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DEVELOPMENT OF LOCAL HEALTH CARE PLANNING AND DEMANDING IN SAUDI ARABIA BY USING GIS APPLICATIONS

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ABSTRACT

The purpose and the goal of the paper is to show how Geographical Information Systems (GIS) can be used to support health planning and demanding on a micro-scale and explore the possibilities of using GIS for health care services in hospitals at Saudi Arabia sub_areas. GIS as a computer system that stores and links non-graphic attributes or geographically referenced data with graphic map features to allow a wide rang of information processing and display operations, as well as map production, analysis, and modeling. GIS has several useful functions and tools that can be used in health planning field.

GIS spatial planning support tools have an important advantage; changing the valuation criteria to visually illustrate and depict the implications of different spatial decisions and alternatives is convenient. The capabilities needed for decision making readily available in a single system make GIS a great tool for integrating in planning processes. The first part of this paper explain the issues that affect a local health care planning and monitoring of catchment area and facilities management. Each one of these issues is covered using several GIS functions including network analysis and spatial data analysis.

The second part defines GIS and its possible application in the health care field. In this section, the relevant GIS functions have also been explained. In response, alternative sources were used, such as Google Earth, printed maps and information gathered on the ground by GPS. With these, it was possible to implement a methodology grounded in knowledge of the factors that influenced the health of the population. The third part of this paper discusses the created and implemented GIS application models, which is made for a local health care centre in Makkahh Al-Mokaramah region and Taif city in Saudi Arabia. All the produced models can be applied in any private or public hospital in Makkahh region and Taif city.

They can be used to build a spatial decision making support system for hospitals in Taif region and serves five local health services neighborhoods named as Tarabah, Al-Khurma, Rania, Zulam and Al-Moya. The ability of GIS to combine different entities based on their common geographic occurrence makes it a very valuable tool in epidemiological research, disease surveillance and monitoring. Some recent applications of GIS include vector borne diseases, water borne diseases, environmental health and modeling exposure to electromagnetic fields. Also GIS is highly relevant to meet the demands of outbreak investigation and response, where prompt location of cases, rapid communication of information, and quick mapping of the epidemic's dynamics are vital.

In this paper; the former is used to produce drive-time hospital service area and the route is applied at the selected hospital to calculate the size of its served demand. Finally; in this work, three sets of GIS models have been produced. These are catchment area; patient profile and patient distribution; and patient flows models. So, the output of creating and implementing a GIS models are produced to help a local health planners in their health care decision making output.

KEYWORDS: GIS, Health Planners, Network Analysis, Hospital Served Demand, Spatial Data

INTRODUCTION

Health Care Planning and GIS are two relevant fields that depend upon spatial data. Health care facilities at any region can be divided into two main types that are known as primary health centers and hospitals. Location of health facilities, patient distribution and characteristics are examples of spatial data analysis that are dealt with during local health planning. Local health planners use such data to monitor and evaluate health services on local areas. Such tasks can be better made using different GIS functions and models. Health authorities have always aimed to provide health care for all residents using a fair access policy that is characterized as providing the right service at the right time in the right place [1].

This paper outlines the possibilities of using GIS in local health planning. A review of GIS functions that are more relevant to health care system is covered. In order to define more the usefulness of these functions, a local health service centre in Taif city was selected. This centre is selected as a case study to show how GIS can help local health planners and support their decisions. In this work, three types of GIS models are created.

These are centers catchment areas, demand profile; and patient flows. The GIS technique that is used in this application can be applied to other local health centers in Taif City and by doing so, more effective local health planning can be achieved. Local health authorities such as health centers in Saudi Arabia or GPs in the UK are the key players of health planning on a micro scale [2].

The power of GIS lies in its ability to 1) integrate and display the spatial and other kind of information within a single system-offering a consistent frame work, 2) allows for manipulating and displaying geographical knowledge in new and exciting ways by putting maps and other spatial information into digital form, 3) makes connections between activities based on geographic proximity, 4) allows for access to administrative records [31].

