an Governorate using Geographic Information Systems

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Abstract: This study aims to analyze the geographical distribution of urban communities in Ma'an Governorate (South of Jordan) and analyze their geographic locations and spread using Geographic Information Systems (GIS) techniques through spatial analysis tools available within GIS environment. The study adopted the descriptive approach to study the urban communities in the Governorate in terms of distribution and geographical spread as well as the spatial distribution of population on these localities. The analytical approach was used to determine the geographical area of the urban communities, to measure the geographical distribution density of the population and the nature of their spread, to reveal spatial patterns taken by the urban communities in the Governorate and the form of their spatial extension according to the population. The results showed that there is a convergence of the spatial mean and the spatial median according to the population in the urban communities. The spatial distribution pattern of the urban communities took the accumulated pattern through the application of the neighborhood Index. The Moran's index indicates that the spatial distribution of urban communities has taken the random pattern according to its population. The results also showed that the actual weighted trend for the distribution of urban communities in the Governorate, depending on the number of population has taken a form elliptical direction extends Southeast and Northwest.

INTRODUCTION

The geographical distribution of urban communities in any region is a reflection of the natural, human and economic conditions in the region. These factors directly and effectively affect the distribution and spread of urban communities and therefore, on the concentration of populations in a particular region or their dispersal in

other regions. Natural factors may have a direct and significant impact on the spatial distribution of a region's population but economic and social factors can make a region densely populated, although, it is not normally suitable for human habitation[1]. The study of urban and population groups in terms of shapes, patterns, geographical distribution, types, sizes and their inclination towards change over time has attracted the attention of geographers, especially with the development of modern technical tools and methods in geography. This is not because it has a traditional interest in place and spatial variation but also because the distribution of urban communities varies according to the sites characteristics and their advantages as well[2]. It is obvious that we find diversity in the patterns of geographical distribution of the urban communities in Ma'an Governorate and in the variation in size and spread according to geographical regions represented on the Governorate. Therefore, this study investigate and analyze the geographical distribution of the urban communities in the Governorate, analyze their geographical locations and their distribution, the factors and forces that influenced the emergence of these patterns, their evolution and the changes that occurred using GIS technology. Because GIS techniques give the access to accurate information and results and thus accuracy in the analysis of the phenomena geographically.

The study problem: Ma'an is one of Jordan's largest Governorates, accounting for 37% of the Hashemite Kingdom of Jordan. Due to the diversity of its surface, climate, water, vegetation, human factors, variation in the levels of economic, social and administrative development and the historical development of some sites and others, the patterns of geographical distribution of urban communities varied in the Governorate's regions and villages. The distribution is an important element in developmental studies (from a population perspective) to its relationship with economic and social development programs and plans. The dispersal of urban communities leads to the impediment of the implementation of development plans in a balanced manner. The study aims to answer the following questions:

- What is the pattern of urban communities and their geographical spread in Ma'an Governorate?
- Is there a spatial pattern or conglomeration of urban clusters in Ma'an Governorate according to the population of each urban cluster?
- What is the nature of the geographic factors that affected the geographical distribution of urban communities in Ma'an Governorate?
- What is the role of GIS and its importance in studying the spatial analysis of urban clusters in Ma'an Governorate?

The importance of the study: The study of spatial analysis of urban clusters is one of the vital topics that has attracted the attention of many researchers, especially in the fields of urban and regional planning because of its practical importance in addressing many of the economic, social, administrative and organizational problems.

To highlight the spatial characteristics of the urban communities in Ma'an Governorate and its relation to the natural and human geographical factors that influenced them. The diversity of the natural regions in Ma'an due to their large area on the one hand and the multiplicity of urban communities and their size and growth rates on the other hand. Such topics have not been studied in depth with the use of geographic information systems, although, they are important in planning and development processes.

The study objectives: This study aims to achieve the following main objectives:

- Geographical analysis of the distribution of urban communities and their geographical extension in Ma'an Governorate
- Detection of the spatial pattern of the distribution of urban communities in Ma'an Governorate according to the population in each urban community
- Determining the spatial area of the impact of each urban community in Ma'an Governorate

Study area: The Ma'an Governorate is located in the southern region of Jordan, extending between east 35-38 longitude and north 12-12-29-31 latitude. Its administrative boundary reaches north to the border of Amman Governorate. The Eastern and Southern borders of Ma'an are the border between the Hashemite Kingdom of Jordan And Saudi Arabia. The study area is also located in the border with Al Karak and Tafila Governorates in the north and west and the Governorate of Aqaba in the west as shown in Fig. 1. The study area is a link between the most important Governorates of the Kingdom[3]. The Ma'an Governorate is divided into four departments as shown in Fig. 2, namely: the Qasba Ma'an Department which includes about 30 urban communities, the Petra department about 11 urban communities, the Shubak department about 15 urban communities and the Husseiniya department includes about 2 urban communities.

