Studying and Evaluating the Development axis in Damietta Governorate based on Geographic Information System (GIS)

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Abstract—Rapid urbanization and population growth in Damietta governate have effect on the sustainable development axis and spatial distribution of urban services as other governates in Egypt. The educational services are an important service as one of axes of sustainable development because of their effect on the community, economic life and its sustainability. The correct planning for urban services in general and educational services in particular in order are important to actualize the social justice. The aim of this paper is to study and evaluate the spatial distribution of educational services in the most of educational stages in each district in Damietta governate using different geographic information systems and analysis methods. The Satellite images, the geographical location of each school, area, boundary of each district and number of schools in different stages are the important data to evaluate the study. The results of this study were produced digital, paper educational services maps by using GIS .The most patterns of spatial distribution of schools were Clustered .The average shortage percentage in educational services by about 34% in primary schools, about 39% in Preparatory schools and about 33% in secondary schools.
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Index Terms— Damietta governate, GIS, Nearest Neighbor index, SDE, Standard Distance ,Sustainable development, urban services,.

1 INTRODUCTION

Sustainability is "the capacity for continuance into the long term future. Anything that can go on prepared on an indefinite basis is sustainable. Anything that cannot go on being done indefinitely is unsustainable [1].In addition to substitutability, this definition of sustainability is also founded on several other important principles. Contained within the common definition of sustainable development, intergenerational equity recognizes the long-term scale of sustainability in order to address the needs of future generations [2]. School mapping comprises physical location analysis of the primary schools. In order to be, accomplished knowledge of the settlements and population of the area is required. Accessibility analysis organized based on the location and attributes of roads, houses, and other infrastructures as layers. Accessibility and spatial analyses make it easy for necessary decisions to be created [3], [4]. GIS database provides comprehensive framework and organization of spatial and non-spatial data, which intern well help decision makers and planners. It apparently provides a mapping tool for the relationships between the distribution of schools and the school age population within the populated areas [5].

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2 AREA OF STUDY AND ITS CHARACTERISTICS.

Damietta governorate located at the extreme northeastern part of the Arab Republic of Egypt is the study area. (Damietta Governorate is located in North Delta on the east bank of the Nile) . Damietta Governorate is considered as one of the Nile

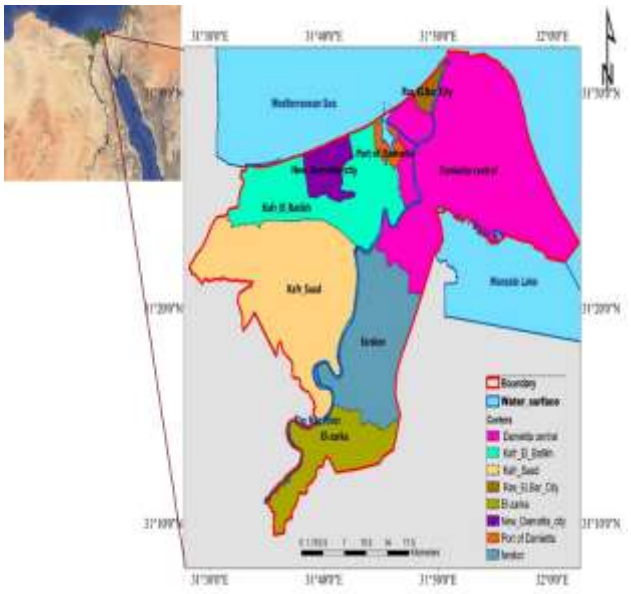

Fig.1 Location map of the study area in Egypt

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Delta coastal governorates it is surrounded by the Mediterranean in the north, Manzala Lake in the east and Dakahliya in west and south. It is considered one of Egypt's window on the coast of the Mediterranean Sea, where the meeting point with the Nile River is. The Nile River divides the governorate into two parts along its farms and plains. Geographically, Damietta governorate is located between longitudes 31° 27′& 32° 03′ and latitude 31° 10′ & 31° 32′ (31° 25′ 12″ N and 31° 49′ 12″ E) [5]. It covers an area of 930.627 square kilometers, which represents around 5% of the total surface area of the whole Nile Delta and around 1% of the surface area of Egypt. The governorate encompasses five administrative centers, which is divided to 15 cities and 85 local village units. The districts are Faraskor, Kafr saad, Kafr Al-Buteekh. Damietta district and El-zarka in addition to Ras El Barr city, New Damietta city and the Port of Damietta which vary in terms of area covered and number of population density[6],[7]and[8]. Damietta is the capital of the governorate .The number of population was approximatel1092316 capita in 2006 and estimated at about 1,332,376 million people in January 2015.The population growth of Damietta is estimated to be around 2.03% per year. Damietta is one of the most important industrial centers of Egypt and its importance has increased as a new container platforms harbor along the Mediterranean Sea was constructed in 1980s. The surface area of Damietta is occupied by built up areas which are estimated to be around half a million square kilometers and more than 120 thousand acre of agricultural activities such as corn, cotton, rice, potatoes, lemon, grapes, and tomatoes in addition to coastal and industrial areas. The total number of the schools in the governorate is 936 in the academic year [2015 - 2016] [7], [8] and [9].

2.1 Study Objectives

- Studying and evaluation of the conformity of educational services in Damietta Governorate with Egyptian standards.
- Examine the compatibility of the geographical distribution of schools with the population growth of the urban area in Damietta Governorate
- Developing spatial maps for educational services by using GIS techniques.
- Proposing new suitable places for public services to fix the current situation

In order to achieve the objectives, the study based on the using the spatial analysis of the spatial differences of school distribution and arrangement on e surface of the earth using some analysis method by geographic information systems.

2.3 Materials and Methods

This study based on the selection of educational services as one of the axis of sustainable development. It evaluates the geographical locations of schools in all educational stages and analysis their spatial distribution on the urban area in each of the districts of the governate. Using satellite images from Google Earth, SAS Planet program, the data collected for the number of schools, it's descriptive and geographical Data from central Agency for public moilization and statistics, as well as access to sources of information available from previous studies, books, references, foreign periodicals, published on the subject of the study.