They carry out several functions together from the core of local health planning. These functions include monitoring of patient lists, monitoring of catchment areas, assessment of health needs and facilities management. These functions can also be seen in the form of a checklist which include: (a) Where do their existing patients come from (by age, sex and specialty), (b) What is the Potential for increasing the workload by attracting patients currently referred elsewhere, (c) What are the implications of proposed contracts on the future viability of units and specialties within the organization, and(d) Who are their main competitors? [2, 8, 20].

Ideally, every local health authority should always find answers to these questions because by doing so, better health planning will surely be achieved. Spatial epidemiology is another important subject that researchers and local planners investigate on the scale of health centers.

Defining the location of health incidences, and studying the relationship between such incidences and the surrounding environment are all important issues in any epidemiology study. In order to perform the above tasks, health centers usually collect and store large sets of data such as child immunization data, communicable diseases, centers performance, socio-economic data, physical environmental data etc.

All of these data have clear spatial references. This means that the use of Geographical Information Systems (GIS) is of great value to health planners. GIS is a very useful tool for handling spatial data since it has several functions for capturing, editing, manipulating and modeling spatial data. The most important step before using GIS is that such data must be geo-referenced, that is, they must have a known grid reference for the location of the data. The following sections will discuss how health planners have applied GIS in handling their relevant data [21-25].