Previous studies: Literature and geo-urban studies have taken a great part in specialized studies and research around the world[4]. Ettlinger and Archer[5] followed the changes in the pattern of geographical distribution of the world's largest cities during the 20th century, showing that the pattern of distribution of cities was predominantly fragmented.

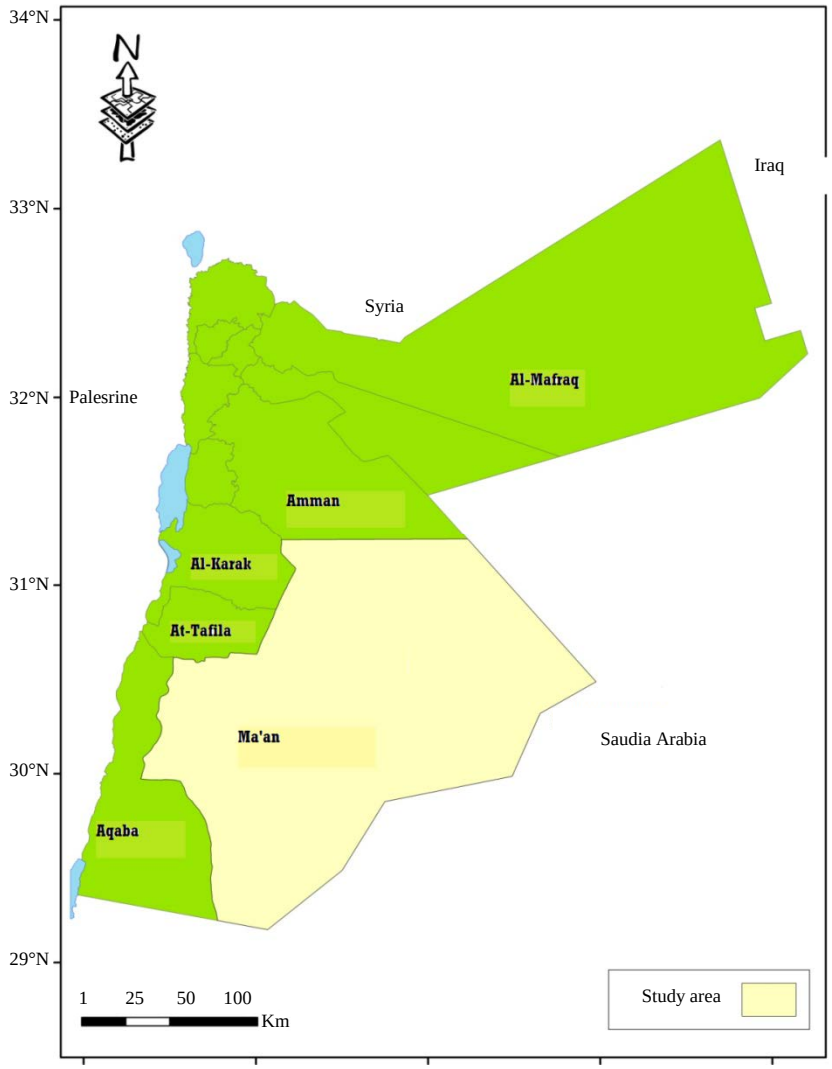

Fig. 1: Study area

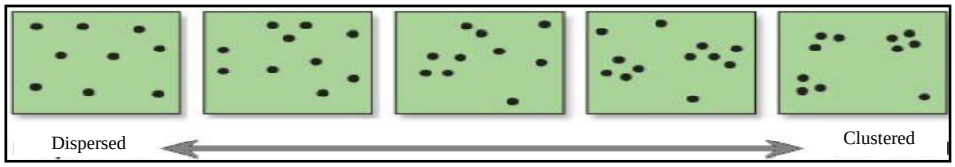

Fig. 2: Spatial distribution patterns of phenomena according to the nearest neighbor rate