3 METHODOLOGY

This research used three methods of analysis as follows:

3.1 Nearest Neighbor Index

The nearest neighbor index analysis defined as the most important engineering technique and statistical value. It explains the type of the patterns of spatial geographical distribution of phenomena. It provides the user with a statistically precise measurements based on the principle mathematical to determine the spread of geographical phenomena about each other and measure the dispersion form of spatial distributions [10], [11], and [12]. The methodology of this technology determined the geographical location of each point of the phenomena, then measures the geographical location of the nearest point to these, after that computes the average distance between all the points. Dividing the estimate distance by expected distance for the total distance between the points, finally the analysis outputs are represented as forms and distribution patterns, which it varying from clustered pattern to dispersed pattern passage of random pattern as shown in figure .2.

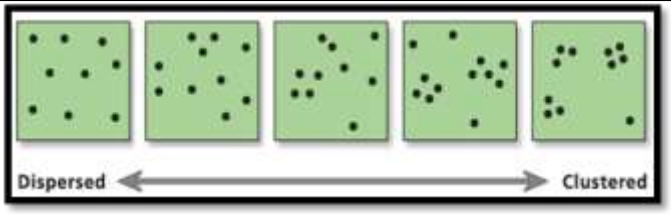

Fig .2 Nearest Neighbor index (source: ArcGIS help 10.1)

The following equation used to determine the Nearest Neighbor index (1):

$$R = 2M\sqrt{N/A} \quad (1)$$

Where:
R: Nearest Neighbor.
M: Arithmetic average between each point and the nearest neighboring point.
N: Number of points in the research area.
A: The research area space.
From the value of (R) where it confined between (0 and 2.15) can identify three main types of secondary spatial distributions of several nearby and patterns (table.1).

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Table1. Nearest neighbor index guide values

Main distribution pattern	Secondary distribution pattern	The Guide values
Clustered	Convergent (Lumpy)	0-0.09
	Clustered (panicle)	0.1-0.49
	Clustered(Random)	0.5-0.99
Random		1
Dispersed	Dispersed (Regular)	1.1-1.99
	Dispersed (Irregular)	2
	Trifling	More than 2

To investigate if the distribution pattern was normal distribution or not normal, a research has taken the theory of normal distribution phenomenon for the base points by measured the standard value of the phenomenon Z_Score that is calculated from the equation [2]. The value has fixed in the previous studies in significance level (confidence) (0.05) negatively or positively on both ends of the bell distribution (natural) which it position at the bottom of the patterns distribution:

$$Z = (X_i - \overline{X}) / S \quad (2)$$

Where:
Z: standard values for point Xi.
$\overline{X}$: Arithmetic average.
S: standard deviation.

3.2 Standard Distance

The standard distance is a beneficial statistic because it supplies only one measurements summary of distribution form of the points phenomena around their center (similar to the way a standard deviation measures the distribution of information values around the statistical mean)[13], shown as figure .3.

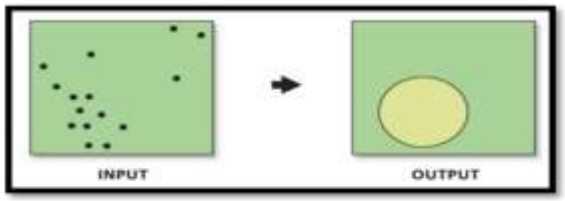

Fig. 3 The standard distance for the studied phenomenon (source: ArcGIS help 10.1)

(Z-score) for any spatial distribution is computed by the standard distance using the following equation [3]

$$SD = \sqrt{\frac{\sum (Xi - \overline{X})^2}{N} + \frac{\sum (Yi - \overline{Y})^2}{N}} \quad (3)$$

Where:
SD: standard distance.
Xi: East coordinate for each element.
$\overline{X}$: Average East coordinates.
Yi: North coordinate for each element.
$\overline{Y}$: Average north coordinates.
N: Number of elements raster phenomenon.

It is necessary to identify direction in the spatial distribution of public services within the urban area in the town's boundary by using the spatial analysis's tools (spatial statistics Tools) in the program (ARC GIS10.2) for the aim to determine the concentration active position or current position (Mean center) and default position of the point (Center Feature). In addition to determine the form of real direction and create the distribution of public services in the city.

3.3 Standard Deviational Ellipse (SDE)

The standard distance is the method used for measuring the direction of the position of points, or computing the areas. The pervious measurements are done by measuring the x and y separately, according to these, it defins the axes of an ellipse including the distribution of public services points. The ellipse is defined as (SDE), as the determined method that is used the standard deviation of the x coordinates and y coordinates from the mean center to measure the axes of the ellipse[14],[15], shown as figure .4.

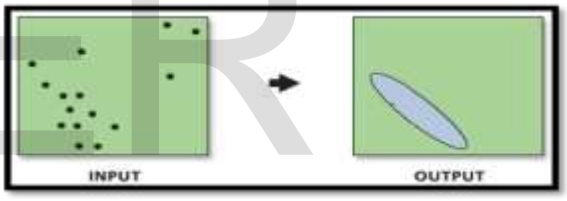

Fig. 4The Standard deviational ellipse for the Studied phenomenon (source: ArcGIS help 10.1)

The ellipse allows the user to define if the distribution of service points is extended and if it has a particular direction. The calculating of SDE makes the orientation clear when the user can get the direction by drawing the service points on a map .the user can calculate (SDE) using each geographical position of the points or using the locations that are affected with an attribute value related to a spatial data. The Standard deviational ellipse is calculated (Z-score) for any spatial distribution using the following equations [4] and [5]:

$$SDE_x = \sqrt{\frac{\sum (Xi - \overline{X})^2}{N}} \quad (4) \qquad SDE_y = \sqrt{\frac{\sum (Yi - \overline{Y})^2}{N}} \quad (5)$$

Where:
SD: standard distance.
Xi: East coordinate for each element of the phenomenon.
$\overline{X}$: Average East coordinates.
Yi: North coordinate for each element of the phenomenon.
$\overline{Y}$: Average north coordinates.
N: Number of elements raster phenomenon

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3.4 Scheme of the research methodology for Educational services

Data analyses and their manipulations were carried out in this research as demonstrated in Figure .5.

