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Technical Foundations of GIS for the planning and management of the educational sector in the city of Nasiriyah

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ABSTRACT

The local government of the city of Nasiriyah has always appealed for a number of problems which it described as the difficult problems facing the reality of education in the city of Nasiriyah in Iraq, pointing to a large shortage of school buildings and educational staff and overcrowded classrooms. In order to improve the status of education in general and in the city of Nasiriyah in particular, the researcher presented in this paper a number of methods and modern techniques, which are considered as the basis of the context of the unit of GIS in the Directorate of Education Dhi-Qar to study the current reality of the educational institution and to identify the foci of these problems to control and solve them in an effective and rapid manner. In this research, the programming, analytical and statistical methods of the ArcGIS program and Python programming language were used. The researcher concluded that following these principles leads to locating the focal points of the problems of the educational sector in the city of Nasiriyah, located in the Eastern Ring and the southeast of the city. Several recommendations have been made in this research to solve these problems.

Keywords: Mapping, GPS, Python, GIS, Nasiriyah

1. INTRODUCTION

By science, peoples rise and nations and societies progress. It is no secret to any of us how important it is to improve the educational level of the society [1], which depends on the need to provide the educational service in a typical way and to the maximum potential available to us, as the adoption of educational institutions based on modern scientific foundations by reducing the time factor in the speed of achievement and reduce costs. The use of Geographic Information System (GIS) software in this sector and its modern scientific technology capabilities will help effectively solve most of the obstacles facing the Directorate of Education in terms of urban planning and expansion of the educational sector [2, 3], which provides great potential in Studying and analyzing the current educational reality and outlook of the region. It is an efficient tool in managing and planning the accessibility to the educational schools [4, 5, 6].

Because of the lack of ownership of the Directorate of Education of Dhi-Qar for modern maps of the reality of the city of Nasiriyah and the absence of such maps to the competent institutions in this area, the researcher used scientific methods in the

creation of digital maps required for this research from the adoption of GPS (Global Positioning System) [7]. As well as the use of software with special geographic competence in the formation of maps (shipfile) and the adoption of satellite images and photographic images of the city of Nasiriyah for the same purpose as well as the formation of a descriptive database of those sites, relying on the information that was reinforced by the Directorate of Dhi-Qar Education. The province of Dhi-Qar in general and Nasiriyah in particular are located in the southern and south-eastern parts of Iraq between the widths (29.5, 31.5) north and length (46.4, 47.65) east. Thus, Nasiriyah is located in the lower sections of the central offers in the northern hemisphere. It is bordered to the north by Wasit province, from the south by Basra and from the east by Maysan and from the west by Qadisiyah and Muthanna. In the Sumerian civilization (Ur civilization), which is located 11 km west of the city, and the civilization of Arrido, 40 km west [8, 9]. This is evidence that the area was not free from the city on the day of the expropriation of the (Muntafiq), and from that urban (Alarjaa) city in its known location on the western side of the city (Shameya). The city grew up in these places, which could be called the inheritance of places that had the effect of making this city a race in the construction of schools. In 1917, the first elementary school was established. The school had five teachers, two of whom were religious teachers. The number of students was 48 students only.

At present, the city is suffering from poor educational services in which, there is a shortage in the number of schools and educational cadres and the increase in the number of students greatly, which burdened the Directorate of Education in the city to solve these problems and make it in urgent need to adopt modern methods in the management, planning and analysis of educational reality. The establishment of a methodological basis to be followed by the specialists working on the management of the Geographic Information Systems Unit in the planning and follow-up matters will contribute to raising the level of effectiveness of this unit in finding the correct and sound decisions in diagnosing and developing suitable solutions for all obstacles facing this Directorate [15]. By reviewing previous relevant studies, a study was conducted to assess spatial distribution of schools in Jeddah, Saudi Arabia [11].