Al-Saeed[6] analyzed the neighborhood relation in six regions in Saudi Arabia, he found that the convergent pattern prevails in the centers in the north and center and the divergent pattern prevails in the South and West. Al-Syriani studied the distribution of urban settlements in the Al-Baha area of Saudi Arabia and found that their distribution takes several types: the pattern of dense villages with close distances, the pattern of small stacked villages, the pattern of scattered rural centers and the pattern of scattered communities. Ayazraat[7] discussed the geographical characteristics of the urban system in Jordan during the period (1979-2004) in order to reveal the spatial patterns of distribution of urban centers in Jordan and he found that there are significant changes in the urban system in Jordan which included growth in the size of cities in general. Al-Zahrani[8] studied the pattern of geographical distribution of population and housing in the Governorates of Saudi Arabia by using some GIS

Software accessories. It was found that there was a difference in the pattern of distribution of population and housing in governorates and the distribution was random. Linard *et al*.[9] dealt with the spatial distribution of population and urban centers throughout Africa and the results of the study showed a large variation in settlement patterns and population concentration. Ahmad[10] studied the patterns of urban centers and job distribution in the south of Ilorin in the state of Kwara in central Nigeria. He pointed out that the pattern of geographical distribution of the areas took the random pattern and he recommended that more regional development programs. Al-Tarazi[2] examined the patterns of spatial distribution of the human settlement centers in Irbid Governorate using the neighborhood link coefficient and found that the pattern of spatial distribution of the centers took several forms: the irregular divergent pattern and random pattern. Qatishat and Abu Sobha[11] analyzed spatial distribution patterns of Jordanian cities using geographic information systems technology, the study showed that Jordanian cities are not randomly distributed but concentrated in specific areas and the size, distribution and spacing of cities is influenced by natural and human factors alike.

MATERIALS AND METHODS

The study adopted the descriptive approach in studying the urban clusters in Ma'an governorate in terms of distribution and spread as well as in the study of the geographical distribution of the population on the urban communities in the governorate. The analytical approach is used in the spatial analysis of urban clusters, to measure the geographical distribution of the population and the nature of their spread and to reveal the spatial pattern of urban communities in Ma'an governorate according to population. The later approach was also used to determine the pattern of urban communities and their geographical extension in the governorate.

The study used the latest scientific techniques, geographic information systems GIS, for spatial and statistical analysis. GIS is one of the types of information systems through which automated database management and the best way to manage the spatial databases. The reliance on this technique has enabled the use of cartographic and statistical methods in the analysis, linking and interpretation of the multiple associative relationships that were included in the study in an automated manner.

The study was based on the GIS technique due to its importance in the study of distribution and geographical analysis of the demonstrations. The spatial analysis tools included in the ARC Toolbox were used within the GIS environment.

Spatial statistic tools: A number of spatial statistical methods were used to measure the geographical distribution of the urban communities and analyze the distribution pattern. The most important of these are the following:

Measuring geographic distributions: Geographers are interested in studying the spatial distribution of some geographical phenomena such as urban clusters by identifying intermediate sites that represent the centers of gravity or the main points of attraction of these distributions as well as measuring the dispersion of these clusters and the nature of their distributive direction, therefore, the following methods were used.

Mean centre: One of the most important measures of spatial centrality which is the point of convergence of the average coordinates of the vertical axis and the horizontal axis of all the parameters in the study area. It is simply the location that occupies the central position between the points under study (urban clusters in Ma'an Governorate), so that, the distance of the total points from it less than any other location on the map. It is possible to express the importance of each group (weight) in the number of population in each group. In this case, we call it weighted Mean centre. It is used when we wish to give a weight to each urban assembly proportional to its population. It is unreasonable that the effect of large urban population groups is equal to that of small urban population clusters.

Central feature: This measure involves finding the focal point closest to the distribution center of the phenomenon under consideration, i.e., it locates the most interposition feature on the light of calculating the distances from each feature to other features. The middle position in the map is the location where, if you draw two intersecting columns, each of the columns will divide the information into two halves, right, left, bottom and above. The middle location is the location where the distance between it and the other sites is less than the distance between those locations and any other place. If we assume the existence of a number of sites on the highway and we wanted to choose a suitable site that offers public services for those sites, so that, the total distance from those less than the distance from any other place, that site known as middle location.

Standard distance: A measure of dispersion and spatial spread, it is an indicator to measure the spatial spacing or concentration of the phenomenon. The standard distance is often used to draw a circle called the standard circuit, through which the concentration or spread of the spatial dimension of the phenomenon can be known. The center of the circle is the center of the Mean Center. The larger the circle, the greater the spatial spread.