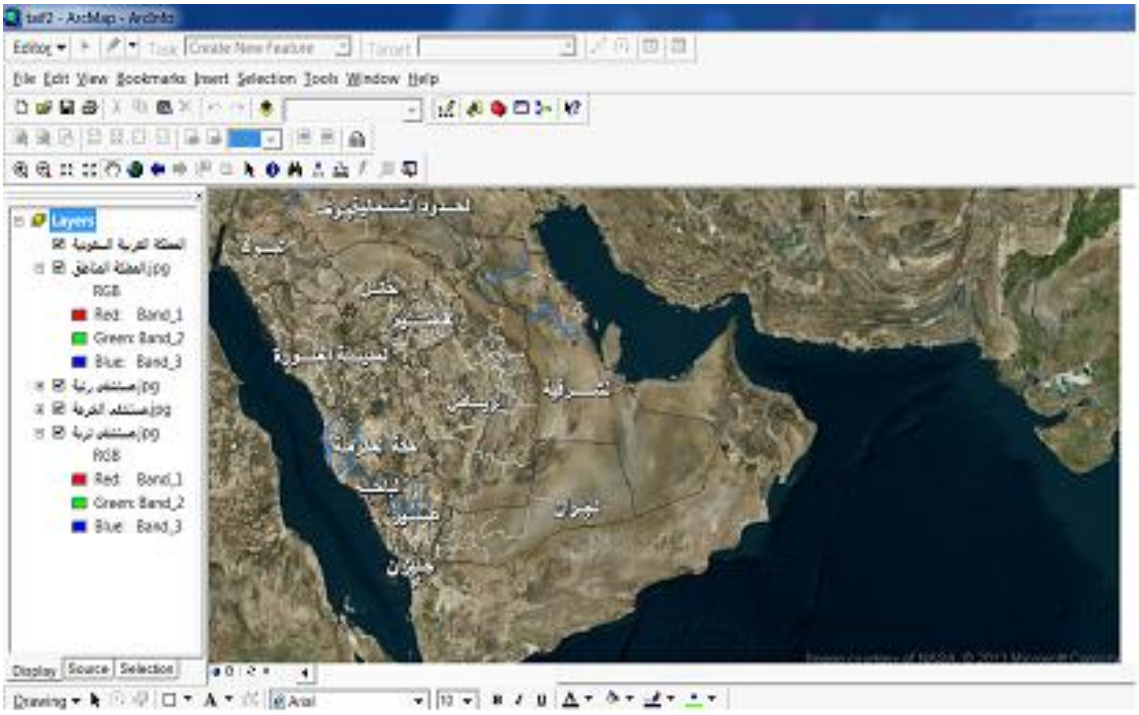

Figure 1: Health Care Centers and Hospitals in Saudi Arabia

Health Care Planning in Saudi Arabia

Health care planning system in Saudi Arabia has different agencies that play important roles in providing health care to residents. These agencies are The Ministry of Health, The National Guard, The Ministry of Defense and Aviation, and The Ministry of Interior [3]. In addition to these agencies there are specialist hospitals in Saudi Arabia that provide health care to specialist health cases. These agencies provide health care services on the basis of exclusive free health care to all citizens. In addition, the private sector in Saudi Arabia plays an increasingly significant role in the Kingdom and coordinates with the referral network and the regulatory requirements of health sector as a whole [4]. The Ministry of health in Saudi Arabia has seen that the primary objective of both the public and private health sector is to improve the health conditions of all citizens through the provision of comprehensive preventive and curative health services throughout the Kingdom, with particular emphasis on equitable and efficient primary health care (ibid). In order to achieve this objective, The Ministry of Health have identified long term objectives to be accomplished in the future including (a) the completion of all preventive and primary health care facilities, and the full implementation of the referral system for the optimal provision of preventive and curative health services, (b) the development of a health information system necessary for efficient, effective health care delivery, and (c) further development of national health manpower through programmers which raise productivity and improve performance, and which provide the specialization needed to maintain a high level of health services [5].

Saudi Arabia is divided into eleven health regions each is headed by a regional health directorate. Most of the planning and decision-making output has been centralized in Riyadh, which is the capital of Saudi Arabia. However, regionalization has started with more authority being delegated to the regional directors [6]. The Ministry of Health provides almost 65% of health services, 28% of the services are provided by more than ten government agencies, and 18% of the services are provided by the private sector [5]. Health facilities in Saudi Arabia are growing every year in terms of number of new health centers, additional health supply, and more new public hospitals. According to the Ministry of Health annual report, health centers have increased from 1707 centers in 1993 to 1737 centers in 1998 and the number of hospitals also increased from 174 in 1993 to 180 hospitals in 1998 [7]. There are sets of standards that are produced in

Saudi Arabia to evaluate and plan the location of health facilities. These indicate that every hospital should provide 2.5 beds for every 1000 persons with a catchment area of 4 – 8 km and, health centers, on the other hand, should serve a catchment area of 2 – 4 km. These standards are going to be tested by this study at the GIS application section [8, 20].

GIS and Health Care Planning

The area of GIS and health care has risen to prominence in the past 5 – 10 years with the recognition that health surveillance practices and health service allocations need to become more sensitive to the needs of people in local geographic areas [8-9]. The collection, storage and manipulation of geographic information have undergone a revolution in recent years with the development and wide spread availability of GIS software's. Today, many health care planners and officers can benefit from education and training in the GIS field and this will give them the chance of influencing the progress of health surveillance, environmental health assessment and the geographic allocation of health resources [8].

The rapid adoption of GIS in the field of health care planning is actually a result of the following issues:

- The increasing availability of geo-coded health data that lead to having health information systems
- The availability of digital geographic data at micro and/or micro scale that has several GIS coverage with enormous attribute data such as addresses land use, ownership, etc
- GIS software's such as ArcGIS produced by Environmental Systems Research Institute (ESRI) become inexpensive and easier to use and runs on a wider range of platforms e.g ,Unix, IBM, Windows
- The availability of spatial analysis tools, as separate software modules or embedded is GIS

All of the above issues have encouraged many health organizations to use GIS and benefit from its tools and functions. For example, the Center for Disease Control (CDC), the USA world's premier disease tracking organization, has used GIS for at least a decade to study how disease spreads from place to place and to study how toxic substances affect people's health [10, 30]. GIS has continued to be used in public health for epidemiological studies [11]. By tracking the sources of diseases and the movements of contagions, agencies can respond more effectively to out breaks of disease by identifying at risk populations and targeting intervention [12]. Public Health uses of GIS include tracking child immunizations, conducting health policy research; and establishing service areas and districts [13]. Today, many health authorities have adopted information systems to manage their tasks. These systems can be used with the GIS to have a complete health information system that should contain the following elements [8]:

- Perceived health problems with incidence rates
- Environmental, socio-economic and other risk factors, which influence health, under
- serviced, poor, inaccessible areas and other geographic and demographic factors
- Population sub groups with specific health problems, health needs and demand
- Health services directed at health problems or risk factors for all or part of the population
- Health care inputs, e.g., staff, funds, capital resources, medicines and equipment used etc
- Health care outputs, e.g., number of client contacts, proportion of population reached for particular programmers and proportions of target population reached
- Health care outcomes, e.g., change in health status as a result of intervention of health care programs [1]

GIS TOOLS FOR HEALTH CARE PLANNING AND METHODOLOGY

Study Area

Saudi Arabia is the most important country in the middle east and Arab region; because of the religion areas inside. Saudi Arabia healthcares is the most factor that Governments can concentrate on giving services to their populations. Makkah region has a population of about 6.391966 persons while Riyadh has about 5.631890 persons. Numbers of hospitals and health cares were discussed the see the affection with the number of populations. Disease like blood pressure; and blood cancer is discussed. GIS Tool was applied using Esri ArcGIS 9.3, ArcCatelog 9.3 was used to build the Geodatabase of Saudi Arabia Cities, subareas, high way streets, major streets in selecting this hospital. Figure 2 shows a Geodatabase in a Multi-tiered Architecture [26-29].

