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Efficiency of Spatial Distribution of Health Services for Ombada and Karari Localities in Khartoum Sudan Using Geographic Information Systems (GIS)

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ABSTRACT

The significant of this study comes from the complete absence of the use of geographic information systems for decision-makers, as well as, the absence of correct and accurate map of the health facilities in health care planning. Thus, the use of geographic information system (GIS) becomes crucial method for data collection and proper planning. One of the most imperative objectives of this study is to identify the efficiency and adequacy of the distribution of health services in the study area, and to detect the deficiencies by using a number of local criteria, such as the population factors, as they are the most determining factors for the location of health facilities, as well as, preparing a geodatabase for all health services in the study area, and then analyzing statistical and analytical data to provide accurate information for decision-makers in the field of health planning, as well as, providing recommendations for the authorities in order to improve the efficiency of health services in the study area. It is important to note that, the strength of geographic information systems lies in its ability to integrate information from different sources and display data in different forms.

1. INTRODUCTION

The development of the healthy system of any country reflects the extent of human development in that country for it has a connection with the lives of people. The history of the health system in Sudan extends in the past to the colonial period, where the response to the colonial need to provide medical services to its military and civilians. Throughout its history it was characterized by the adoption of a western approach, nonetheless, its concept to modern medicine is bias towards the urban and focuses basically on urban areas and localities. It should be mentioned that, after the independence, the health system witnessed a great development in its infrastructure with its human and financial aspects, as the number of health facilities increased. The lack of equitable distribution of health institutions and human resources remained, nonetheless, a prominent feature. Similarly, the health system remains bias to the urban and major cities; for these areas continue to influence decision-making. The lack of clear overall vision for the health system in Sudan, and the weak capacity of the centers for planning and setting standards and specifications is the major predicament facing the Sudanese health system. Despite the expansion that the health system witnessed, it remained weak with the low quality and weak responsiveness to the needs of society. Inequality in the distribution of resources and funding, and absence of clear studies, on what is available is another reason for the poor health system in Sudan. During the past five decades, GIS has evolved from concept to science. The tremendous development of the geographic information system from a primitive tool to a modern and powerful platform for understanding and planning our world and possessing high capabilities in spatial analysis, has made researchers and governments able to solve human problems. This paper studies the spatial distribution of health services in the localities of Ombada and Karari, using Arc GIS software; with the hope that the solutions and proposals presented in this paper will help in the spatial redistribution of health facilities in the two states. Our research problem statement lies in the fact that, there is a low efficiency in the spatial distribution of health services in the localities of Ombada and Karari and it does not correspond to the density of the population in a way that reflects receiving the level of efficiency of health services in the localities in the face of the growing and steady increase in the population. At the same time, the paper aims to identify the efficiency and adequacy of the distribution of health services in the two localities, in order to find areas of weakness, by adopting

a number of local and international standards, to prepare a digital geographic database (Geo Database) for all health services in the localities.

2. HISTORICAL BACKGROUND OF OMBADA AND KARARI: THE STUDY AREA

The study was carried out in two localities; namely, Ombada and Karari localities. These two localities were selected for the main reason that both localities have ostensible weakness in planning and spatial distribution of health facilities.

Historical Background of Ombada

The area of Ombada came up during the Mahdist revolution in the Hijri year of 1315 AH corresponding to 1896 CE, as a camp for the fighters (mujahideen) who came from all parts of Sudan in response to the call made by Caliph Abdullah al-Ta'ishi, the successor of Imam Muhammad Ahmad al-Mahdi in preparation to repel the invaders who came to invade Sudan at that time and after the battle ended in the interest of the invaders, those who remained returned to their lands, except for a few families scattered as Bedouin houses on these vast lands and worked to cultivate them, and it remained so until the forties of the nineteenth century.

Hence, the urban life took hold again with the displacement of the members of the Al-Jumouya tribe with their livestock from the neighbourhood area. The Arabs in Omdurman, as well as, some weak and poor families displaced from Omdurman, began to attract arrivals from northern Sudan and then some regions in later periods; subsequently, administratively separated from the Khartoum Rural Council and joined the Omdurman municipality in 1961 AD, as an administration of Omdurman municipality, and in 1963 AD it reached population density to be a parliamentary constituency. Therefore, in 1971 AD during the era of Mayan rule the name changed to the new Omdurman and became a boundary of Omdurman councils in the Omdurman People's Assembly (West Nile) and continued to bear this name until the National Salvation Revolution in 1989 AD. Then within the framework of the decisions of the Federal Government, the eleventh Republican

Decree was issued to divide the city council into four localities: (Al-Amir, Al-Baqaa, Al-Salam, and Western Countryside) who later joined the Emir locality and with the same decree in the year 1994 AD, the city was upgraded to a governorate and it was named Ombada Odeh due to the old name. (Local Information Centre, Ombada)

The locality is bordered on the east by the facade street that goes south and passes through the street separating neighbourhood 14 Ombada and Mohandessin. And then it turns west by the street separating Abu Saad and Imbeda until the beginning of Dar al-Salaam and turns south and passes west of squares 38,39,40 al-Baqa'a and west of (al-Muwailih) towards the south and with the boundaries of the project MatariOmbada.

Therefore, all the villages, Jaden, Heglig and squares 50,49,48 belonging to Lamderman and the border continues to the south until the end of the Ombada rain project. Subsequently heading west in a straight line that passes north of Fattah to the state borders from the western side, and on it. The fatash will be affiliated with Lamderman and all the villages of the southern countryside, either separating them.

The locality of Karari to the east, starting from Al-Facah Street, passing north of Al-Hara 19, 20 Ombada and South Al-Hara 28, heading west, passing south of Al-Hara 26 Al-Thawra, then heading north-west of Al-Hara 26 Al-Thawra, leaving Al-Fatimab village, following Lampeda.And the border continues north to pass directly east of Al-Markhiyat Mountains and continues north until the western end of your neighbourhood 52 Al-Thawra then turns north-east toward Jabal Abu Walidat; from there it turns northwest toward Jabal al-Muqron, and then turns northwest toward Jabal al-Barij until the borders of the northern state, adding al-Hara 50 and villages. Abu Ashr and Al-Muqron for the Karary locality. Regionally, it is bounded to the west by "North Kordofan State and to the north by Northern State and South by White Nile State. (Local Information Centre, Ombada)

Historical Background of Karari

Karari locality lies to the west of the Great Nile River, east of Ombada locality, north of Omdurman locality, and south of River Nile State. The area of the locality is about 4,646 km2, its climate is semi-desert, and it has one of the largest underground water basins in Sudan, which is the Nuba Aquifer Basin. (Local Information Center,Karari). Urban revival began with the housing revolution projects in 1959, which have so far reached 105 lanes, and the city of Al-Fath alone includes 904,423 residential plots, in addition to the cities of the Nile, the beach, the oasis, and the planned villages.

Karari locality was administratively divided, as the revolution belonged to the Omdurman district council until 1994, then it was modified and established Karari Governorate, then the revolution was annexed again to Omdurman in 2000, and in 2003 Karari locality became one of the seven localities of Khartoum state. The locality includes four main administrative units which are the Revolution Unit, the Karariunit, the Northern Countryside unit and the Al-Fateh unit. The unit of the revolution is located adjacent to Omdurman and ombeda locality from the southern and western sides and is distinguished as the nucleus of the urban sector of Karari locality, which was established at the end of the fifties of the last century, followed by extensions in subsequent housing plans in addition to the random expansion in the last two decades. (Local Information Center Karari).