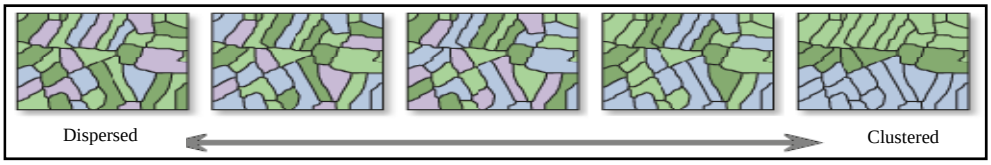

Fig. 3: Spatial distribution patterns according to Moran index of spatial self-correlation

Directional distribution: It is also called the standard oval shape of dispersion and the distributional trend reveals whether the spatial distribution of the phenomenon has a particular distribution trend.

Analyzing pattern: A number of spatial statistical tests were used to analyze the pattern of distribution of urban clusters, the most important of which were[12].

Average nearest neighbor: To detect the pattern of urbanization in Ma'an Governorate. This measure reflects the nearest neighbor indicator as a ratio between the viewed distance divided by the expected distance. The expected distance is the average distance between adjacent urban centers in a default random distribution and the value of the indicator is between 0 and 2.15. If the value of indicator 0 shows the irregular distribution pattern and if the indicator value is equal to one, the random distribution pattern appears. There are several forms and patterns between the random pattern and the irregular pattern as well as between the random pattern and the regular pattern, ranging from clustered to dispersible as shown in Fig. 2.

Spatial autocorrelation coefficient (Moran's index): The Moran's index is used to measure the similarities of contiguous phenomena which are based on a comparison of the values of each parameter with the statistical value of the Moran's index. If the difference between contiguous parameters is smaller than the difference between all parameters, the similar values are aggregated. The Moran's index is one of the important measures in detecting the degree of self-correlation between the elements of the phenomenon studied. When the values of contiguous phenomena are more similar than the divergent values, a positive spatial self-correlation is the most common condition. If the values of contiguous phenomena differ, there is a negative spatial self-correlation, i.e., the absence of spatial self-association. The outputs of the analysis show patterns of spatial distribution in terms of a clustered, discrete or random pattern as shown in Fig. 3. The Moran's index is between -1 and 1. If the value is close to one, this indicates the combined pattern, but if the value is close to zero that indicates random pattern of spatial distribution. It differs from the nearest neighbor that requires a certain non-spatial value to be taken into consideration when calculating the spatial correlation coefficient, for example, the population per urban pool[13].

Spatial analyst tools

Density analyst: Density analysis deals with certain values of certain phenomena and propagates them across the landscape based on the value studied in each site and the spatial relationship of the studied values of the locations. Density surfaces show the locations of urban settlements or the concentrated parameters (dense). For example, if data on the population of urban communities represented in points are available, more information on the spread of population can be identified in the region. The most important methods of measuring density are:

Kernel density: This analysis calculates the density of the geographic distribution of a certain phenomenon, this analysis calculates the density of the geographic distribution of a certain phenomenon whether linear or bitmap (points) in the geographic area in which the study area extends and determines the areas where the phenomenon is concentrated. The value is higher in the center and decreases when it is far away.

Point density: it reveals the nature of the density distribution of the point phenomenon under study that based on a known value such as population.

Results analysis: The population of Ma'an Governorate is about (60) urban communities, the most important of which is the city of Ma'an which is the center of the governorate as shown in Fig. 4. The population of the governorate is about 148,100 people and the population density is 4.5% individual/km^2 of the total population density of the Kingdom of about (57.4%) individual/km^2.

In order to uncover the precise picture of the spatial distribution of urban areas in Ma'an Governorate, the weighted spatial mean which represents the center of gravity for the spatial distribution of urban centers in Ma'an Governorate. Figure 5 according to GIS outputs shows the weighted mean center for the total urban localities in Ma'an Governorate that is located near the city of Ma'an in the location mediating the largest urban communities in the province, namely: Shoubak and