The researcher observed that schools do not cover many residential areas in the city and other less populated schools with excess school coverage. In the city of Yola in Nigeria [12], the study showed the random distribution of schools and environmental problems that can be solved by the GIS program and a more efficient database was designed than the manual approach. A study in Kuwait [13] also showed a large percentage of areas where there are no schools that do not meet the minimum standards set by the Ministry of Education. These values are crucial for decision makers to prioritize immediate action to resettle schools or expand services and access. In another study conducted in the Debre Markos Town of Ethiopia [14], the result revealed that 89% of schools are less than two kilometers away from other schools and 11% of schools are more than two kilometers away from other schools. The study recommended the government and urban planners to apply GIS technology to determine the location of the appropriate school.

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2. RESEARCH PROBLEM

Some of the problems raised by the Directorate of Education and Local Administration on the distribution of schools and their numbers in the city of Nasiriyah that have been summarized in this research as follows: (1) The absence of a structured work context by the competent authorities to work on it to reduce the time factor and reach a clear vision that allows the competent authorities to know the real fault sites., (2) The high percentage of the population density of the city of Nasiriyah in general and the side of Al-Shamiya in particular, and the high rates of numbers of students in primary schools on the one hand and the failure to open or develop new schools in the city on the other hand, (3) The lack of the Directorate of Education in the city of Nasiriyah to digital geographical maps of the sites of the educational sector in the city and the lack of clarity in the vision of the Directorate of the educational reality of the city and the lack of conducting analytical studies and the establishment of schools in the incorrect locations, leading to material and temporal losses in solving the problems facing the educational sector at present and in the future, and (4) Failure to follow the modern mathematical and engineering methods by the Directorate of Education in the study and analysis of the educational reality of the city of Nasiriyah.

3. DATA RESOURCES AND METHODOLOGY

The city of Nasiriyah is one of the cities that lacks the official digital geographical maps approved for developmental studies and scientific research. On this basis, it was necessary to follow some practical scientific research methods in order to create digital maps with the construction of a descriptive geographic database showing all the data related to the educational system of the research area. A descriptive information database for the schools within the research area was created by obtaining the data file (Excel file) by the Dhi Qar Education Directorate containing all the required data for the educational system, such as the name of the school, the number of its pupils, the size of the school and Teaching staff and so on.

In order to create a digital shipfile for this region, there were several sources adopted in the composition of these maps, including the adoption of the use of a GPS device to locate some schools of unknown coordinates. Some of the software that helps in the creation of these maps has been used as Spatial Manager Desktop, which helps to retrieve the shipfile maps from the geographical maps such as road and bridge maps and most of the facilities defined in these sites as in the open street map [10]. As well Google Earth has been adopted to obtain detailed satellite images of the research area and to rely on documented photographic images such as the educational atlas published by the Iraqi Ministry of Education. After the formation of digital maps of the research area and using the characteristics and guidance that characterize the GIS program from the statement of the simplest elements and data required for the maps and research databases, we find the research area consists of sixteen residential neighborhoods and an area of more than $10339 km^2$, it is an urban area characterized by an urban cultural character and a process of science and education. It contains 29 primary schools and both sexes in Figure 1 and 2.

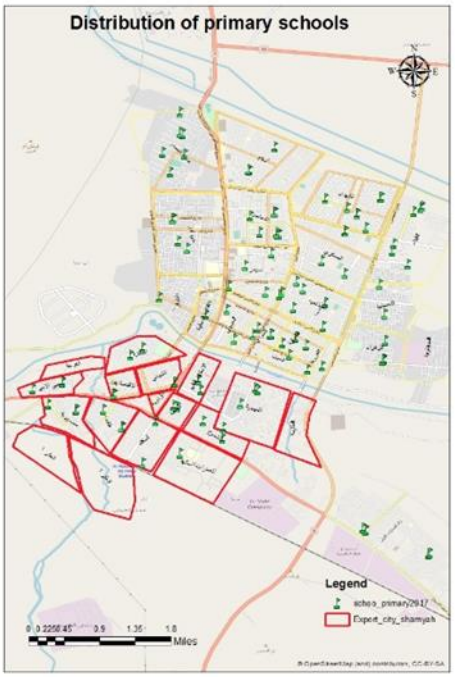

FIGURE 1. Distribution of primary schools in the city of Nasiriyah

FIGURE 2. Primary school database in Nasiriyah

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One of the priorities of disclosure and study the educational reality of a particular area begins to indicate the locations of these schools for the study area and the gender of students and the census of students in each school in a digital map illustrating the facilitation of the reading process for the region and effectively through the advantages of this program, which allows the person competent to control this information as shown in Figure 3.