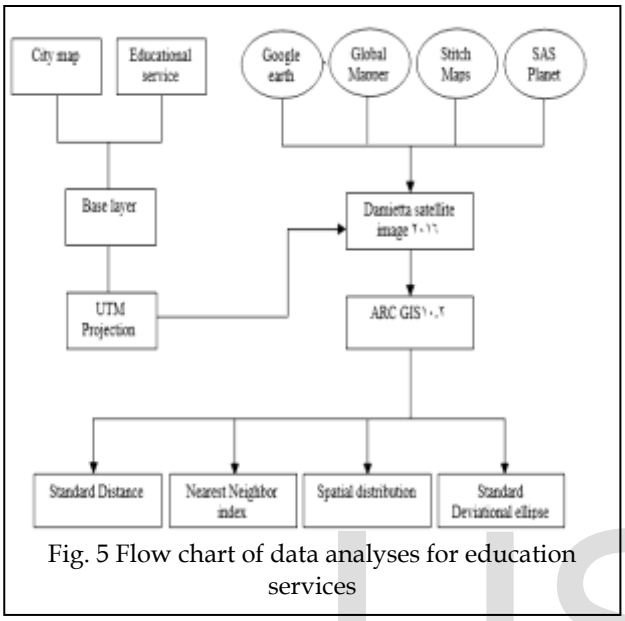

Fig. 5 Flow chart of data analyses for education services

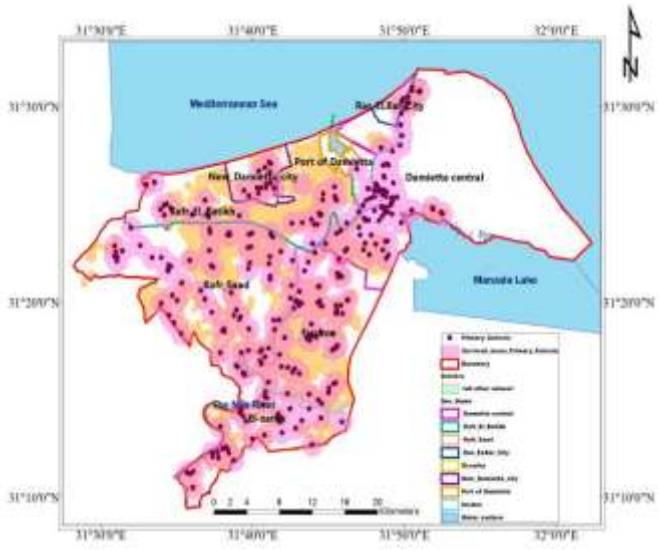

Fig .6.Serviced areas in accordance with boundary for Primary schools.

4 Results and Discussions

This study is based on the selection of educational services as one of the axies of sustainable development. It evaluates the geographical locations of schools in all educational stages and analysis their spatial distribution on the urban area in each of the districts of the governate. In order to achieve the objectives of the study, the study is based on using the spatial analysis of the spatial differences of school distribution and arrangement on the surface of the earth using some analysis methods by geographic information systems. Using satellite images from Google Earth, SAS Planet program, the data collected for the number of schools, it's descriptive and geographical Data from central Agency for public moilization and statistics, as well as access to sources of information available from previous studies, books, references, foreign periodicals, published on the subject of the study.

4.1 Primary Schools

The total number of pre-primary schools in Damietta governorate are 168 school and 361 primary school which are distributed in all districts in the governorate. Analysis of data after projection primary schools on the Damietta governorate's map, it was found that the mean percentage of the primary schools's deficit in the governorate of Damietta is estimated at about 33.25% Depending on the Urban areas of the governorate as Shown in table (2) and Figure .6.

Table 2. Serviced and unserved areas and the proportion of the deficit for primary schools.

Districts	Serviced Area (km2)	Service ratio (%)	Shortfall Service (%)
Damietta district	66.82	66	34
Kafr El_Batikh	172.29	74	26
Kafr_Saad	142.18	63	37
Ras_ELBar_City	17.27	67	33
El-zarka	63.19	73	27
New_Damietta_city	5.75	65	35
farskor	62.35	60	40

4.1.1 Nearest Neighbor Index for Primary Schools

Nearest Neighbor, analysis showed the distribution of schools in the Damietta governorate, according to number of schools and the study area. It was found through this simulation analysis for each education stages in each district, the coefficient value of the mean Nearest Neighbor was (0.026). Indicating the distribution pattern type and the criteria adopted for test Nearest Neighbor is standard value of the phenomenon Z_Score as the value of Z (-2.48), the value is different to expect value for Z for each districts. Criterion of a geographical pattern is shown in figure .7.

4.1.2 Standard Distance for Primary Schools

The concentration of primary schools are found after analysis the data by standard distance method. The schools are concen-

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trated in the old areas of the governorate, which is considered as the point of beginning construction in each district, is shown in figure .8.