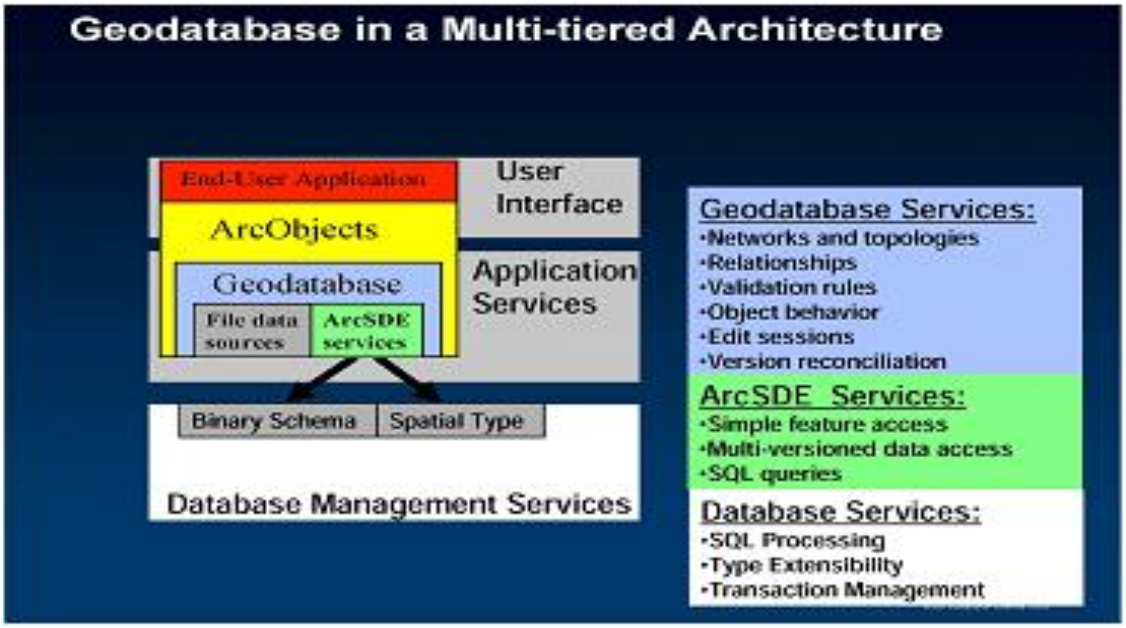

Figure 2: Geodatabase in a Multi-Tiered Architecture

These include accessibility to health demand data and the types of health services that are available at this hospital. In addition, all the planning issues that are dealt with at this hospital are relevant to the remaining hospitals of Taif city. Number of hospitals; and Health care system have a relations of numbers of Doctors, Nurses, pharmacies and the number of beds in hospitals like Makkah hospitals are 147620 beds while number of Doctors are 10474 [3,5,7]. Table 1 illustrates Health Services per population in Saudi Arabia Regions.

Table 1: Health Services per Population in Saudi Arabia Regions

HealthCare No.	Hospitals No.	Beds Numbers	Doctors No.	Dental Doctors	Pharmacy No.	Nurses No.	Other Health	Populations No.	Area
735.1311098	42	14762.04	10478.63	1150.669	1726.159	21594.48	12339.7	6391965	Makkah
70.62599195	17	1418.229	1006.71	110.5478	165.8366	2074.639	1185.508	614093	Al Gasim
67.60621047	17	1357.589	963.6656	105.8211	158.7459	1985.932	1134.819	587836	Zazan
65.53156987	11	1315.928	934.0934	102.5737	153.8744	1924.99	1099.994	569797	Tabook
47.4707303	11	953.2517	676.6525	74.30387	111.4658	1394.453	796.8301	412758	Hail
647.7159287	41	13006.67	9232.607	1013.842	1520.899	19026.66	10872.37	5631890	Al Riyadth
37.8507188	10	760.0739	539.5279	59.24608	88.87713	1111.865	635.3514	329112	Najran
169.8039103	19	3409.804	2420.402	265.7867	398.7159	4987.99	2850.28	1476445	Al Madinath
101.1098332	46	2030.37	1441.23	158.2628	237.4156	2970.101	1697.201	879150	Aseer
337.3579068	38	6774.427	4808.733	528.0517	792.1488	9909.889	5662.793	2933327	Al Shargia

Using GIS for Local Health Services Centre

GIS is considered as an useful tool for health planners in defining how well patients are served by health services and anticipate demand for such services. The aim of this part is to discuss a GIS application created for a local health

centre called Taif health services centre at Taif City. This application is designed to act as a spatial data decision support tool for health planners and officers. Figure 3 illustrates the process flow of registration point from patient Arrival to Health Services Centre. At first, the issues which are relevant to the centre's health planning were defined. These are (a) drawing out the centre's catchment area, (b) Identifying the spatial variation of diseases and (c) modeling the flow of patients to the health centre. The data base: The first step in building any GIS application is to ensure that the required data is available at some sources either as records in tables or/and as digital GIS files. In the case of this application, digital health data was not available and therefore, a new GIS database was built based on the collected paper format data.