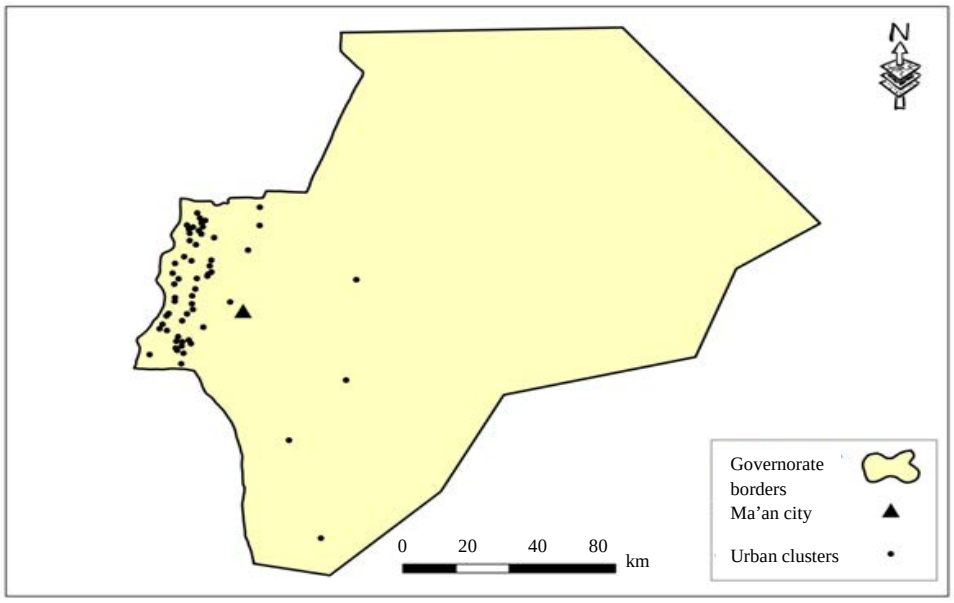

Fig. 4: Geographical distribution of urban communities in Ma'an Governorate

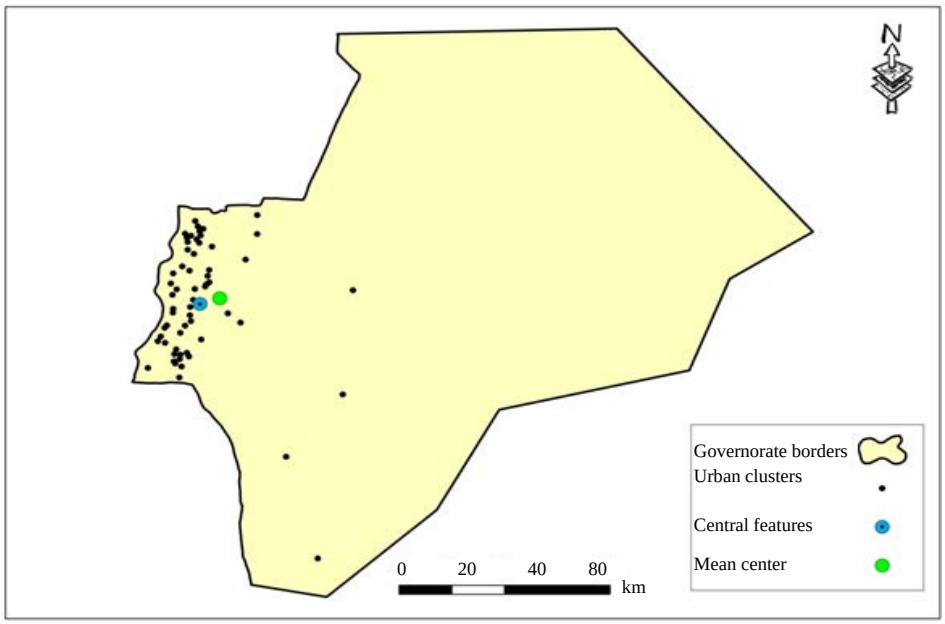

Fig. 5: The average center and the weighted mean center of urban clusters in Ma'an Governorate

Husseiniya, Wadi Musa and Alenaimat villages. Figure 5 shows the weighted central feature where there is a clear convergence between them. In order to show the extent to which the urban clusters were dispersed around their weighted average position, the weighted standard distance and distribution trend were calculated. Figure 6 according to GIS outputs shows the standard distance. The radius of the circle which represents the weighted standard distance for urban clusters was about (29281.86). It included 48 urban communities out of 60 the total urban communities. Figure 6 also shows that the actual weighted trend of distribution of urban population according to the population takes an oval shape extending southeast and North-West at an angle of 170.69°; this extension largely related to the nature of the topography of the area which to some extent is flat to wavy.