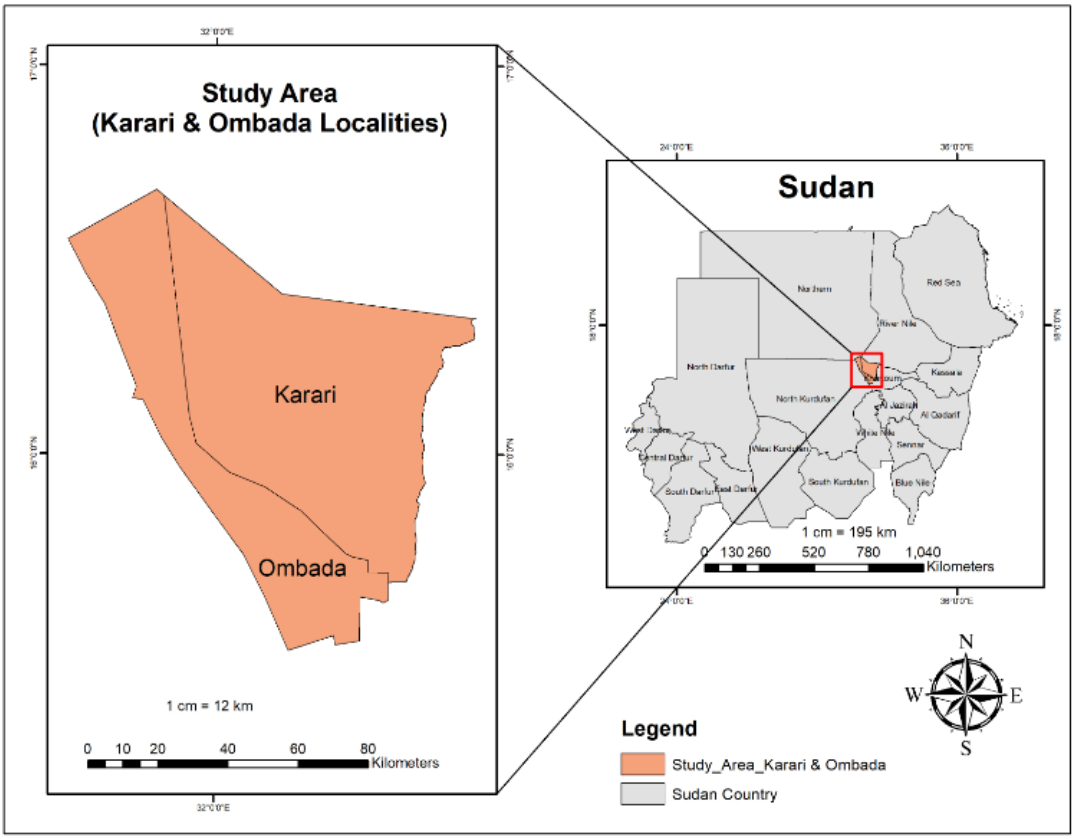


Figure 3.1. Location of study area

3. BUILDING GEODATABASE

In this section, the research studies how to build a geodatabase as well as how to manage and adjust it whenever needed. A geodatabase is a database designed to store, query, and manipulate geographic information and spatial data. The geodatabase design can be structured into two stages; the conceptual and logical stages. In the conceptual phase, the data requirements should be identified and characterized. Here, involved specialists, operators and managers have to work closely with each other to define which parameters and issues in emergency management are necessary. The result of this phase produces the main geodatabase datasets. In contrast, the logical phase presents data specifications, structure, relational properties, and rules. (English, M., 2008)

An ArcGIS geodatabase, therefore, is a collection of geographic datasets of various types held in a common file system folder, a Microsoft Access database, or a multiuser relational DBMS (such as Oracle, Microsoft SQL Server). The geodatabase is the native data structure for ArcGIS and is the primary data format used for editing and data management. While ArcGIS works with geographic information in numerous geographic information system (GIS) file formats, it is designed to work with and leverage the capabilities of the geodatabase. Geodatabases have a comprehensive information model for representing and managing geographic information.

This comprehensive information model is implemented as a series of tables holding feature classes, raster datasets, and attributes. In addition, advanced GIS data objects add GIS behavior; rules for managing spatial integrity; and tools for working with numerous spatial relationships of the core features, rasters, and attributes. It is also known as a spatial database. Within a spatial database, spatial data is treated as any other data type. Vector data can be stored as point, line or polygon data types, and may have an associated spatial reference system. A geodatabase record can use a geometry data type to represent the location of an object in the physical world and other standard database data types to store the object's associated attributes. (Bobbe, M., Kern, A., Khedar, Y., Batzdorfer, S., and Bestmann, U., 2017)

If one notices figure 3.2, it displays sample of geodatabase, it is having many feature classes and every layer have unique characteristics (point, line and polygon).

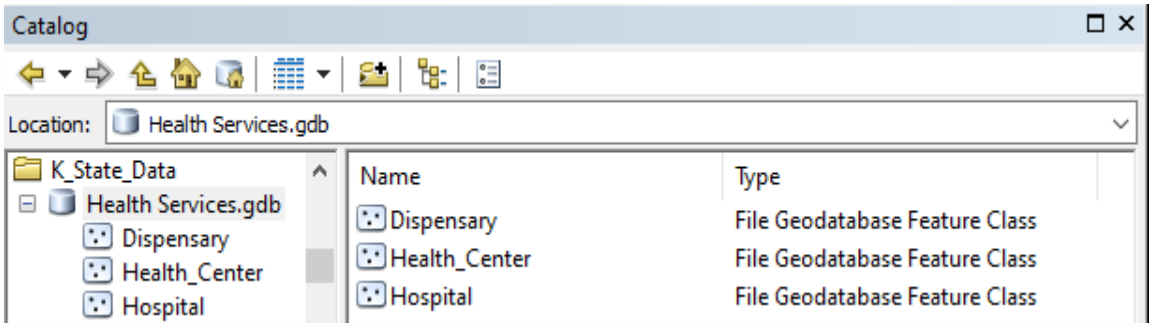


Figure 3.2. a sample geodatabase that was built for the Ministry of Health

Geographic data, which include both spatial and attribute data that describe geographic features. Whereas spatial data describe the location and shape of geographic features and their spatial relationships, attribute data describe the characteristics of spatial data. Geodatabase can store huge for all types of geospatial information and non-spatial information like:

- Vector model(Analogue map, digitizing …etc)
- Raster model (satellite image, aerial photo …etc)
- Reports, lists, tables, graphs

Spatial Data

Spatial data consists of points, lines, polygons or other geographic and geometric data primitives that we can map by location. It is possible to maintain spatial data as vector data or raster data. Each provides information connected to geographical locations. Vector data consist of sequential points or vertices to define a linear segment. It has an x coordinate and a y coordinate. Furthermore, raster data consists of a matrix of cells or pixels arranged into rows and columns. Each cell contains a value representing information

ATTRIBUTE DATA

Attribute data are descriptions or measurements of geographic features in a map. It refers to detailed data that combines with spatial data. Attribute data helps to obtain the meaningful information of a map. Every feature has characteristics that we can describe. For example, assume a building. It has a built year, the number of floors, etc. Those are attributes. Attributes are the facts we know, but not visible such as the built year. It can also represent the absence of a feature.

Stages of building the system for the Ministry of Health

Geospatial data systems go through several stages until they are built: Input data, Manipulation data, Analysis, Output User interface.

Input data

It is the procedure of encoding data into a computer-readable form and writing the data to the GIS data base. There are two types of data to be entered in a GIS - spatial (geographic location of features) and non-spatial (descriptive or numeric information about features). Data on health facilities were obtained and analyzed within GIS environment. Statistical data about population were gathered from the Central Bureau of Statistics which is responsible for conducting censuses and demographic surveys in Sudan. Population number in each zone of two localities was available and provided according to 2020 census. The spatial data-set was obtained from Khartoum State Ministry of Health & the Ministry of Physical Planning. Health facilities is a point layer which defines the latitude and longitude of health service locations. Other two layers, the first one in the form of polygon represent the administrative boundaries of two localities (Ombada and Karari) and the second in form of line represent road network.

The attribute data were aggregated and joined the spatial layer of district boundary. Khartoum State Ministry of Health is categories the health system depends on many criteria: Dispensary is a small outpatient health facility which contains a medical assistant who performs the most basic primary

healthcare services to rural communities, it is serves population of 5,000 to less than 10,000 citizens within 5 km^2 buffer zone, Healthcare center is a network of clinics staffed by group of general practitioners and nurses providing healthcare services to people in certain area. Typical services covered are (family practice and dental care, pediatric, women's care, waiting room, nutrition, small operations, pharmacy, optometry, laboratory testing, and children's immunizations), it is serves population of 10,000 to less than 20,000 citizens within 2 km^2 buffer zone, Hospital is a health care institution providing patient treatment with specialized medical and nursing staff and equipment moreover it contains emergency room ,intensive care unit and specialized clinics such as internal medicine , gynecology and obstetrics …etc ,where most of the cases are transferred to the hospital from healthcare centers or dispensaries as each hospital serves population of 100,000 to less than 250,000 citizens within 20 km^2 buffer zone . the total number of all health facilities across two localities was 220 with a total area size of 7,459 km. The total number of governmental hospitals are7, the total number of Healthcare Center is 177 and total number of Dispensary is 36.

Manipulation Data

A. The process data must be conformity with the system by converting it to a geographical database, and this stage was done by using the ArcGIS 10.3 software, where a single geo-database was created and all data were included after converting from different formats into the database, after that a map projection is made using the Universal Transverse Mercator (UTM), as the two localities (Ombada and Karari) are located in the Khartoum state in Zone 36 north of the equator.
B. Ensure that the previous manipulation is correct by placing the map on the modern satellite image in order to ensure that all the features match in the image with their real location.
C. Cartographic manipulation: A map is always a graphic representation at a certain level of detail, which is determined by the scale. Cartography, as the science and art of map making, function as an interpreter, translating real world phenomena (primary data) into correct, clear and understandable representations for our us. It is including map key, north arrow, map scale …etc can be added. We produced three maps layout represented of existing

Dispensary in figure no (3.3), existing Healthcare Center in figure no (3.4) and existing Hospital in figure no (3.5).