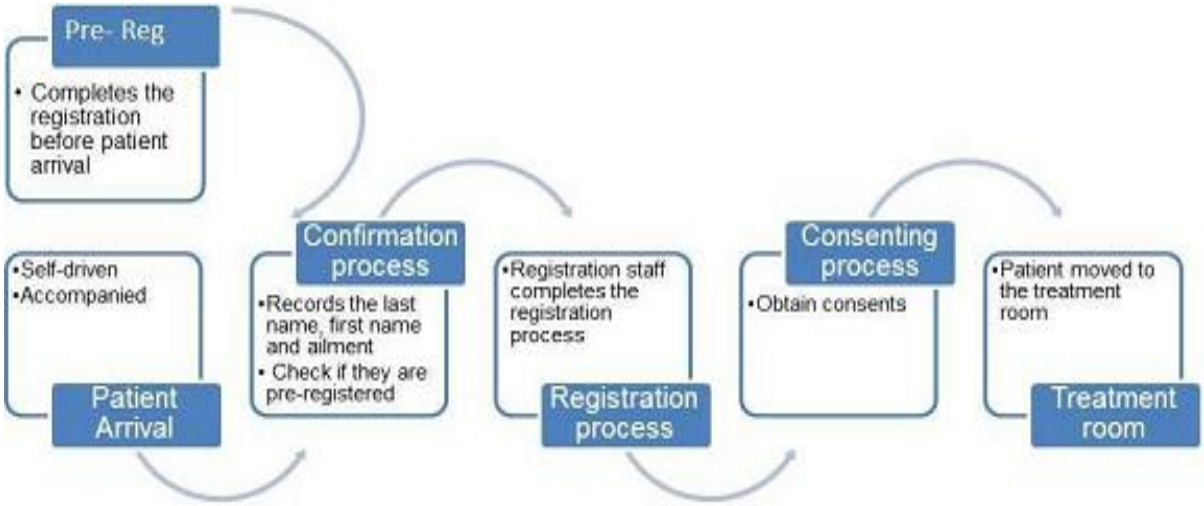

Figure 3: The Process Flow of Registration Point from Patient Arrival to Health Services Centre

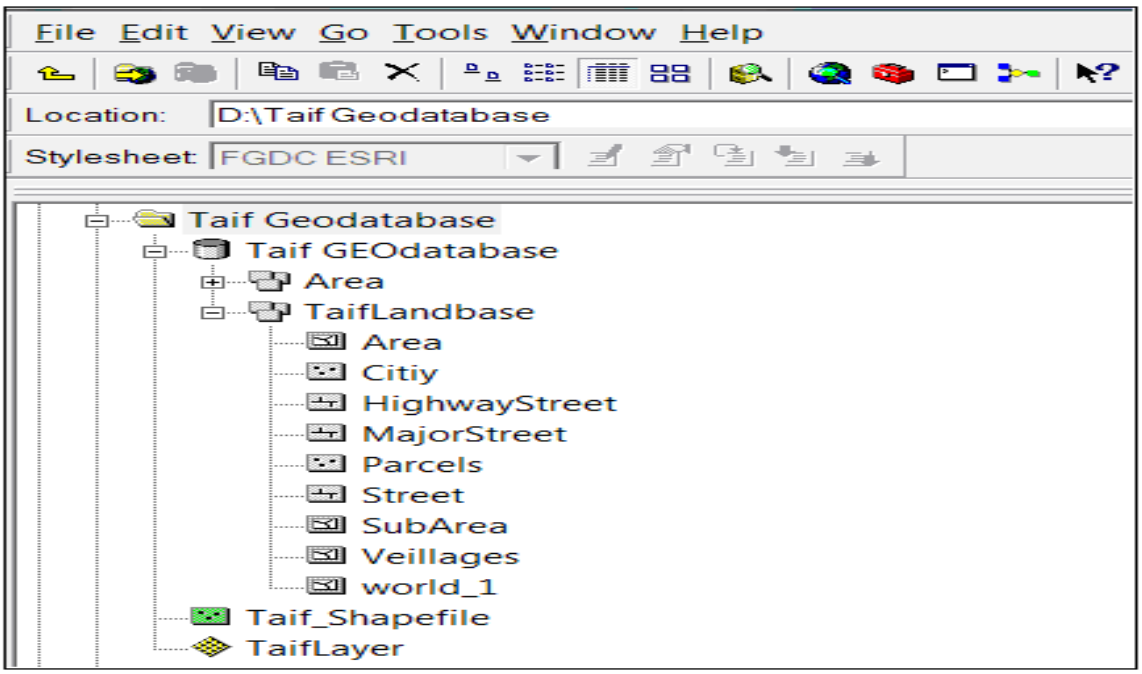

Figure 4: The Geodatabse Layers in ArcCatelog Platform

Three main GIS coverages were digitized and captured using GIS software (ArcGIS) and the geodatatbase. These are road network that shows all types of roads in the selected area, parcel map showing land subareas, and a neighborhood coverage showing the health service area boundaries. Each one of these digital coverage has also several attributes such as road types, land uses, population size and characteristics and epidemiology data for diabetic, blood pressure, and asthma patients. All of the collected data have been digitized and given a uniform reference in ArcGIS. Figure 4 show The geodatabse layers in ArcCatelog Platform.