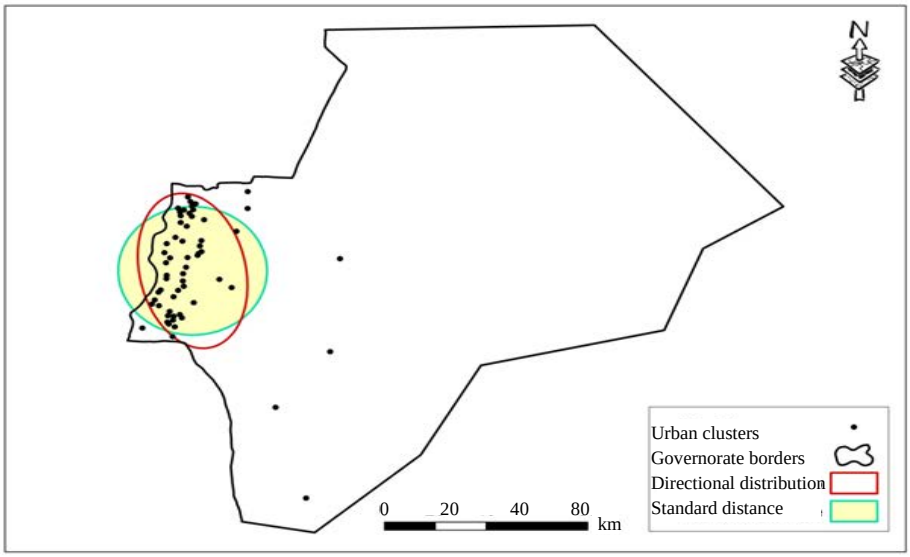

Fig. 6: The standard distance and distribution direction of urban clusters in Ma'an Governorate

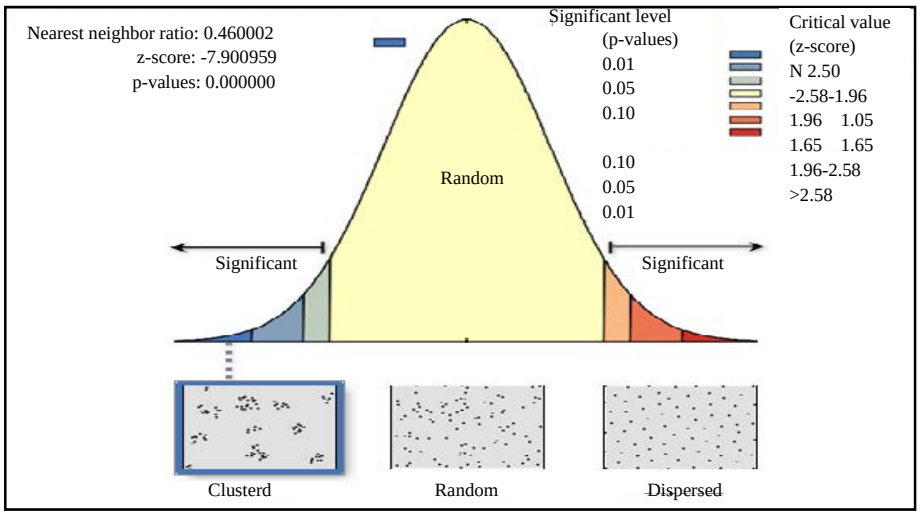

Fig. 7: The coefficient of the neighborhood to urban clusters in Ma'an Governorate

According to the GIS outputs, it was determined by applying the coefficient of the neighborhood index to the sites of the urban localities at the level of Ma'an Governorate that the pattern of geographical distribution of urban clusters is closer to the aggregate pattern as shown in Fig. 7.

Figure 7 indicates that the value of the neighborhood Index coefficient for urban clusters in Ma'an Governorate reached (0.46) which means that it took the irregular pattern. The analysis also showed that the value of the Z score for the urban clusters reached (7.99) to fall outside the critical value (-2.58) and (+2.58), that is, it falls within the rejection zone. Therefore, we reject the initial hypothesis (null hypothesis) and accept the alternative hypothesis: that the geographical distribution pattern of urban communities is organized according to a special pattern is far from random pattern due to certain factors. The reasons for the clustered pattern of urban clusters, specifically on the Western side of Ma'an Governorate, can be attributed to the prevailing natural conditions such as climate, soil, water, etc. The Eastern regions of the governorate suffer from dry climatic conditions and poor types of soils and no water sources, unlike the western regions. The human factors played a major role in the geographical distribution of the urban communities in the governorate, such as the practice of agricultural and tourism activities and the availability of road networks and Hijaz railway, the population concentrated in the