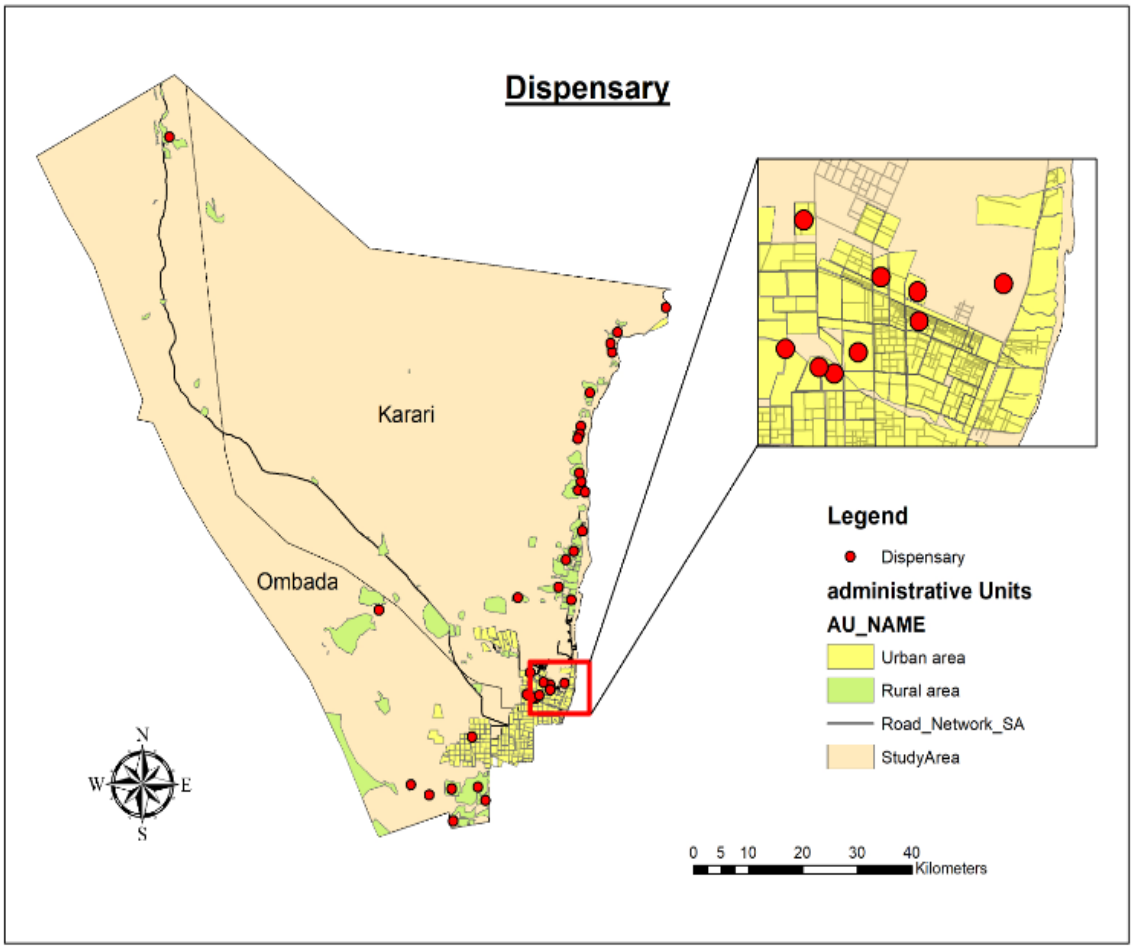


Figure 3.3. Location for exciting Dispensary

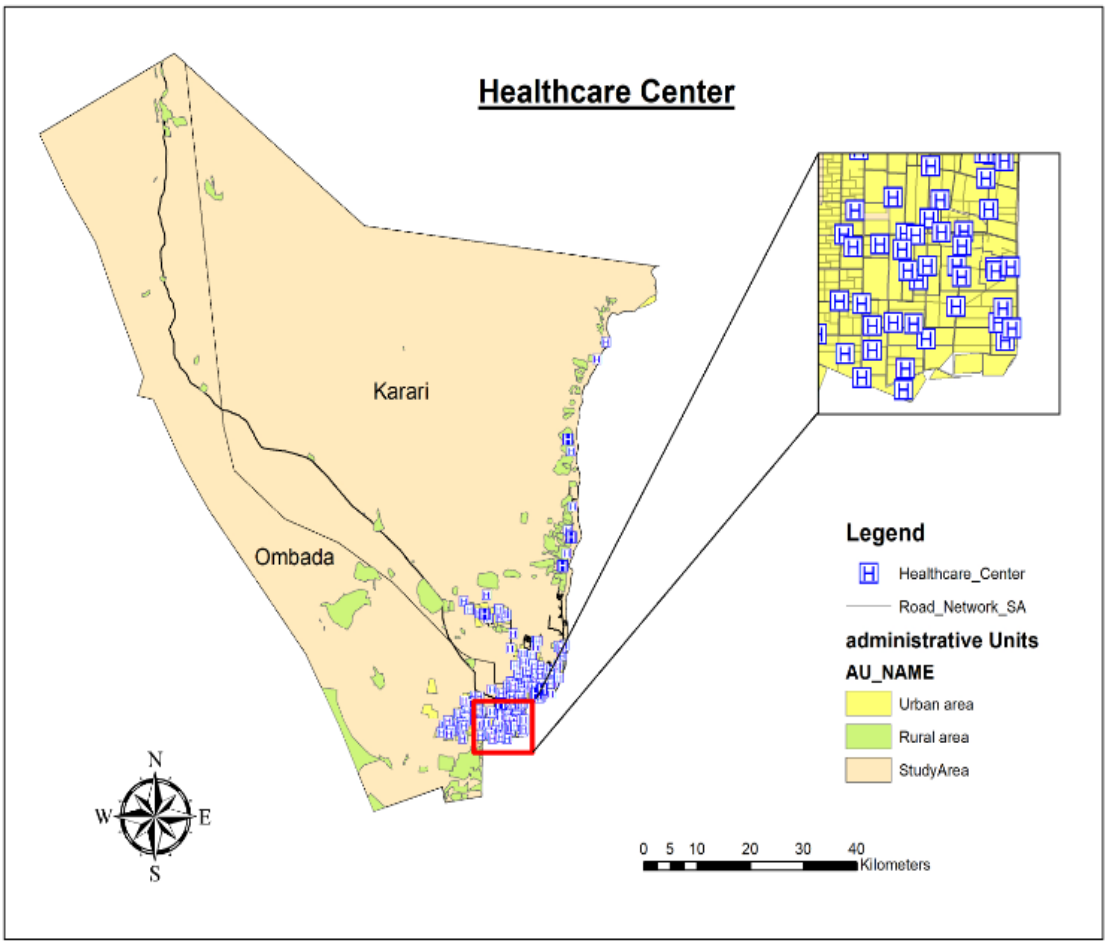


Figure 3.4. Location for exciting Healthcare Center

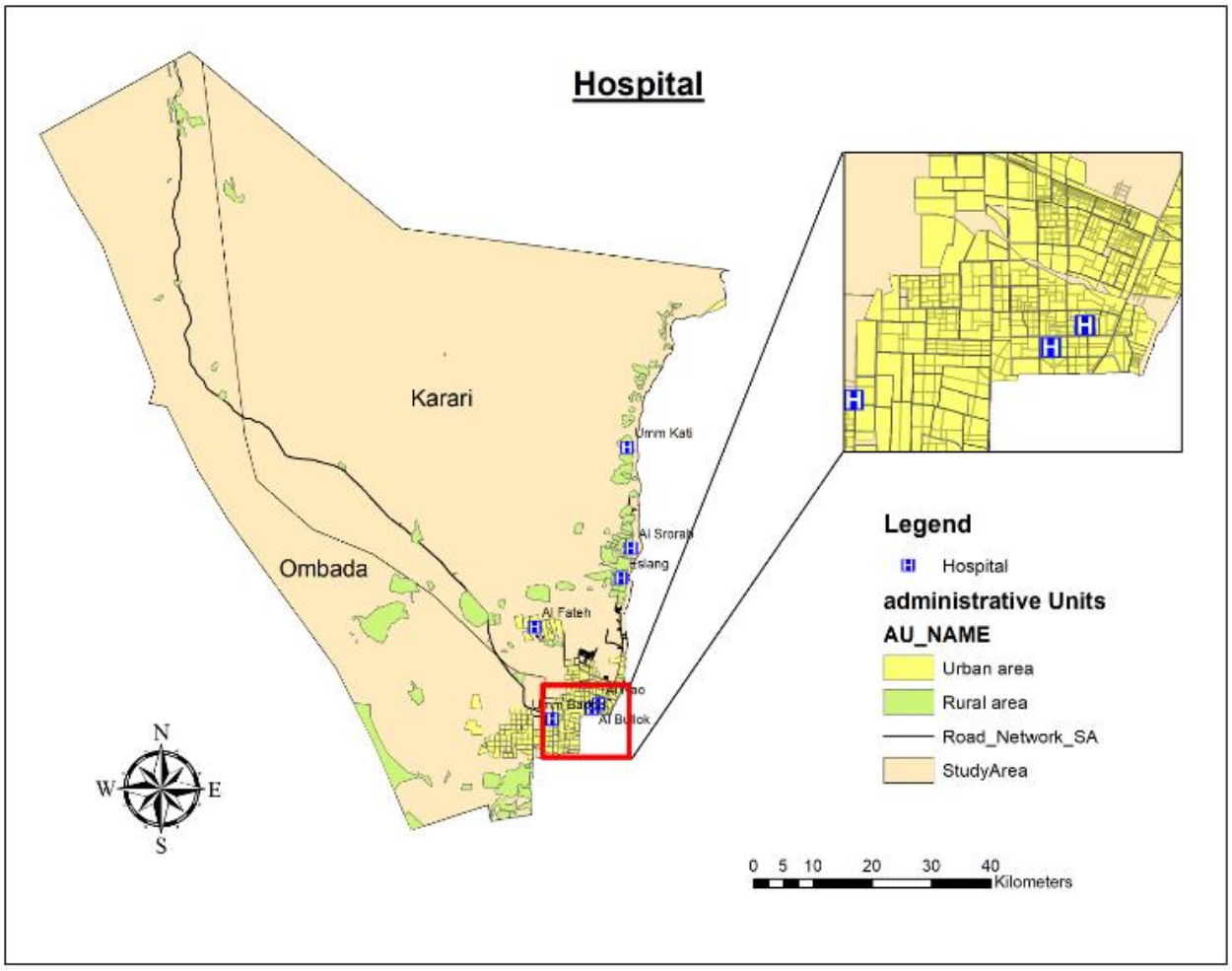


Figure 3.5. Location for exciting Hospital

Analysis

The term *analysis* refers to data manipulation and data querying. In the context of **spatial analysis**, the *analysis* focuses on the *statistical analysis* of patterns and underlying processes or more generally, spatial analysis addresses the question "what could have been the genesis of the observed spatial pattern?" It's an **exploratory process** whereby we attempt to quantify the observed pattern then explore the processes that may have generated the pattern. In detailing this analysis here, where we used a number of analyzes of the health system in the localities of

Ombada and Karari in the state of Khartoum representing in the following:

1. analyze by Population
2. analyze by Buffer
3. analyze by Average Nearest Neighbor

Output