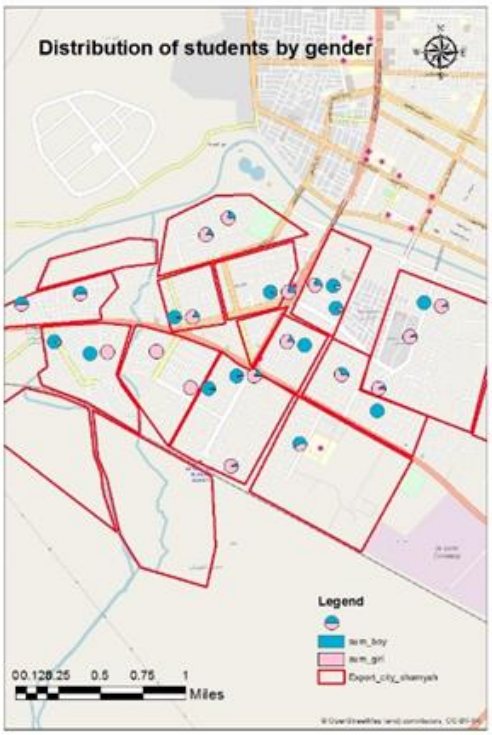

FIGURE 3. Distribution of students by gender in the Shamiyah area

By specifying the areas that should be covered by these schools in terms of determining the planned path, the path of the primary school student from the residential area to the school site as a real and actual reality for that area and according to the educational standards prescribed by the Iraqi Ministry of Education is to calculate Circular area centered on the site of the school itself and with a diameter of 500 m (educational basin of the school). This is done by using Buffer instruction. To illustrate these areas, how much they are covered by the research area, and to sort the areas outside this range, the Dissolve instruction is used to unify all of these circuits in one form. Figure (4) shows the total coverage of primary schools for the Shamiyah side. In this research, the Python language was used to manually program these commands in order to increase the control and obtain the best possible details that the researcher wishes to obtain, and because of the characteristics of the map resulting from it, the same instruction cannot be obtained in the case of the Arc tool box.

The areas containing intersections of these circuits are then indicated by the use of intersect instruction. These intersections show the extent of convergence between these schools in a given place, indicating that these areas are considered to be areas with high student densities that led the competent authorities to increase the number of these schools in the smallest possible space, and also indicate that these areas are the oldest residential areas within the circle research. As shown in Figure 5.