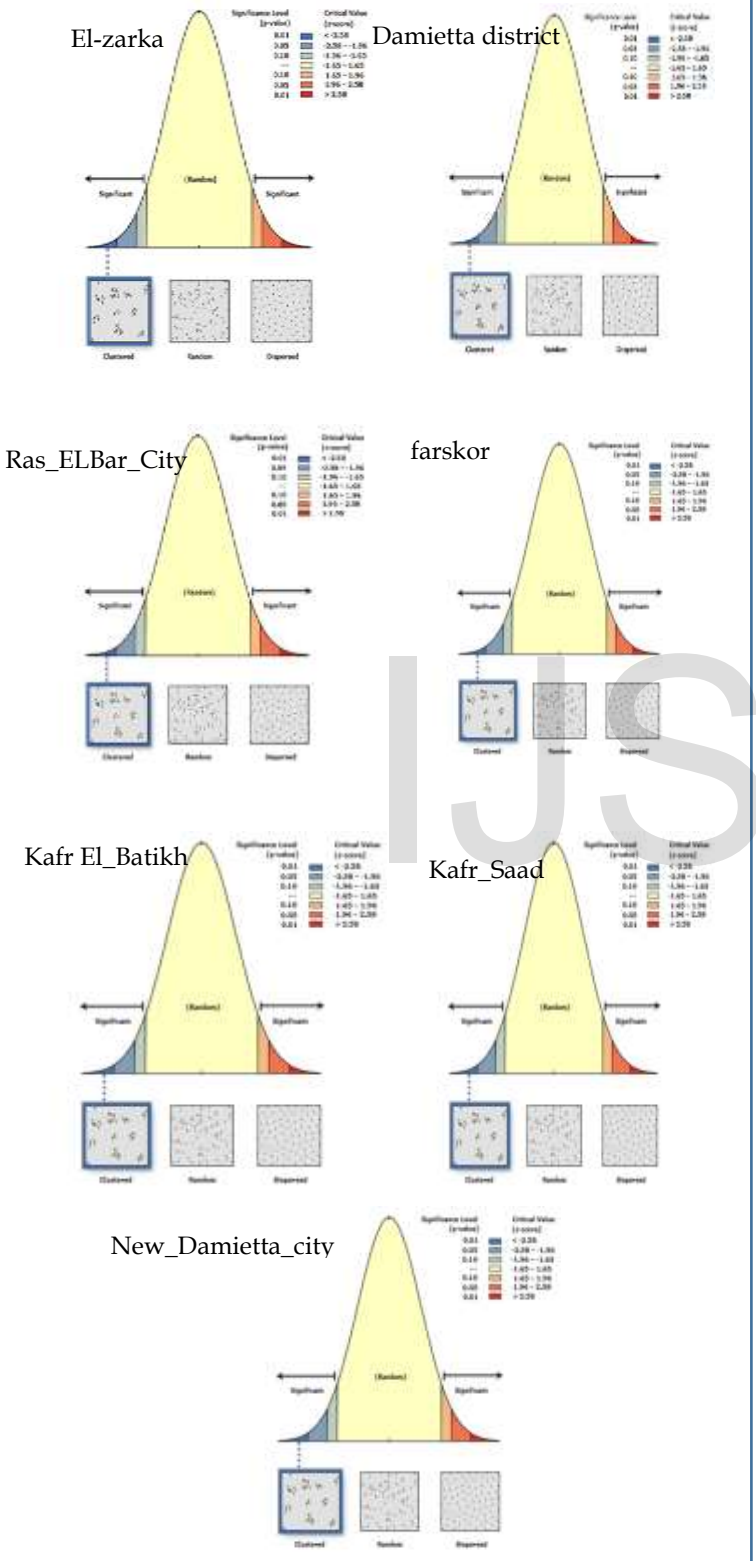

Fig .7 The Average Nearest Neighbor Summary for the distribution of primary schools.

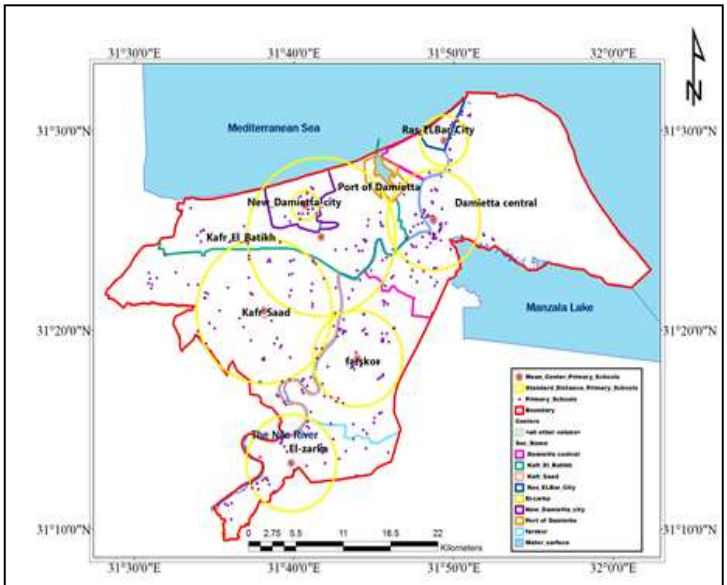

Fig .8. Distribution concentration of primary schools by standard distance method.

4.1.2 Standard Distance for Primary Schools

The concentration of primary schools are found after analysis the data by standard distance method. The schools are concentrated in the old areas of the governorate, which is considered as the point of beginning construction in each district, is shown in figure .9.

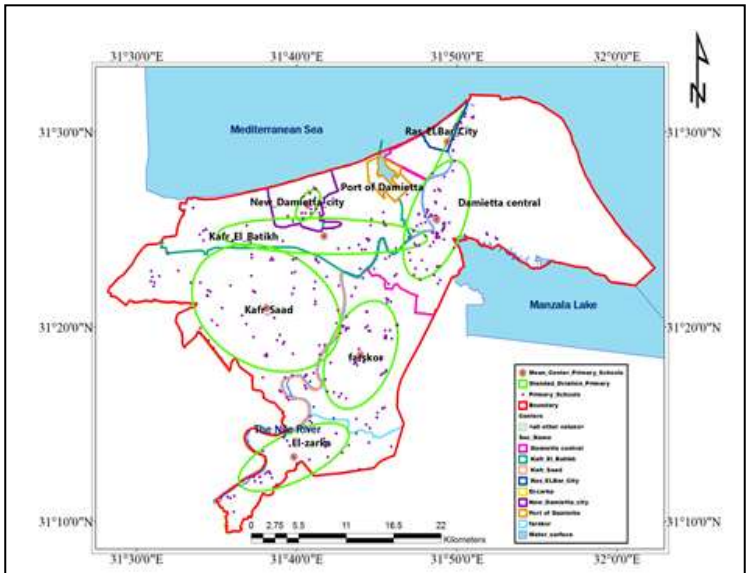

Fig .9 Distribution and direction concentration of primary schools by Standard deviational ellipse method.

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4.1.4 The Proposed Sites for the Primary Schools

After analysis method and the required results were obtained for educational services by, depend of the
Adopted standard for primary schools and the percentage of deficit for the primary schools. Ten geographical location proposed for primary schools that can be a development for the educational projects in Damietta governorate to overcome the

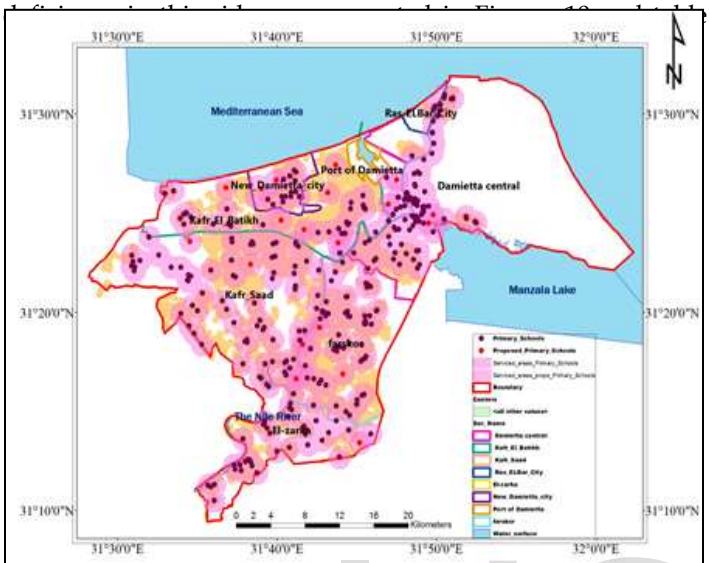

Fig .10 New Serviced Areas for Primary Schools.