The end result of many geographical processes can be better visualized or imagined by means of a map or a graph. Maps have great efficiency in preserving and communicating geographical information. Cartographer have used maps for thousands of years to illustrate spatial and geographic relationships, but GIS offers new and exciting ways to develop the art and science of cartography. The cartographic display can combine reports, three dimensional views, photographs, and other type such as multimedia. We display the example of output by displaying the maps model used in the health system of localities. In figure no (3.6)

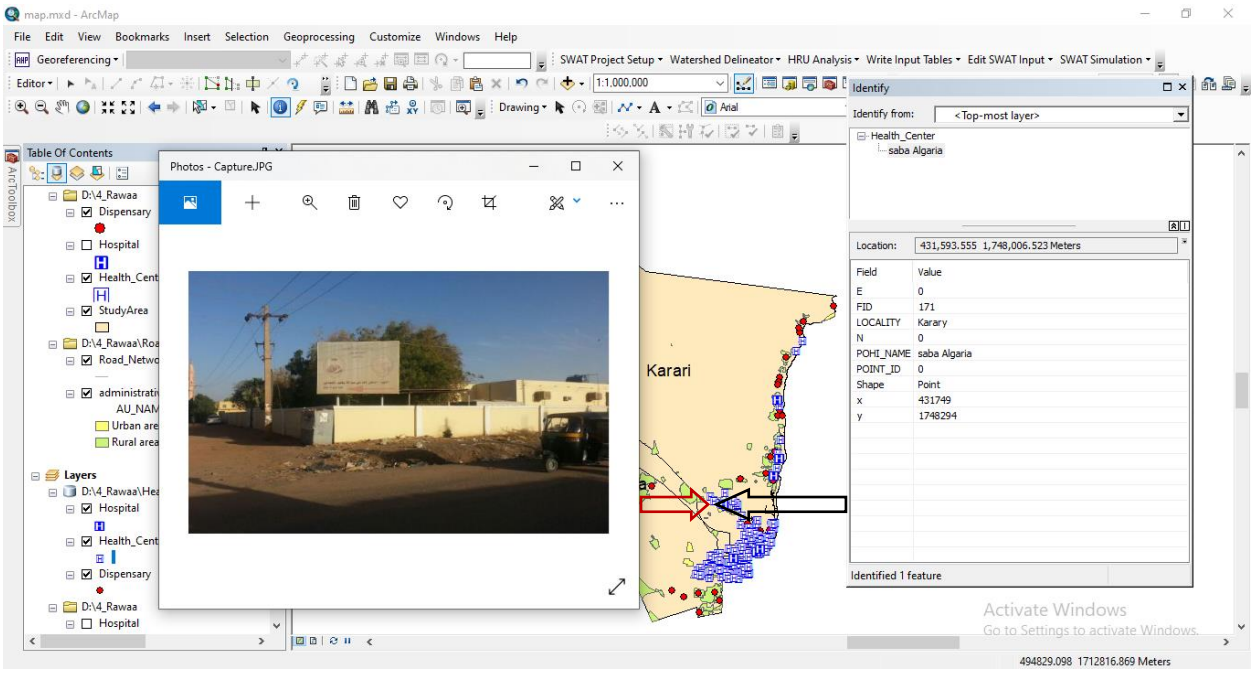


Figure 3.6. a layout for outputting data to the screen

User Interface

The GIS software has a slightly easy interface, but some users of the program may suffer from the complexity of some operations, so it was necessary to build a user interface that meets the user's

requests, as we used the programming language visual Basic (VB) to make an interface for the user to perform the various operations within the system. They are shown in figure no (3.7), figure no (3.8) and figure no (3.9).