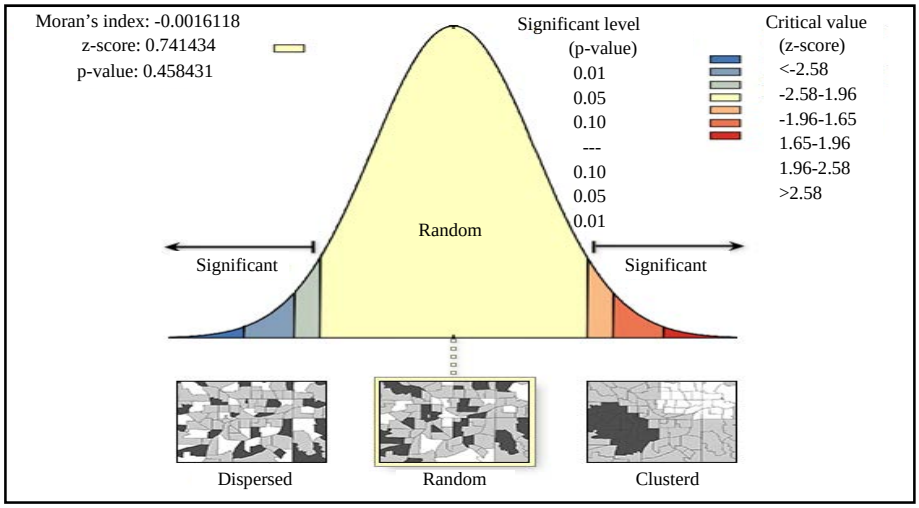

Fig. 8: Spatial distribution pattern of urban clusters in Ma'an Governorate according Moran index

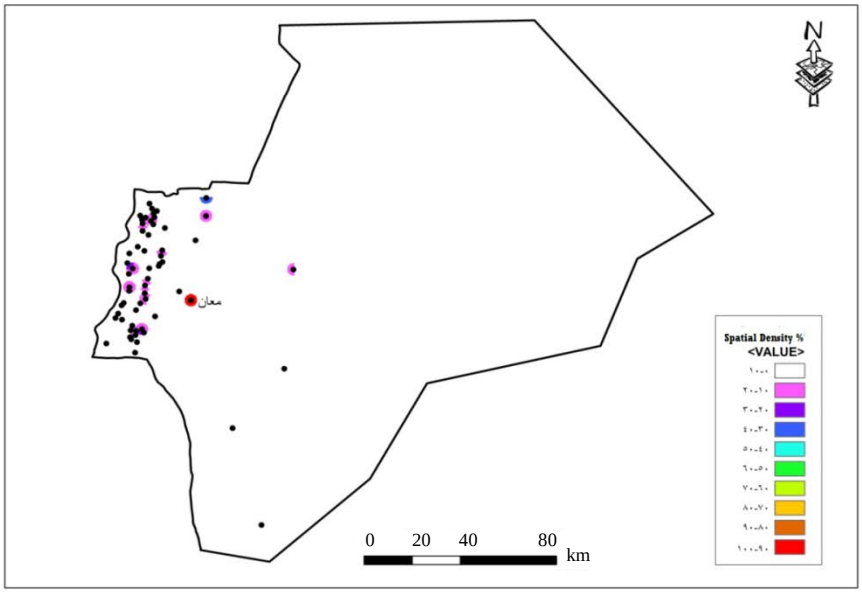

Fig. 9: The spatial density analysis of the population on urban communities in Ma'an Governorate

Eastern regions. In addition, to the lack of interest in the government and the inclusion of areas of the governorate and included within the programs of comprehensive development plans had an impact on the concentration of population in other regions.

To illustrate the pattern of geographic distribution of contiguous urban localities according to their population in terms of dispersed, clustered or random pattern, the Moran's Index, called the Moran's Index. Figure 8 shows that the Moran Index of spatial correlation is close to zero, approx. (-0.002). Thus, it indicates a random spatial correlation between the urban clusters of Ma'an Governorate taking into account the population in each urban cluster. Given the figure, the random pattern appears to be within the 0.10 confidence level. It is also associated with critical z-values ranging from (+1.65 to -1.65). The value of z is about 0.7 which indicates that urban clusters are distributed randomly.