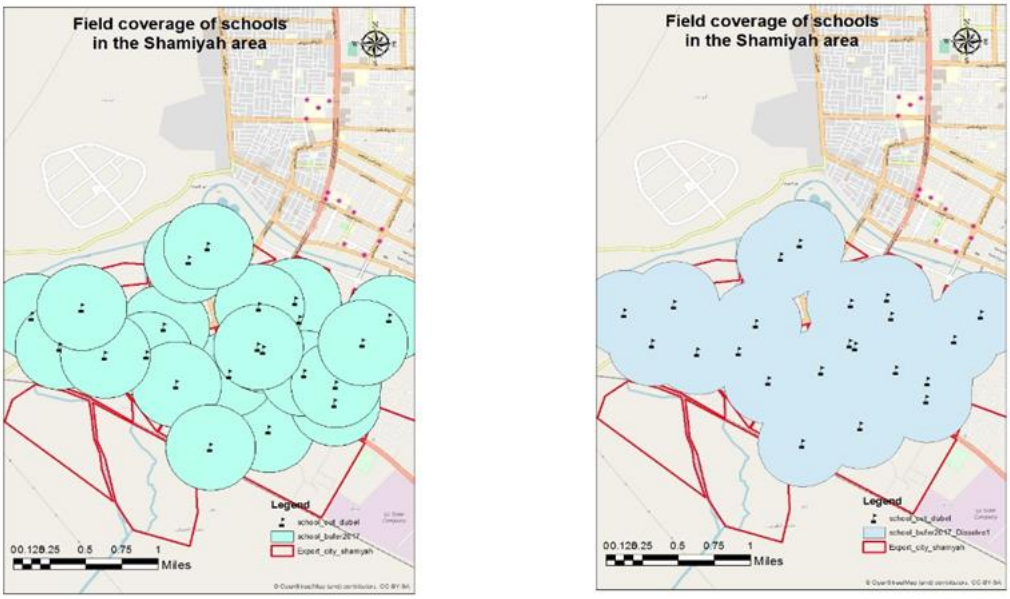

FIGURE 4. Field coverage of schools in the Shamiyah side according to the criteria approved by the Iraqi Ministry of Education

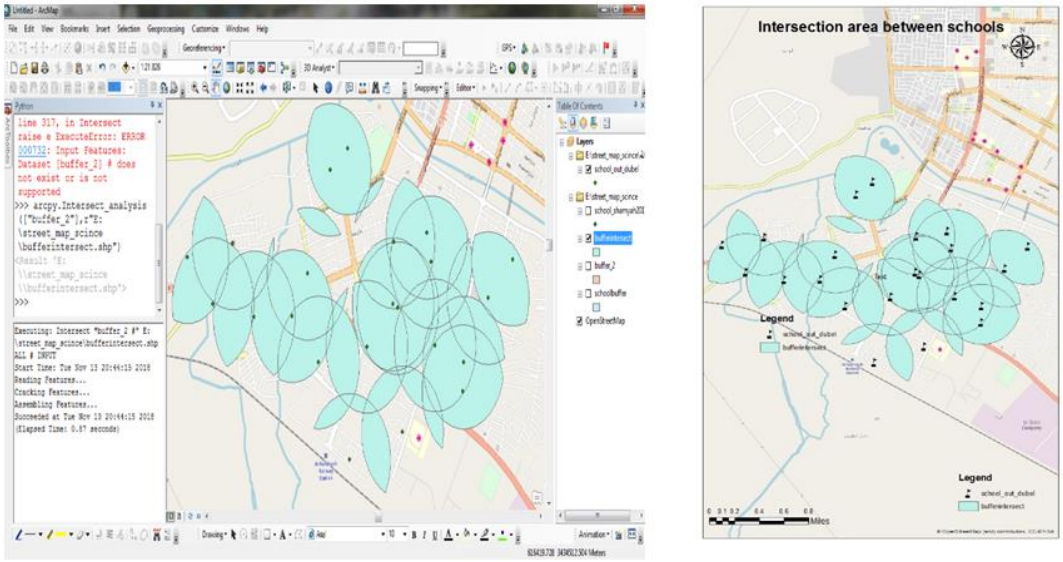

FIGURE 5. Intersection areas between schools within the standards of the Iraqi Ministry of Education to show the density of schools in the Shamiyah side

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FIGURE 6. The spatial distribution of schools to the current reality of the Shamiyah area using Thiessen polygons

In the second stage, divide the research area according to the location of the school sites by using Thiessen polygons, so that the specialists can divide the research area to the same distance between the two adjacent schools to show the length of the path between each school and the size of the area covered by each school compared to the neighboring schools. Figure (6). For this purpose, the Natural Neighbors algorithm [16] is used by the natural neighbor induction tool. It finds the nearest subset of the input samples to the query point and weights are applied based on the proportional areas of the value interpretation. It is also known as Sibson or interpolation "theft zone". Using only a subset of the samples surrounding a query point, and the overlapping heights ensure that they are within the range of the using samples. The surface passes through the input samples and is smooth everywhere except for the sites of the input samples. According to equation (1).

$$G(x,y) = \sum_{i=1}^{n} w_i f(x_i, y_i) \quad (1)$$

where $G(x,y)$ is the estimate at (x,y), w_i are the weights and $f(x_i,y_i)$ are the known data at (x_i,y_i). The weights, w_i, are calculated by finding how much of each of the surrounding areas is "stolen" when inserting (x,y) into the tessellation.