Especial Study Region

Taif is the popular city of Saudi Arabia peoples, situated on the western region of Saudi Arabia map. The city has a population of over 1.1 million people that represents 9% of the total population in Saudi Arabia [10]. There are two main types of health facilities at this city. They are called public and private health facilities. The former covers health centers and hospitals owned by the Ministry of Health. There are 50 health centers and seven hospitals at Taif and neighborhood cities. They are provided by the Ministry of Health and by other governmental authorities including the Ministry of Interior and the National Guard [11]. The second main type of health facilities in Taif is referred to the private health organizations. They provide 12 hospitals with a total capacity of 2416 beds and also provide 151 clinics at different parts of the city [11]. Table 2 illustrates the health services per population in Taif City.

Table 2: Health Services per Population in Taif City

Serial No.	Facts	Per Populations
1	Health care clinics centers	151
2	Number of beds in hospitals	2416
3	Number of doctors	610
4	Number of Dental Doctors	555
5	Number of Pharmacies	2703
6	Number of Nurses	1296
7	Number of Health cares jobs	5518
8	Number of health centers	50
9	Number of general hospitals	7

Both private and public health authorities are faced with different planning issues that can be handled with GIS techniques. These issues include defining the spatial location of health demand and identifying health access and service areas. In order to discuss the potentials of using GIS with health care facility planning in general and with hospital facility planning in particular, the presented study has selected one major private hospital and applies GIS on it. A number of factors were considered in selecting this hospital. These include accessibility to health demand data and the types of health services that are available at this hospital. In addition, all the planning issues that are dealt with at this hospital are relevant to the remaining hospitals of Taif city. This hospital has a capacity of 200 beds and 95 doctors working at different departments including family medicine, gynecology and pediatric department. It is located at the north of the city but expected to serve most parts of city districts. Figure 5 show the content of Saudi Arabia Subareas done by XML Stylus Studio Editor.