Table.3 Sites and the Coordinates of the Proposed Primary Schools.

Proposed primary school	X-coordinate (m)	Y-coordinate (m)
1	371353.2321	371353.2321
2	3479039.0939	3479039.0939
3	371112.7589	371112.7589
4	3478171.5291	3478171.5291
5	375955.1987	375955.1987
6	3474966.2309	3474966.2309
7	379307.7000	3473456.0000
8	379574.6000	3474263.0000
9	384350.6000	3477235.0000
10	385223.8000	3479496.0000

4.2 Preparatory Schools

The total number Preparatory schools in Damietta governorate are197 school which are distributed in all districts in the governorate. Analysis of data after projection Preparatory schools on the Damietta governorate's map, it was found that the mean percentage of the Preparatory school's deficit in the governorate of Damietta is estimated at about 33.88% in Depending on the Urban areas of the governorate as Shown in the table(4) and the figure .11

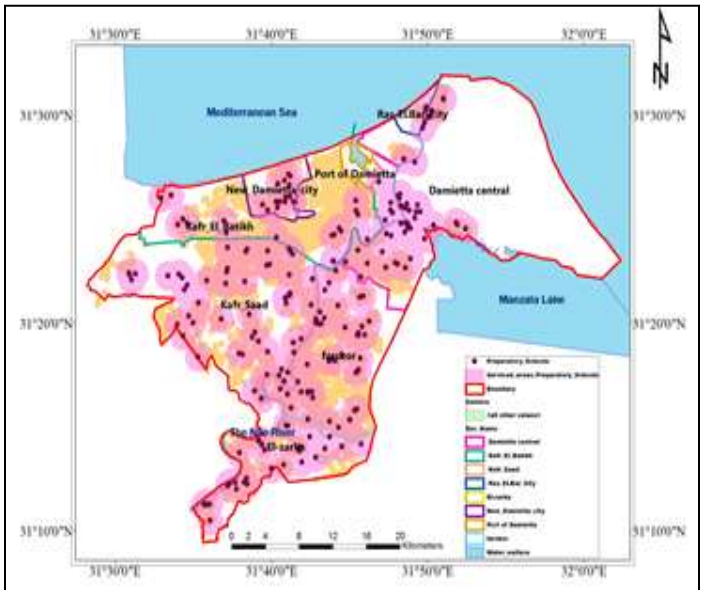

Fig .11 Serviced areas in accordance with boundary of the city for Preparatory Schools

Table4. Serviced and unserved areas and the proportion of the deficit for Preparatory schools

Districts	Serviced Area (km2)	Service ratio (%)	Shortfall Service (%)
Damietta district	71.91	64	36
Kafr_El_Batikh	169.31	77	23
Kafr_Saad	132.90	60	40
Ras_ELBar_City	20.1	25	75
El-zarka	70.19	69	31
New_Damietta_city	5.72	72	28
farskor	60.16	62	38

4.2.1 Nearest Neighbor Index for Preparatory Schools

Nearest Neighbor, analysis showed the distribution of schools in Damietta governorate, according to number of schools and area. It was found through this simulation analysis for each education stages in each district the coefficient value of the mean Nearest Neighbor was (0.845). Indicating the distribution pattern type and the criteria adopted for test Nearest Neighbor is standard value of the phenomenon Z_Score as the value of Z (2.210401), the value is different to expect value for Z for each districts. Criterion of a geographical pattern is shown in figure .12.

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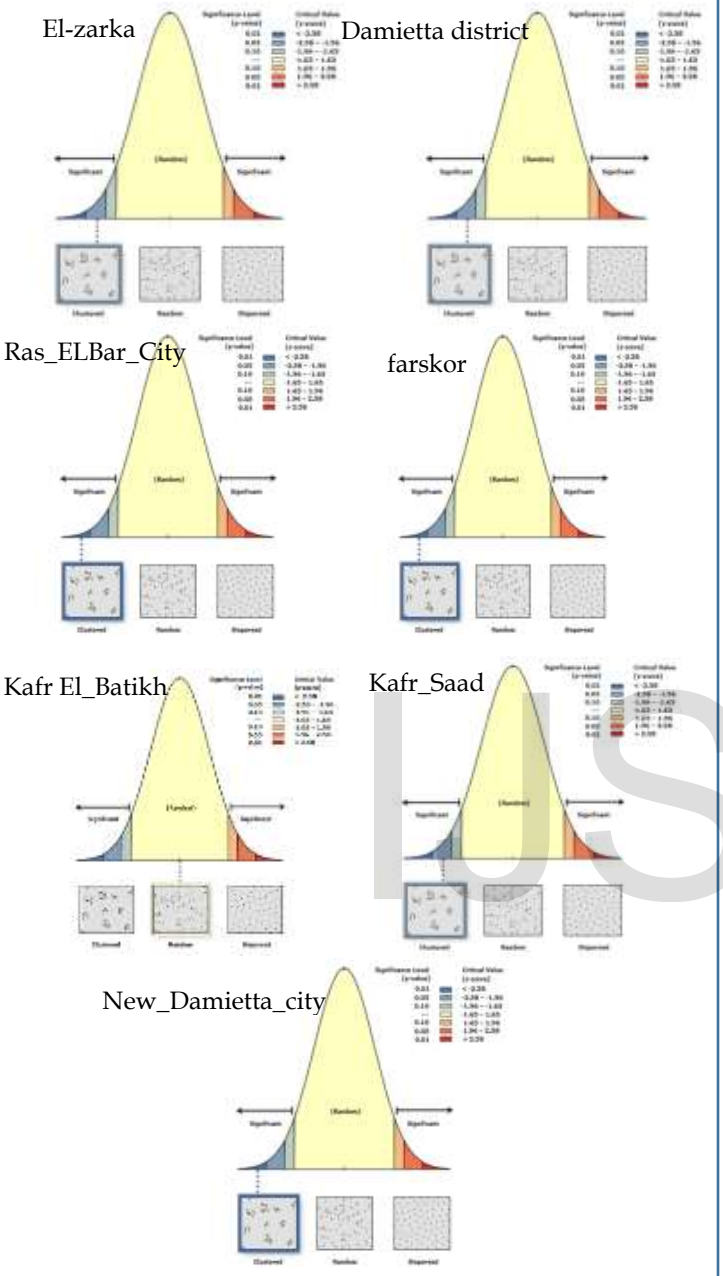

Fig .12 The Average Nearest Neighbor Summary for the distribution of Preparatory schools.