The use of this instruction is to create a picture of those descriptive data that clearly shows the places of high and low student density for the research area for easy study and analysis. This is the basis for classification of areas according to the weight of the student density in Figure 7.

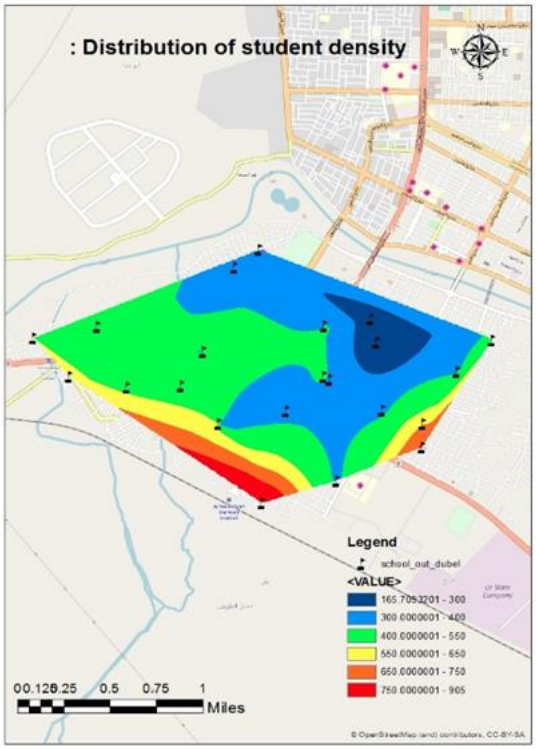

FIGURE 7. Distribution of student density in the schools of the Shamiyah area

4. RESULTS AND DISCUSSION

After entering metadata used by the Directorate of Dhi-Qar Education, we note that the city contains 181 elementary schools distributed over the residential neighborhoods of the city of Nasiriyah and as shown in Figure 1. As the city of Nasiriyah lies on the Euphrates River, it divides the city into two areas of the northern region, called (Jazeera side) and the southern region (Shamiyah side). In Figure 1, by dropping educational facilities (schools) in the GIS program and by geographical coordinates, these institutions are spread in the Shamiyah area. The area of Shamiya contains 17 residential districts distributed in a contiguous and different areas. It was possible to indicate the disparity in the areas of these residential neighborhoods from using one of the features of GIS in the formation of a diagram to read these areas in a simplified and quick way as in Figure 8,The total area of the Shamiyah area is 10339,620 km 2, which contains 29 primary schools, including 11 schools for boys, 15 girls' schools, and three mixed schools for both sexes, as in Figure 3. Distribution of these schools according to sex as it is Between it was close to that distribution would be equal and regular.

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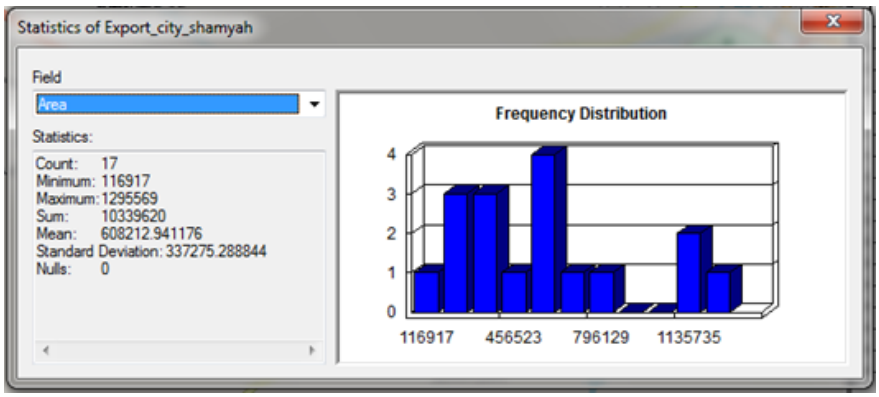