In order to analyze the spatial density of the urban clusters in Ma'an Governorate, the population density of these clusters were distributed as points as shown in Figure 9. It was found that the city of Ma'an with a very large population weight with high density of population compared to other urban communities, since, it is the center of the province and thus, acquired the largest proportion of the population. The analysis of the Kernel coefficient was also used to determine the density of the geographical distribution of the population over the

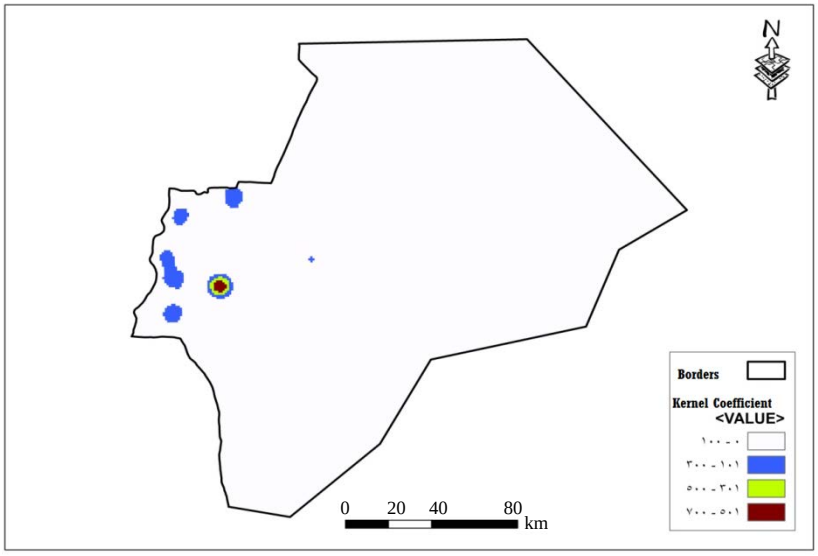

Fig. 10: Kernel analysis of the population spread trends in urban localities in Ma'an Governorate

geographical area of Ma'an Governorate by calculating the density of the points around the center. The value is higher at the center and decreases by moving away from it. The results of the analysis as shown in Fig. 10 are in form of rings reflecting the population density of the urban clusters in each band. It shows the surface trends as represented by the geographic spread of these urban clusters. There is no doubt that the analysis of Kernel showed the density of urban clusters around the weighted spatial midpoint, especially the city of Ma'an and gatherings such as: Shoubak, Wadi Musa, Husseiniya and Alenaimat Villages.

RESULTS AND DISCUSSION

This studya ddressed the geographical distribution of urban clusters in Ma'an Governorate using the spatial analysis tools available within the GIS environment.

The results of the study showed the determination of the average location of the distribution of the urban localities in Ma'an Governorate. The weighted spatial mean (depending on the number of population in each pool) which represents the center of gravity of the spatial distribution of urban clusters in Ma'an Governorate. It is located near the city of Ma'an in the middle of the largest urban communities in the Governorate, namely: Shoubak, Wadi Musa, Husseiniya and Alenaimat villages. All the weighted spatial mean points were identified where there was a clear convergence between them.

The weighted standard distance (depending on the population) was calculated for the shape of the spread of the urban centers around the weighted spatial mean and the direction of the distribution of the urban complexes to show their dispersion. The length of the radius of the circle which represents the weighted standard distance for urban clusters was about 29281.86. It consisted of (48) urban complexes out of (60) the total urban communities under study: Shoubak, Wadi Musa, Husseiniya and Alenaimat villages. It was also shown that the actual weighted trend of distribution of population according to the population takes an oval shape extending southeast and north-west. In other words, most of the large urban communities are concentrated in the south-east and north-western parts of the province. This extension is largely related to the flat-to wavy.

The results of the study also showed that the pattern of the distribution of urban settlements in the governorate takes the pattern of irregular clustered. In addition, the Moran Index indicates that there is a random pattern in the distribution of adjacent urban localities of Ma'an with the population in each cluster.

The study also showed by means of spatial density analysis the population density in the form of points and the density of the geographical distribution of the population on the geographical area in which Ma'an Governorate extends. In addition, through Kernel's density analysis that calculates the density of points around the center in the form of rings reflecting the population density of the clusters in each area. It shows the surface trends as represented by the geographical spread of these urban clusters. There is no doubt that the analysis of Kernel showed the density of urban clusters around the weighted spatial midpoint, especially the city of Ma'an and clusters such as: Shoubak, Wadi Musa, Husseiniya and Alenaimat villages.

CONCLUSION

The study recommends, based on the analysis and discussion of the results, the adoption of criteria that take

into consideration the distribution of the size and functions of urban communities in order to classify them in accordance with local, regional and global standards in urban planning processes. The study also recommends stimulating urban development in small and medium urban communities in the governorate to achieve a balance in the distribution of the population instead of being concentrated in a limited number of urban centers. This balance is achieved by directing investments and creating jobs with the active participation of the private sector and providing infrastructure to establish development areas attractive to the population in the governorate. The study also recommends the importance of regional planning as a strategic tool to reduce developmental disparities among urban communities.

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