4.2.2 Standard Distance for Preparatory Schools.

The concentration of Preparatory schools are found after analysis, the data by standard distance method. The schools are concentrated in the old areas of the governorate, which is considered as the point of beginning construction in each district as shown in figure .13.

Fig .13 Distribution concentration of Preparatory schools by standard distance method.

4.2.3 Standard Deviational Ellipse for Preparatory Schools

Standard deviational ellipse analysis are showed the concentration of Preparatory schools .The Preparatory schools are concentrated in the old areas of the districts which is considered a point of beginning construction at different rotation degree, as shown in figure .14.

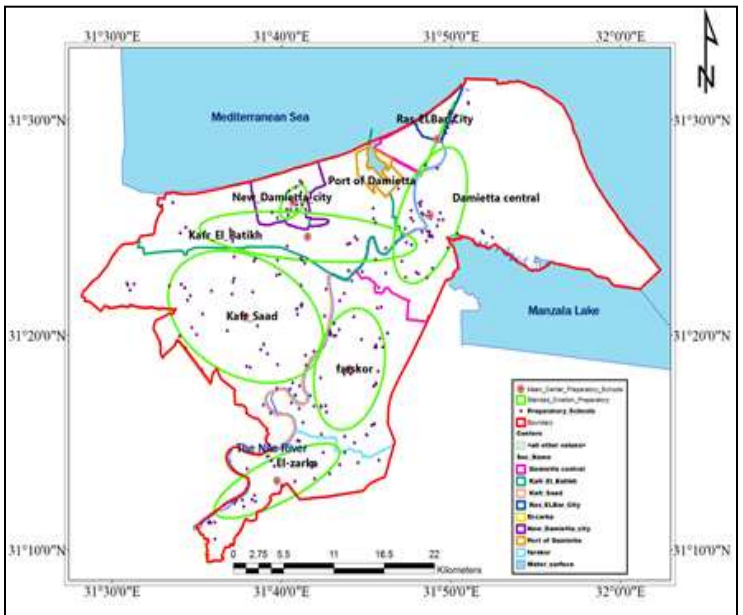

Fig .14 Distribution and direction concentration of Preparatory schools by Standard deviational ellipse method.

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3.2.4 The Proposed Sites for the Preparatory Schools.

After all analysis method and the required results were obtained for educational services by depending on the Adopted standard for Preparatory schools and the percentage of deficit for the Preparatory schools. Eleven geographical location proposed for Preparatory schools that can be a development for the educational projects in Damietta governorate for overcome the deficiency in this side as represented in Figure .15 and table (5).

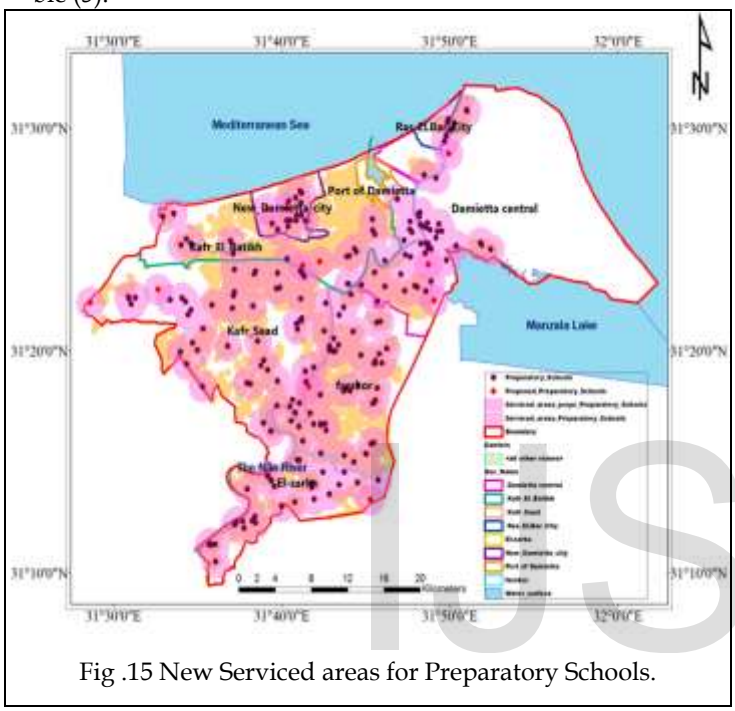

Fig .15 New Serviced areas for Preparatory Schools.

Table.5 Sites and the Coordinates of the Proposed Preparatory Schools.

proposed Preparatory school	X-coordinate (m)	Y-coordinate (m)
1	355138.85	3471475.36
2	361563.73	3472496.12
3	376823.59	3474628.89
4	375220.41	3474302.29
5	387550.99	3471262.12
6	387057.85	3474273.04
7	389078.88	3483438.19
8	371914.68	3479050.62
9	373735.59	3479103.10
10	381361.65	3454810.10
11	375680.79	3464256.28

4.3 Secondary Schools.

The total number Secondary schools in Damietta governorate are135 school which are distributed in all districts in the governorate. Analysis of data after projection Secondary schools on the Damietta governorate's map, it was found that the mean percentage of the Secondary school's deficit in the governorate of Damietta is estimated at about 28.5% in Depending on the Urban areas of the governorate as Shown in table (6) and figure .16.

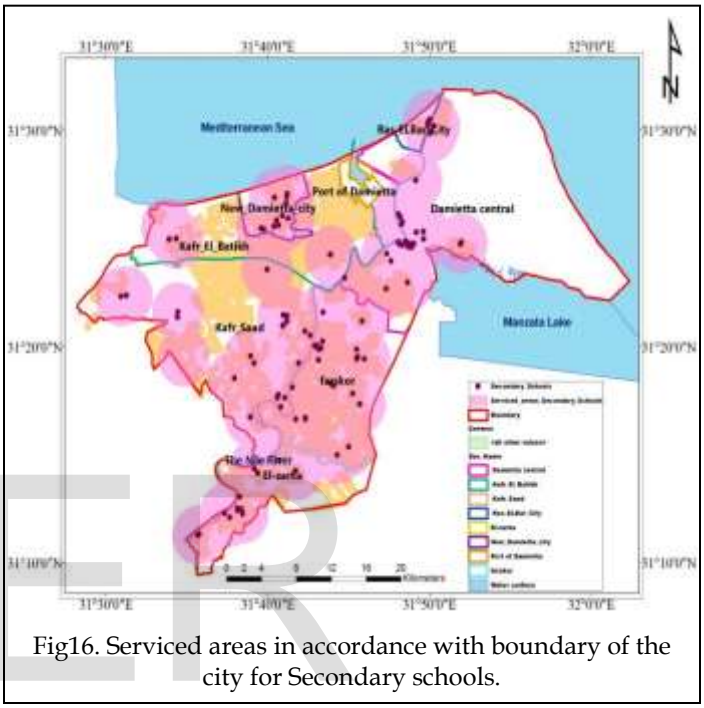

Fig16. Serviced areas in accordance with boundary of the city for Secondary schools.