FIGURE 8. Frequency distribution of residential neighborhoods within the research area

In order to determine the amount of survey coverage of the schools in the research area and according to the standards set by the Ministry of Education, the amount of coverage is calculated as the representation of the school's enclosure with circle of diameter 500-meter. The center of this circle is the site of the school itself. As shown in Figure (4), these schools have a good survey coverage of 89% of the Shamiya area. In Figure (7), it can be observed that when using the natural neighbor by using data from the total number of students in schools, this helps to determine the percentage of student density within the research area, where it is easy to clarify the impact of these neighborhoods and the effectiveness of the preparation of schools to fill the educational need for each neighborhood and the area of Shamiya in general. We note that the northern and northwestern regions have moderate student densities in relation to Iraqi educational standards because these areas are old-fashioned areas and are surrounded by the Euphrates River, which is specific to the urban expansion in these areas.

We note also that the southern and south-eastern regions have more student densities than the established limit, because they are newly established areas characterized by a growing population and large areas, as well as the displacement of the population on the agricultural areas and the process of bulldozing illegal orchards and the absence of specific factors for the expansion of the building helped to increase the proportion of students in these schools. In order to study the distribution of student density according to the prevalence of these schools, using Thiessen polygons feature for the distribution of schools and the areas covered. As a reality we note that the competent authorities in this matter have established schools in harmony with the student densities located in each region. As the areas with low student densities, the number of schools is few and has wider coverage of the areas, as seen in the north and north-west of the region. While the number of schools in areas with high student density is increasing, as is the case in the central regions and areas near the southern regions. In spite of this, we find that there are some shortcomings by the Directorate of Education Dhi-Qar to fill the shortfall in some areas, especially the eastern and south-eastern regions of the research area.

5. CONCLUSION

We conclude from the results obtained from the data of this research as follows:

1. The possibility of geographic information systems in the areas of planning and analytical studies in the management of state institutions because it provides a descriptive database with geographical references that shorten the time and reduce the economic costs achieved in traditional ways routinely.

2. We conclude that the distribution of the student density in the Shamiya area is not a constant level in all the residential neighborhoods, but gradually. The student density of the northern, northwestern and central regions was lower than in the eastern and southeastern regions, where the number of students reached 906 students in the school with a capacity of 489 students and the distribution of schools in the north and north-west was successful in filling the educational coverage in those areas. Although the number of schools in the eastern and southern regions was more than it is from the rest of the regions, but these areas still need to build and develop other primary schools, as these neighborhoods of development and expansion of urban construction and high population.

6. RECOMMENDATIONS

1. The development of significant analytical methods in the practical and scientific studies of the planning and follow-up departments of governmental institutions such as the use of interpolation natural neighbor and Thiessen polygons.

2. Use GIS correctly and create maps that include the whole governorate and enhance it with descriptive databases for all data that fall within the scope of modern methods of study and analysis of the educational reality of the province.

3. Conduct studies that include other methods in the analysis and study of the province, such as the study of school sites of all standards stipulated by the Iraqi Ministry of Education.

4. Strengthening the eastern and southern regions of the Shamiya area in the construction and development of new primary schools to improve the educational reality of the city and dismantle the bottlenecks in the schools of those areas.

5. Through the results of the statistics of the number of students and distribution of these schools according to the nearest health center, this helps in the studies in the competent health side to obtain the numbers of students within the sector of each health center to show the number of vaccines needed, speed control of epidemics and diseases spread as quickly as possible and less cost and indicate the number of cadres medical work required for each health center.

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