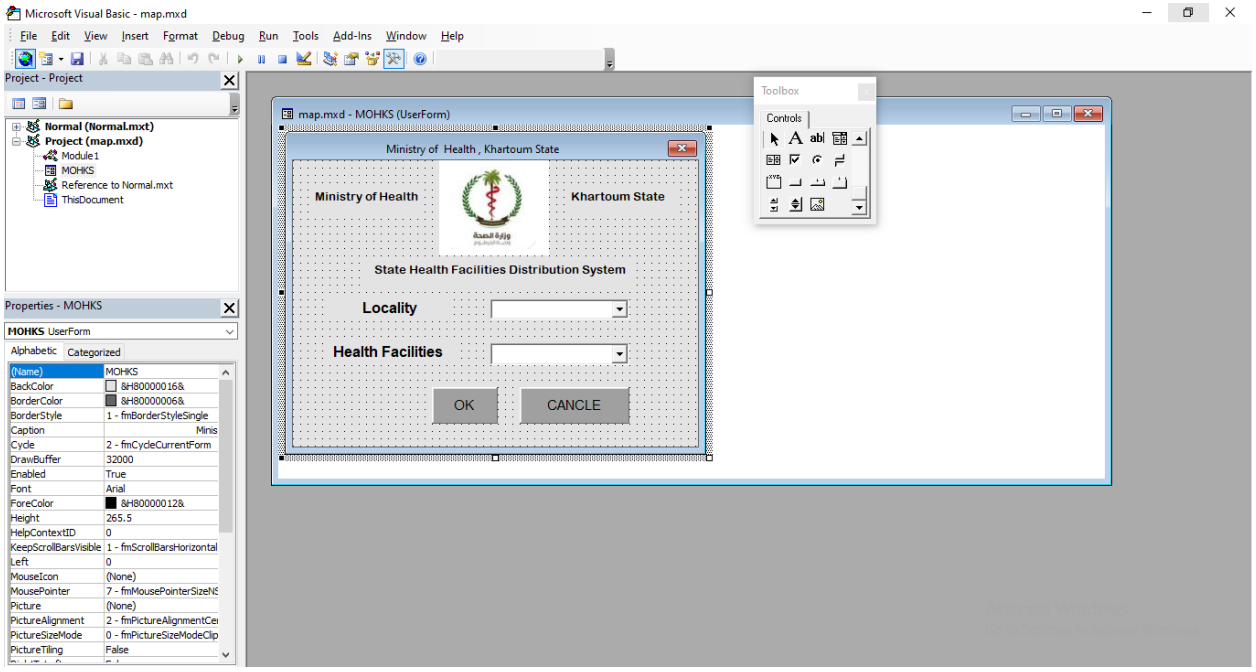


Figure 3.7. the stage of building a user interface for the system

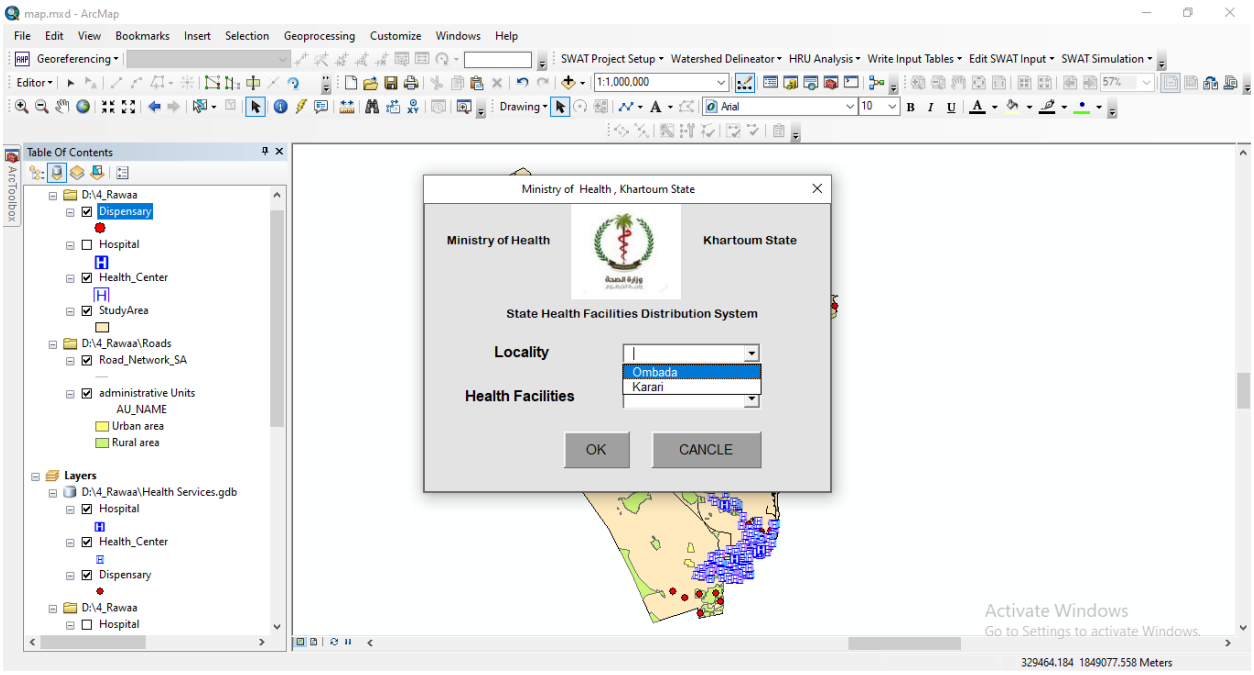


Figure 3.8. the main screen to enter the system by choosing the first option

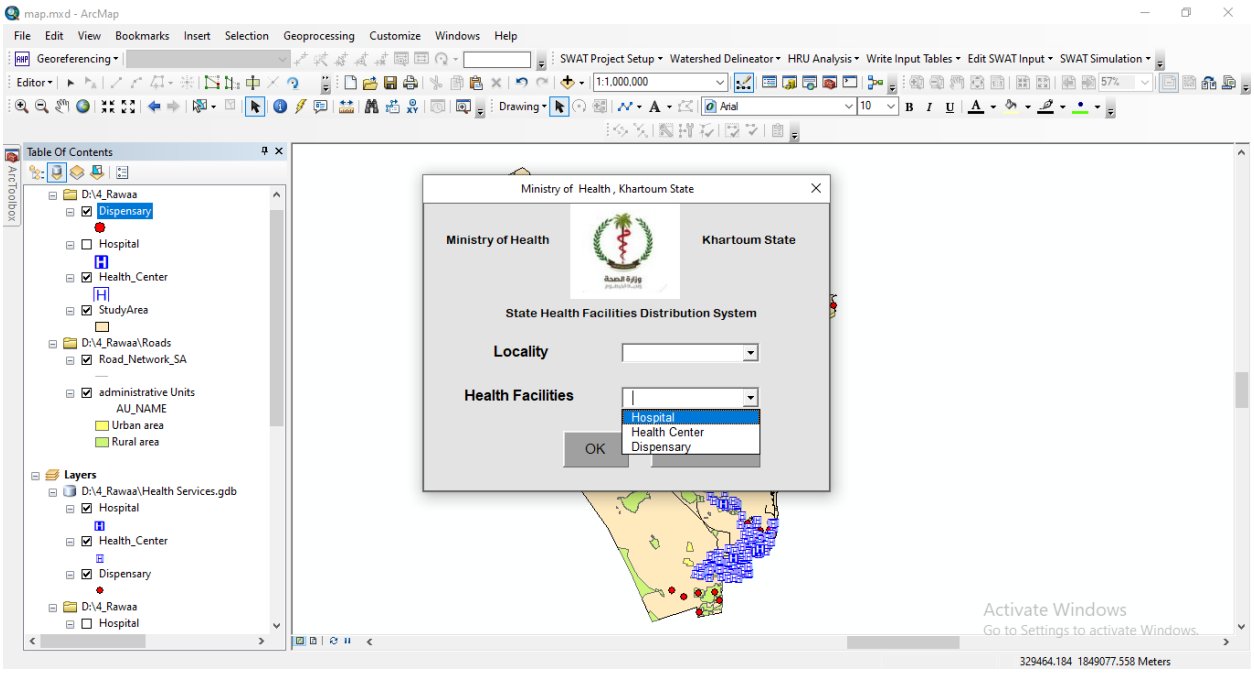


Figure 3.9. the main screen to enter the system by choosing the second option

4. RESULT AND DISCUSSION: THE METHODS USED FOR ANALYSIS

Analyzing geographic information is at the core of the work of geographic information systems (GIS); this is mainly because of its tremendous potential in analyzing complex problems, and at the same time, it has the ability to present the results and indicators in various forms such as maps, graphs, tables, etc. In this research, three types of analysis have been used to ensure the correct distribution.

Analysis by population

One of the most popular analyses in the process of providing services is the population analysis, as it is done by using the population density of the study area and the demographic census to know the current number of population and therefore, through the standards of the Ministry of Health, it is possible to estimate and calculate weather was the number presented enough or needs to be reduced or increased moreover to decide about the kinds of services to be offered to the study area.

Population analysis for Dispensary

From pervious table No (4.1) we make analysis according to the Ministry of Health criteria is serves

Dispensary							
Study Area	Population	Criteria of Population	Existing	Demand	shortage	Buffer Zone	current situation
Two localities (Ombada& Karari)	244,385	5,000 to less than 10,000 average 7,500	36	49	13	5 km^2	6,788

population of (5,000 to less than 10,000 citizens within 2 km^2 buffer zone) an average of criteria was taken with an average of 7,500 people. We find the number of Dispensary available at the study area amounted to 36, while 49 are supposed to be provided according to the criteria of population, there is a shortage of 13 Dispensaries that must be provided and distributed to the rural area, and the current situation shows that any dispensary served 6,788 people.

Healthcare centre							
Study Area	Population	Criteria Population	Existing	Demand	shortage	Buffer Zone	Exist situation
Two localities (Ombada& Karari)	2,286,456	10,000 to less than 20,000 average 15,000	177	229	52	2 km^2	12,918

Population analysis for Healthcare Center

Table No (4.2) Healthcare Centre

From pervious table No (4.2) we make analysis according to the Ministry of Health criteria is serves population of (10,000 to less than 20,000 citizens within 2 km^2 buffer zone) an average of criteria was taken with an average of 15,000 people. We find the number of Healthcare Centre

Table No (4.3) Hospital

available at the study area amounted to 177, while 229 are supposed to be provided according to the criteria of population, there is a shortage of 52Healthcare centers that must be provided and distributed to the urban area, and the current situation shows that any Healthcare center served 12,918 people.

Population analysis for Hospital

From pervious table No (4.3) we make analysis according to the Ministry of Health criteria is serves population of (100,000 to less than 250,000 citizens within 20km^2 buffer zone) an average of

Hospital							
Study Area	Population	Criteria Population	Existing	Demand	shortage	Buffer Zone	Exist situation
Two localities (Ombada& Karari)	2,736,295	100,000 to less than 250,000 average 175,000	7	27	20	20 km^2	390,899

criteria was taken with an average of 15,000 people. We find the number of Hospital available at the study area amounted to 7, while 20 are supposed to be provided according to the criteria of population, there is a shortage of 20 Hospital that must be provided and distributed to whole area, and the current situation shows that any Hospital served 390,899 people.