Table 6 Serviced and Unserved Areas and the Proportion of the Deficit for Secondary Schools.

Districts	Serviced Area (km2)	Service ratio (%)	Shortfall Service (%)
Damietta district	44.73	75	25
Kafr_El_Batikh	188.73	75	25
Kafr_Saad	139.74	72	28
Ras_ELBar_City	1.50	50	50
El-zarka	29.36	75	25
New_Damietta_city	6.26	55	45
farskor	37.28	70	30

4.3.1Nearest Neighbor Index for Secondary Schools

Nearest Neighbor analysis showed the distribution of schools in the Damietta governorate, according to number of schools and area of study. It was found through this simulation analysis for each education stages in each district the coefficient value of the mean was (0.034), Indicating the distribution pattern type and the criteria adopted for test Nearest Neighbor is standard value of the phenomenon Z_Score as the value of Z (2.492356), the value is different to expect value for Z for each districts. Criterion of a

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geographical pattern is shown in figure .17.

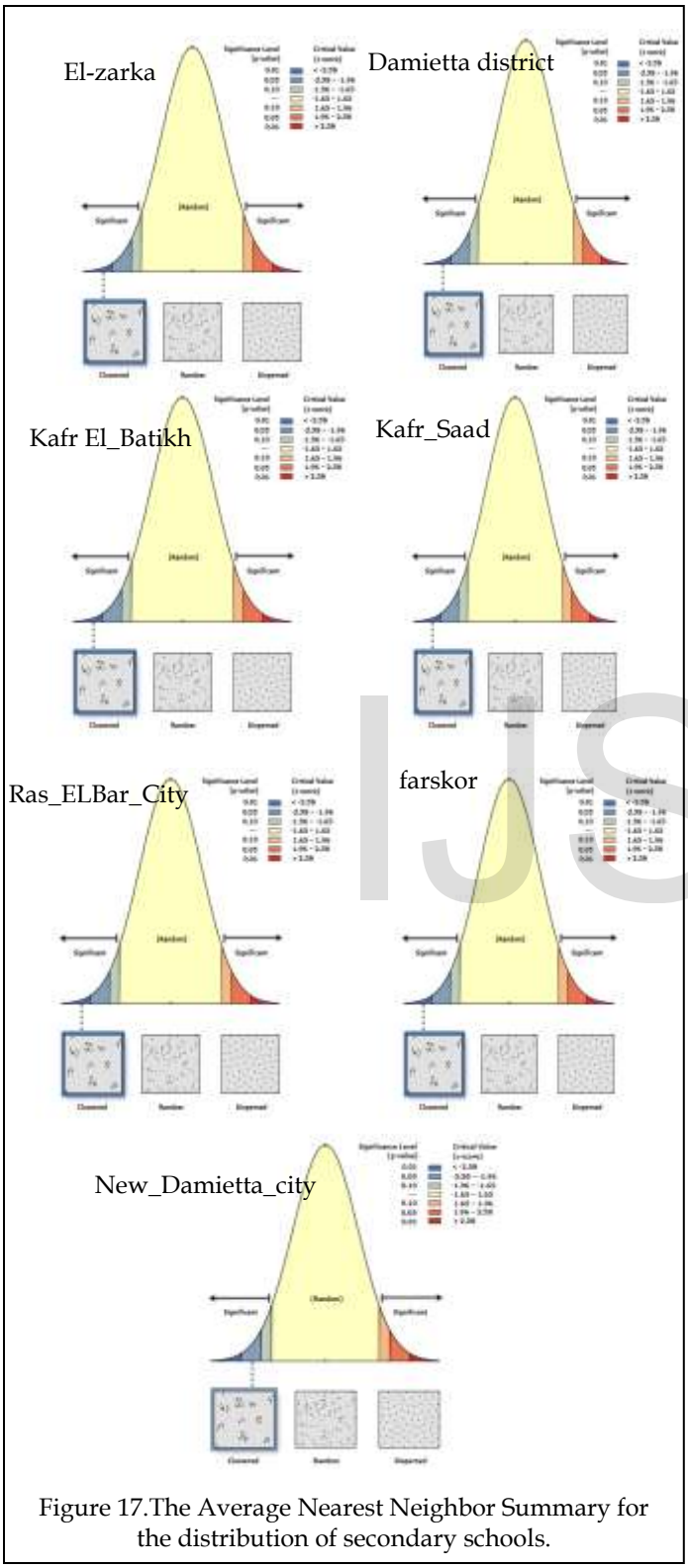

Figure 17.The Average Nearest Neighbor Summary for the distribution of secondary schools.

4.2.2 Standard Distance for Secondary Schools

The concentration of Secondary schools are found after analysis the data by standard distance method. The schools are concentrated in the old areas of the governorate that is considered as the point of beginning construction in each district, shown in figure .18.

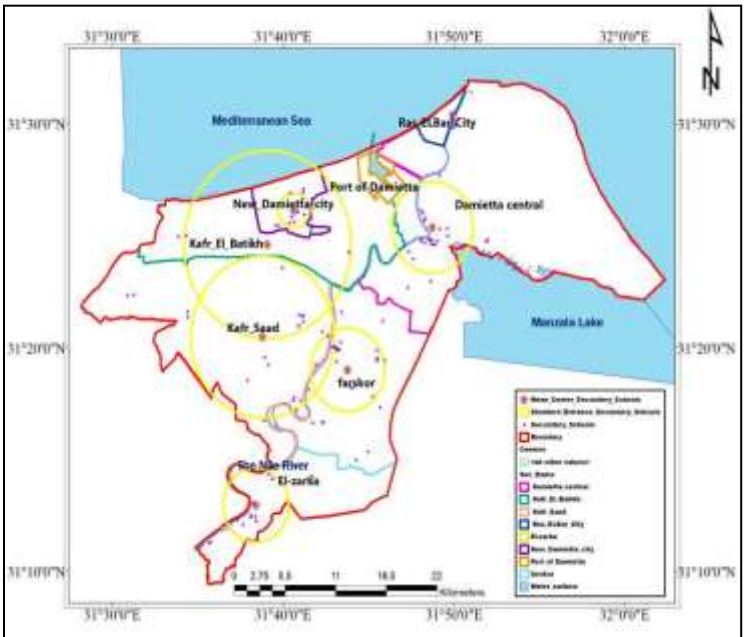

Fig .18 Distribution concentration of secondary schools by standard distance method.