Analysis by Buffer

This method of spatial analysis depends on the study of the distribution of health services in the study area and on the Ministry of Health criteria for the covered service area (Buffer) to give the answer: are the services covers the area? Or is there a deficiency in the distribution, whether it's negative or positive? Show in figure (4.1)

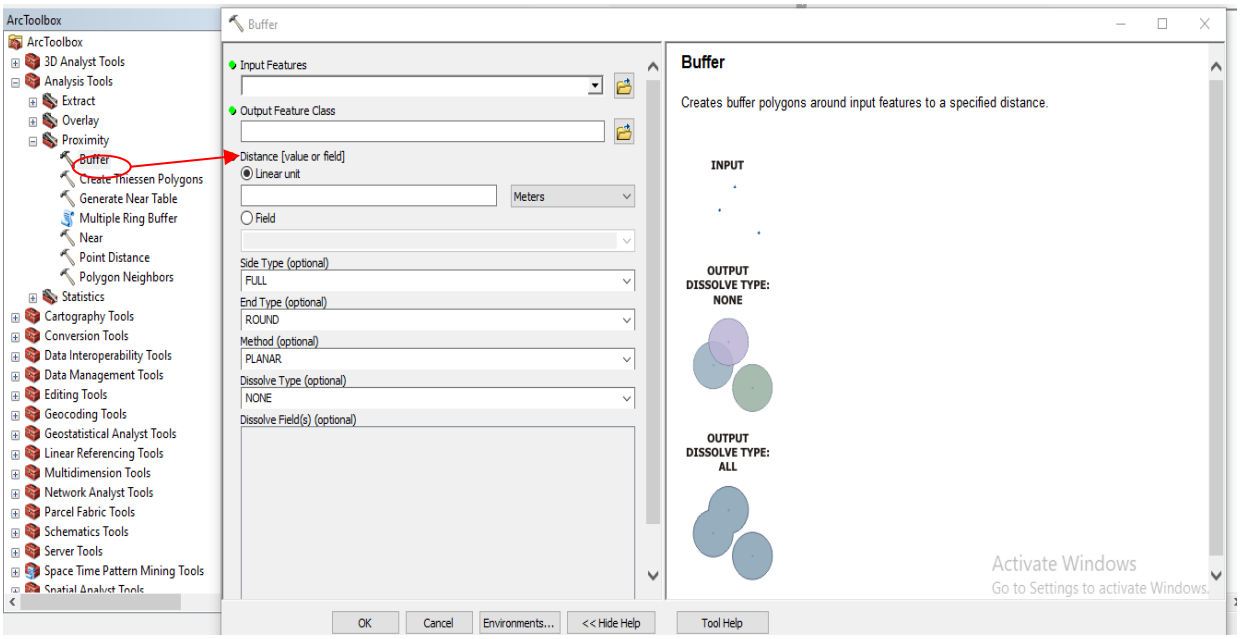


Figure no 4.1. Buffer tool

Analysis by Buffer Tool for Dispensary

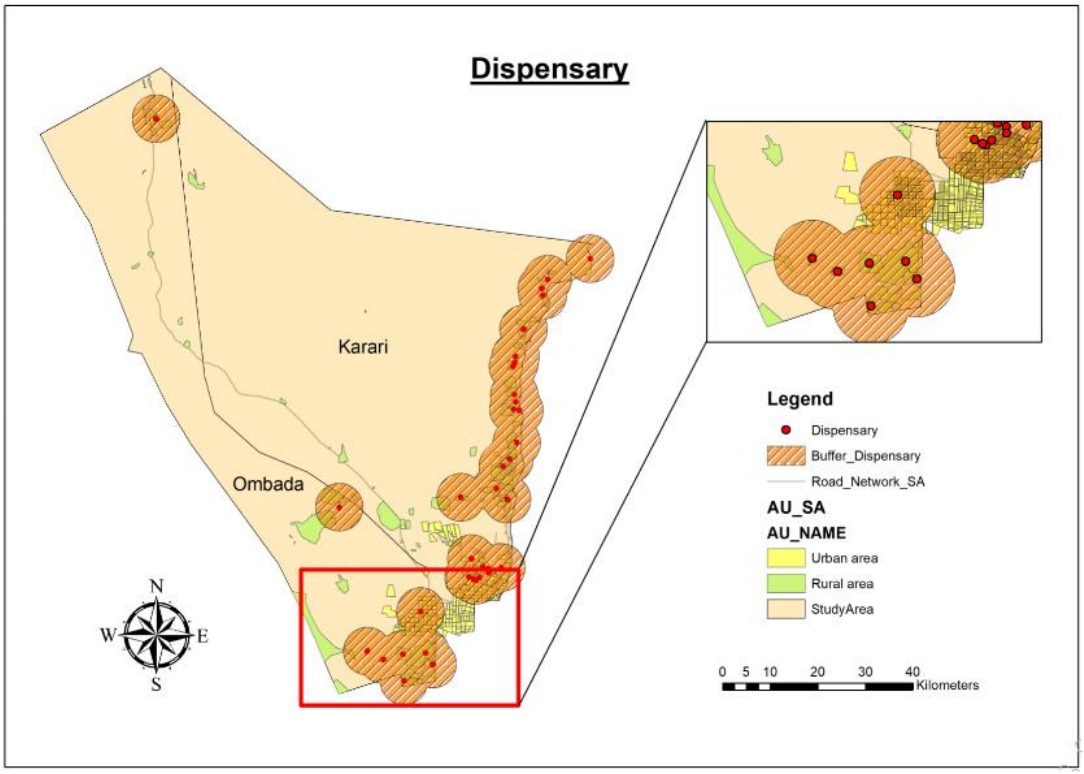


Figure 4.2. Buffer zone for Dispensary

By referring to the figure no (4.2), it is possible to notice to existence of an intense dispensary cluster in rural areas, although to it is not available in other rural areas and on the other hand a good number of dispensaries found in the urban areas.

Analysis by Buffer Tool for Healthcare Centre

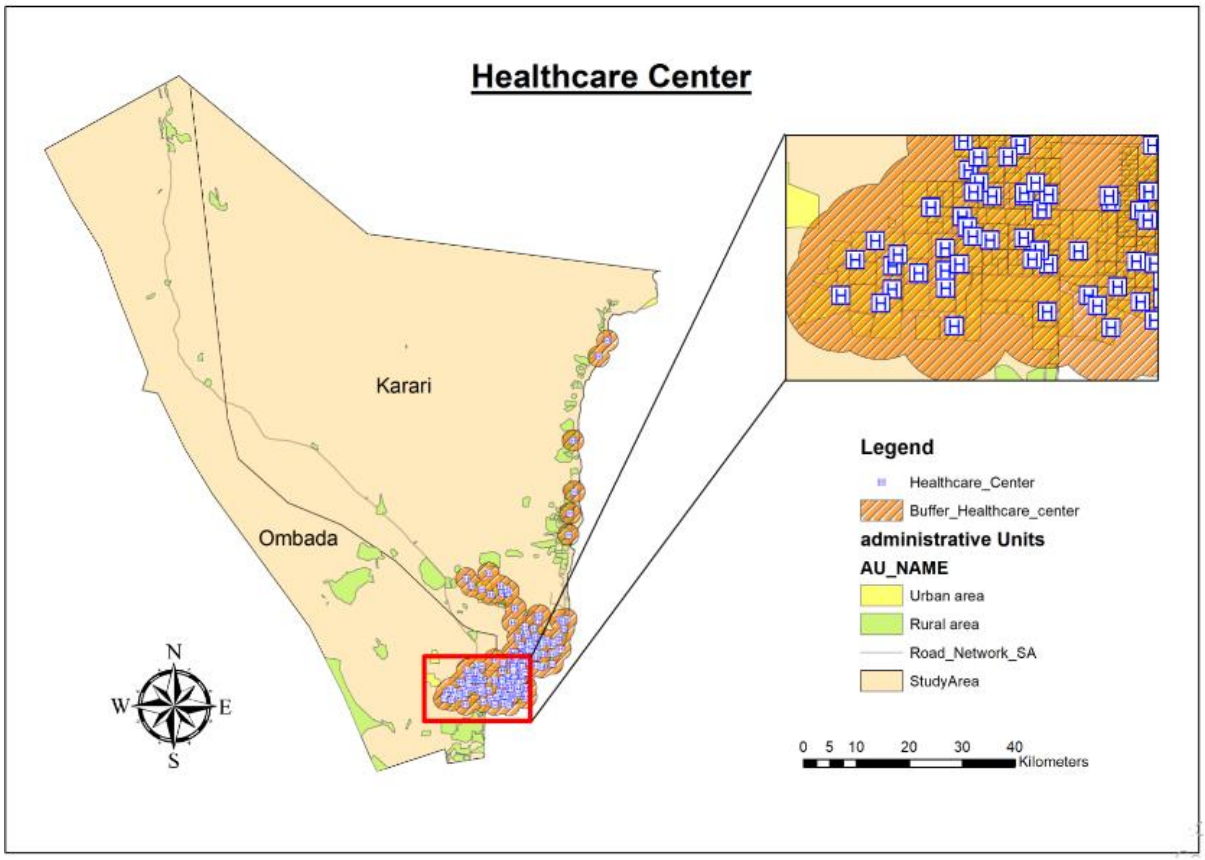


Figure 4.3. Buffer zone for Healthcare Centre

Referring to the figure no (4.3) it is obvious that the coverage of healthcare centers is more intense in urban areas despite of the availability of dispensaries there are some healthcare centers in rural area.