4.2.3Standard Deviational Ellipse for Secondary Schools

Standard deviational ellipse analysis show the concentration of secondary schools .The secondary schools are concentrated in the old areas of the districts which is considered a point of beginning construction at different rotation degree, shown in figure .19.

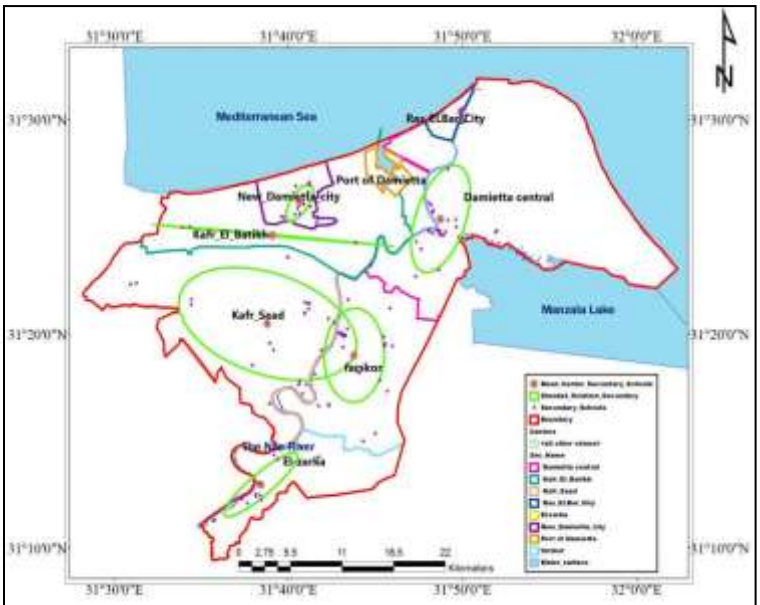

Fig .19. Distribution and direction concentration of secondary schools by Standard deviational ellipse method.

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4.2.4 The Proposed Sites for the Secondary Schools

After all analysis method and the required results were obtained for educational services depending on the Adopted standard for secondary schools and the percentage of deficit for the secondary schools.Twenty two geographical location proposed for secondary schools that can be a development for the educational projects in Damietta governorate to overcome the deficiency in this side as represented in Figure .20 and table (9).

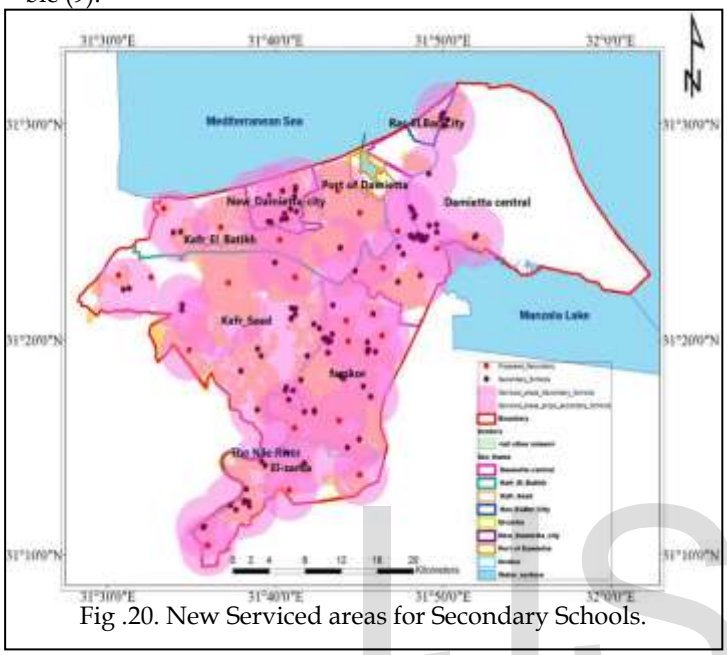

Fig .20. New Serviced areas for Secondary Schools.

Table 9 Serviced and Unserved Areas for Secondary Schools After add New Proposed Secondary Schools.

proposed Preparatory school	X-coordinate (m)	Y-coordinate (m)
1	3472999.73	358360.25
2	3472197.18	368741.72
3	3468418.46	367631.25
4	3473721.83	375432.76
5	3479660.58	372691.61
6	3477034.60	382351.19
7	3478668.66	362716.38
8	3479150.33	362371.16
9	3476974.43	368082.30
10	3475842.60	373678.54
11	3476438.56	384815.22
12	3455586.66	381011.91
13	3454359.15	374290.41
14	3449695.99	366493.10
15	3467511.58	383256.01
16	3459681.64	374860.86
17	3460263.37	379080.93
18	3468832.82	379845.86
19	3467064.72	380047.15
20	3474902.42	388516.01
21	3474325.91	361448.27
22	3472784.45	358360.25

5 CONCLUSION

The study is resulted that the pattern of geographical distribution of the educational service in Damietta Governate is clustered except for the pattern of Preparatory school's distribution in kafr Al-Buteekh district is random. It is revealed that the concentration of different schools's stages are concentrated in the old areas of each district which is considered as the point of beginning construction in Damietta Governate while the other areas Lack the educational service. The main reasons for this problem are the increasing population growth, rapid urbanization and the new services are needed for the urbanization. All these reasons are have effects on the distribution of the services system. The different analysis methods of GIS is used to study and evaluate the services through identifing the pattern of the spatial distribution according to each others or to the other services. Additional to the determination of the direction of services in the Governate. Obviously, the importance of equal distribution of services in each area in Governate can be considered as one of the most solution to support the areas that lack services, decreasing the compression on the available services, as well as decreasing the congestion in the main areas to the development of the poor areas. Thus achieving the principle of sustainable development in all areas in Governate.

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