Analysis by Buffer Tool for Hospital

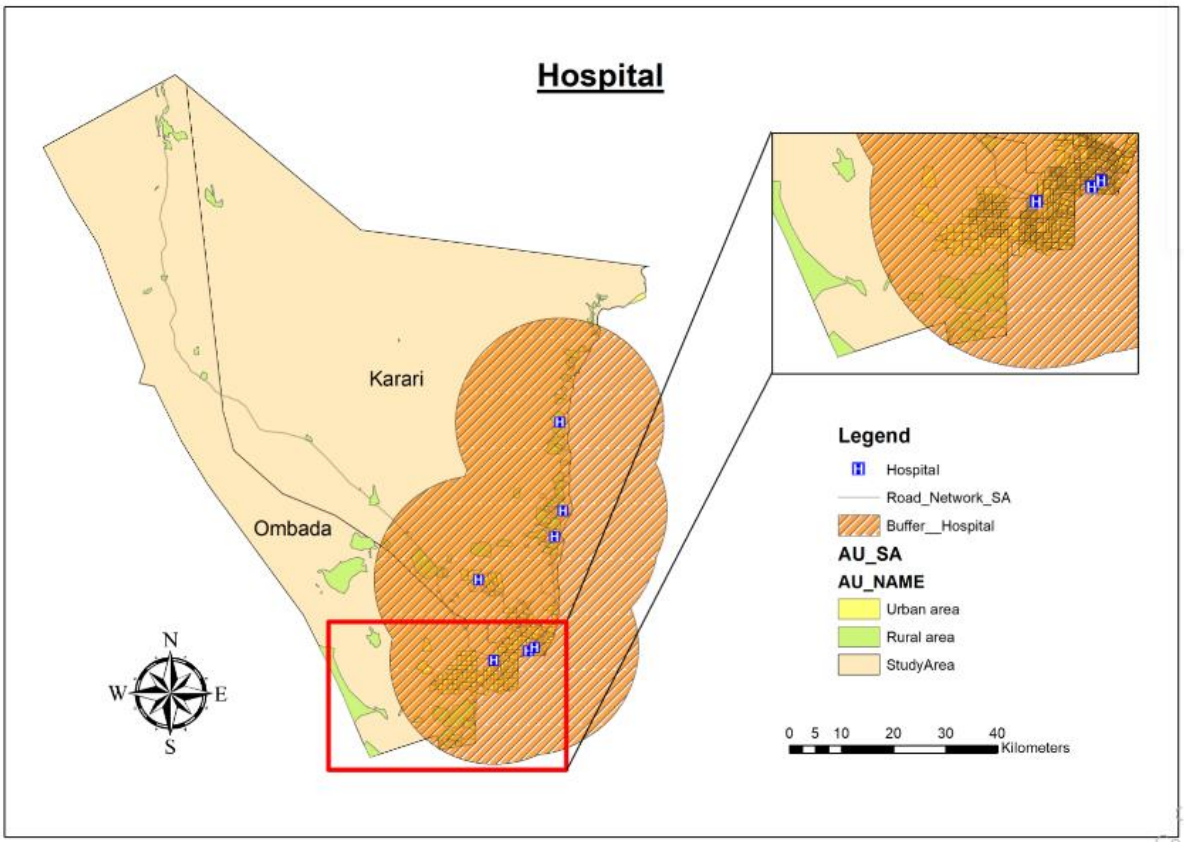


Figure 4.4. Buffer zone for Hospital

Referring to the figure no (4.4), we find that we have only seven hospitals located near each other. Although there are areas in the northern part of the study area that do not have any hospitals.

Analysis by Average Nearest Neighbor

This method is very common and widespread among most planners because of its excellent results in the analysis process, especially the complex ones ,where neighbour link or nearest neighbour methods can be used to analyze spatial distribution pattern for the health sites in the localities and the city , which considered one of the most important method in analyzing spatial pattern because in the one hand it includes in the analysis all health sites in the study area and on the other hand it

depends on the separation distances between each site and the others where it helps in identifying distribution pattern, and to calculate the value of neighbour link average nearest neighbour tool has been used as in the diagraph.

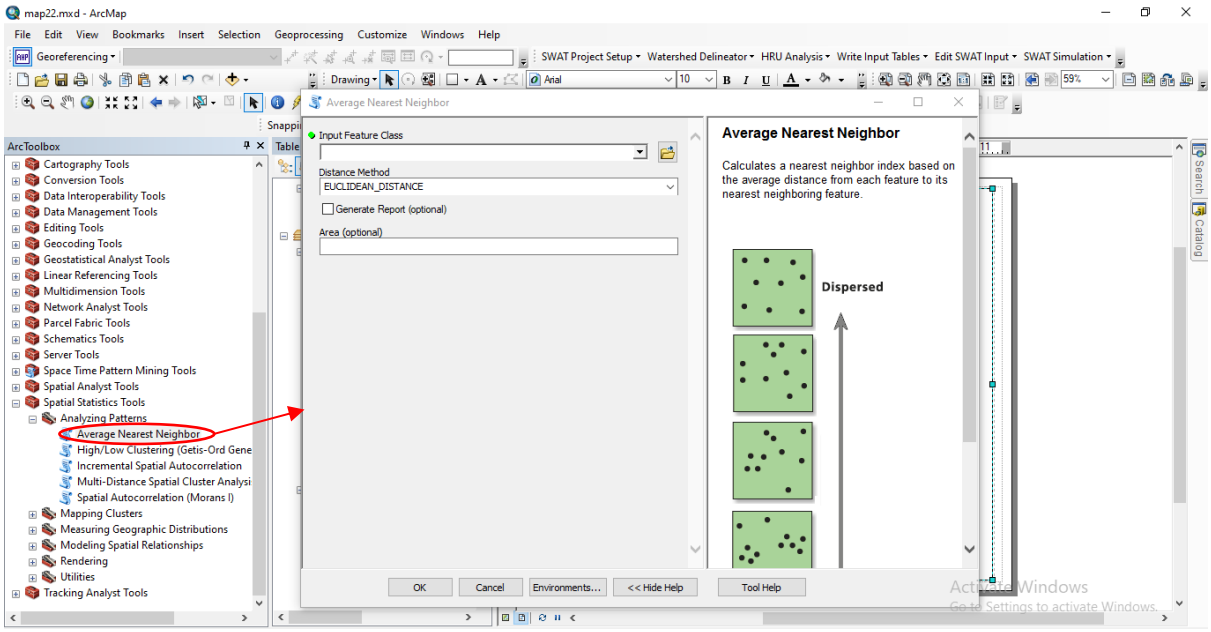


Figure 4.5. Average Nearest Neighbour tool

The Average Nearest Neighbour tool measures the distance between each feature centroid and its nearest neighbour's centroid location. It then averages all these nearest neighbour distances. If the average distance is less than the average for a hypothetical random distribution, the distribution of the features being analyzed is considered clustered. If the average distance is greater than a hypothetical random distribution, the features are considered dispersed. The average nearest neighbour ratio is calculated as the observed average distance divided by the expected average distance (with expected average distance being based on a hypothetical random distribution with the same number of features covering the same total area).The equation that was used in this analysis:

The Average Nearest Neighbour Ratio Given as

$$ANN = \frac{\overline{D}_O}{\overline{D}_E} \tag{1}$$

Where $\overline{D}_O$ is the observed mean distance between each feature and its nearest neighbour:

$$\overline{D}_O = \frac{\sum_{i=1}^{n} d_i}{n} \tag{2}$$

And$\overline{D}_E$is the expected mean distance for the features given in a random pattern:

$$\overline{D}_E = \frac{0.5}{\sqrt{n/A}} \tag{3}$$

In the above equations, d_i equals the distance between feature i and it is nearest neighboring feature. nCorresponds to the total number of features, and A is the area of a minimum enclosing rectangle around all features, or it's a user- specified area value. (https:// spatial-statistics-toolbox/h-how-average-nearest-neighbor-distance-spatial-st.htm)

The Average Nearest Neighbour z-score for the Statistic is Calculated as

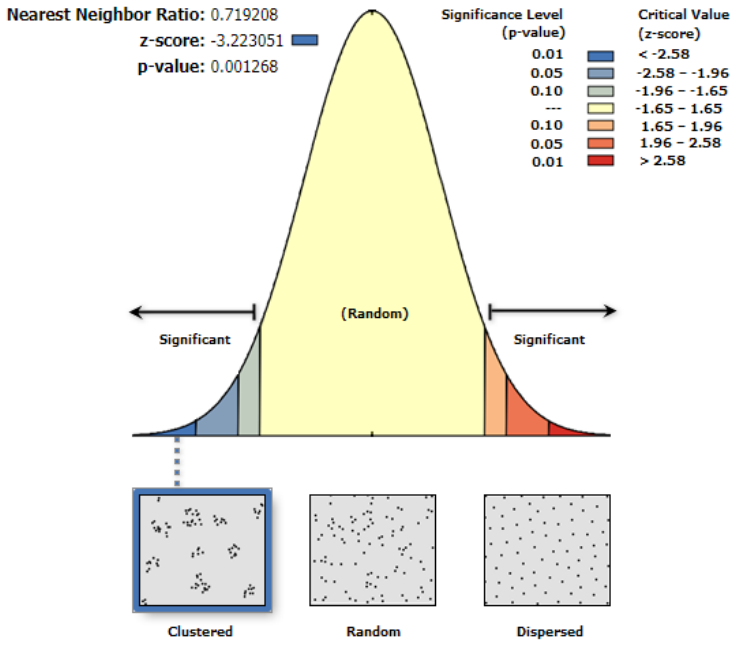
$$z = \frac{\overline{D}_O - \overline{D}_E}{SE} \tag{4}$$

Where:

$$SE = \frac{0.26136}{\sqrt{n^2/A}} \tag{5}$$

Analysis by Average Nearest Neighbor for Dispensary

Average Nearest Neighbor Summary



Given the z-score of -3.22305052703, there is a less than 1% likelihood that this clustered pattern could be the result of random chance.

Average Nearest Neighbor Summary

Observed Mean Distance:	5817.1537 Meters
Expected Mean Distance:	8088.2791 Meters
Nearest Neighbor Ratio:	0.719208
z-score:	-3.223051
p-value:	0.001268

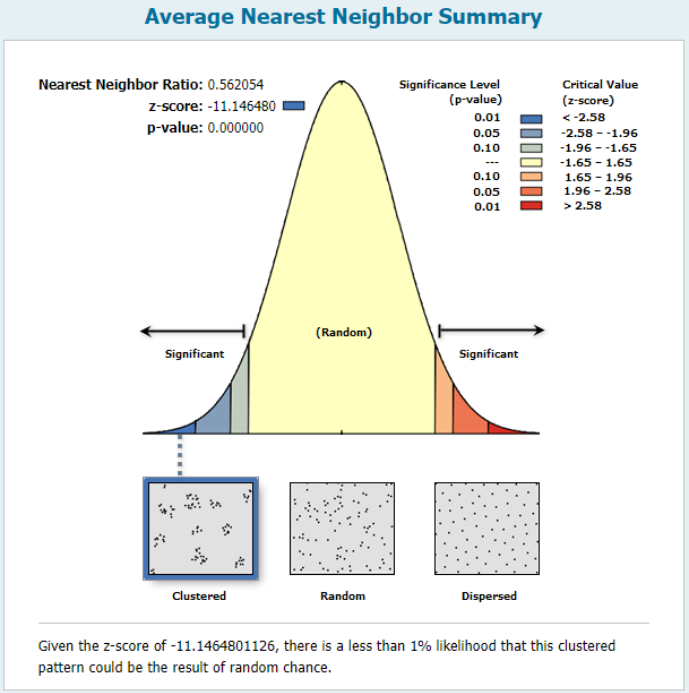
Dataset Information

Input Feature Class:	Dispensary
Distance Method:	EUCLIDEAN
Study Area:	9420517218.300762
Selection Set:	False

Figure 4.6. Average Nearest Neighbour tool used for Dispensary

From figure no (4.6) show z-score = -3.223051, there is a less than 1% likelihood that this clustered pattern could be the result of random chance. The spatial pattern of dispensary is clustered this confirms the validity of the previous analysis in figure no (4.2).

Analysis by Average Nearest Neighbour for Healthcare Centre



Average Nearest Neighbor Summary

Observed Mean Distance:	803.2266 Meters
Expected Mean Distance:	1429.0907 Meters
Nearest Neighbor Ratio:	0.562054
z-score:	-11.146480
p-value:	0.000000

Dataset Information

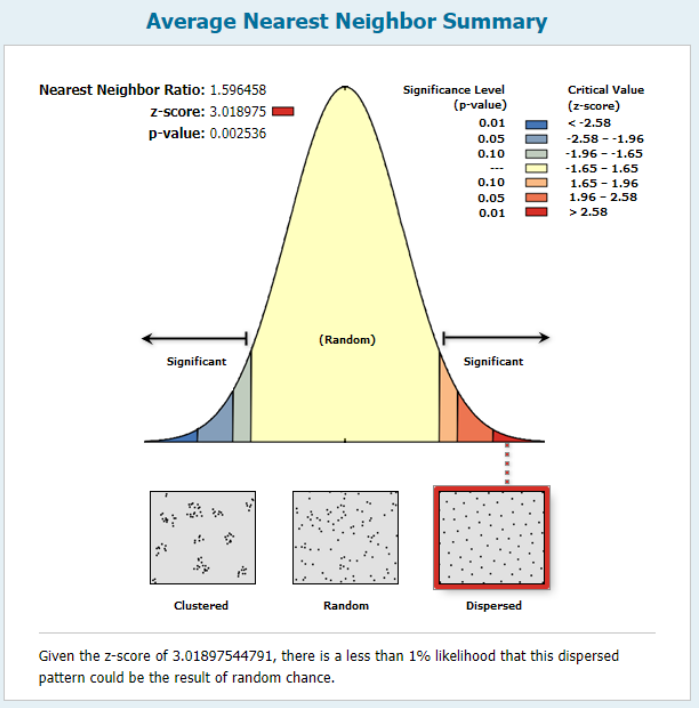
Input Feature Class:	Healthcare_Center
Distance Method:	EUCLIDEAN
Study Area:	1445948574.244824
Selection Set:	False

Figure 4.7. Average Nearest Neighbour tool used for Healthcare Centre

From figure no (4.7) show z-score of -11.146480, there is a less than 1% likelihood that this

clustered pattern could be the result of random chance. The spatial pattern of healthcare centre is clustered this confirms the validity of the previous analysis in figure no (4.3)

Analysis by Average Nearest Neighbour for Hospital



Average Nearest Neighbor Summary

Observed Mean Distance:	7548.1295 Meters
Expected Mean Distance:	4728.0484 Meters
Nearest Neighbor Ratio:	1.596458
z-score:	3.018975
p-value:	0.002536

Dataset Information

Input Feature Class:	Hospital
Distance Method:	EUCLIDEAN
Study Area:	625924365.089713
Selection Set:	False

Figure 4.8. Average Nearest Neighbour tool used for Hospital

From figure no (4.9) show z-score of 3.018975, there is a less than 1% likelihood that this dispersed pattern could be the result of random chance. The spatial pattern of hospitals is widely separated. The results of the above analysis indicate that the focus has been on the availability of health services in urban areas more than in rural areas. We find that the existing dispensaries and healthcare centers are considered acceptable according to the Ministry of Health criteria. But

preferable to build 13 dispensaries and 52 health centers, according of the Ministry of Health criteria. In order for the service to be received comfortably for citizens and to avoid the presence of crowding. While we find the existing hospitals that are unacceptable according to the Ministry of Health criteria. There is a need to build 20 hospitals in order to cover the rest of the region and enable citizens in other regions to obtain health services because the hospital is considered the most comprehensive in providing health services to treat patients with specialized medical and nursing staff and equipment, and it also contains an emergency room, an intensive care unit, and specialized clinics such as internal medicine, gynecology and obstetrics ... etc., where most cases are transferred to a hospital from health care centers or dispensaries.

5. CONCLUSION AND RECOMMENDATIONS

The advancement of governmental health facilities plays a necessary role in ensuring health delivery and well-being of community. Therefore, providing health service based on population location is essential and simply a matter of social policy. Likewise, equity of health access and provision within urban areas and rural areas require measuring several factors, such as availability, quality, travel, and distance from provider to population.

Healthcare planning is an importance and challenging field. Nowadays, health's planners have many tasks to cover to assure that health service is provided at the best location by using GIS. While GIS have big potential to integrate information from different sources and the ability to visually assess the locations of objects on the Earth's surface, rather than trying to interpret numbers on spreadsheets, is a key element leading to the use of a GIS. By integrating GIS into decision making, government stands the chance of making their health care facilities more functional and accessible to the populace.

Based from the results of the study, the following recommendations are proposed:

- the dispensaries located in urban areas (Karari(Al haara 73,Al haara 48,Al haara 55, Al haara 50,Al haara 62,Al haara 16,Al haara 48,Al haara 34,Al haara 41-B),Ombada(block 11)) must be moved to rural areas for they are needed and because they are intended to serve rural areas only based on the Ministry of Health criteria, and health centers located in

rural areas (Al reef al shimaly) must be removed because they are concerned with serving urban areas only based on the Ministry of Health criteria.

- There is a need to build 20 hospitals in order to cover the rest of the region and enable citizens in other regions to obtain health services because the hospital is considered the most comprehensive in providing health services.

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