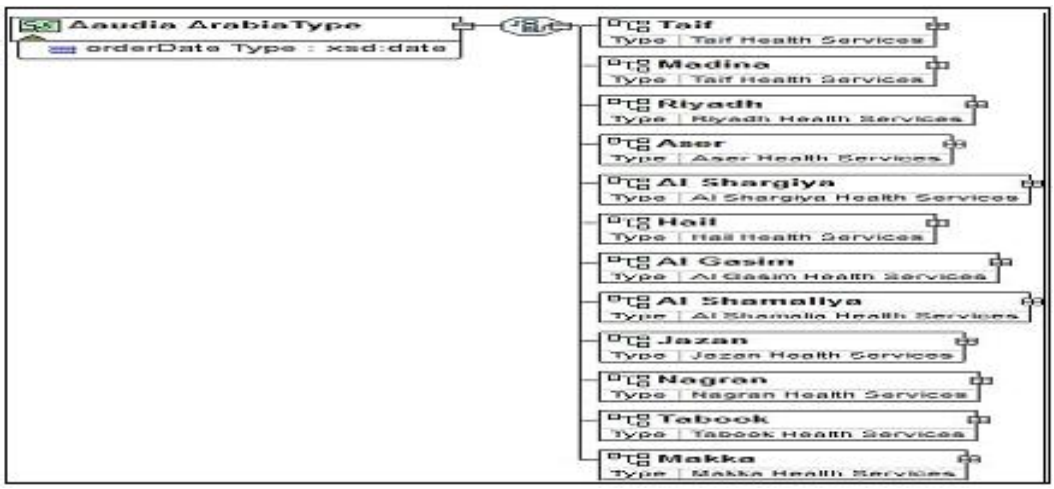

Figure 5: The Content of Saudi Arabia Subareas Done by XML Stylus Studio Editor

Research Issues and Analysis Techniques

GIS has several techniques and functions that can be used for health service planning. Each one of these functions can be applied on different health related issues. For example, the issue of health accessibility can be modeled in GIS using simple functions such as buffer function or using spatial data analytical functions such as spatial analysis technique. This study has selected three major hospital planning issues and uses GIS for analyzing these issues. The first issue is related to defining health demand location. GIS has different tools that can be used for defining any location on the map. One of these tools is called on-screen digitizing which is used by the presented study to capture and define health demand location at Taif city. Figure 6 show Taif hospitals and health services centers neighborhoods.

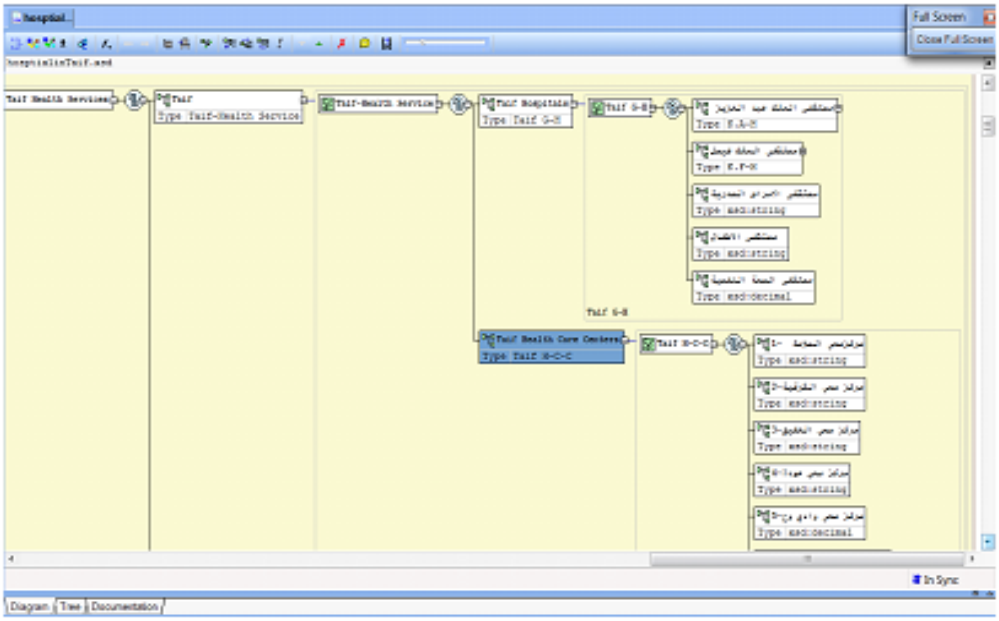

Figure 6: Taif Hospitals and Health Center as XML Diagram

Taif Health Servies XML Code

```
<xsd:complexType name="Taif Health Services">
<xsd:sequence>
<xsd:element name="Taif" type="Taif-Health Service"/>
<xsd:element name="Taraba" type="Taraba-Health Service"/>
<xsd:element name="Khurma" type="Khurma-Health Service"/>
<xsd:element name="Rania" type="Rania-Health Service"/>
<xsd:element name="Zulam" type="Zulam-Health Service"/>
<xsd:element name="Al Moya" type="Al Moya-Health Service"/>
</xsd:sequence>
</xsd:complexType>

<xsd:complexType name="Taif-Health Service">
<xsd:sequence>
<xsd:element name="Taif Hospitals" type="Taif G-H"/>
<xsd:element name="Taif Health Care Centers" type="Taif H-C-C"/>
</xsd:sequence>
</xsd:complexType> <xsd:complexType name="Taif G-H">
<xsd:sequence>
<xsd:element name=" العزيز عبد الملك مستشفى" type="K.A-H"/>
<xsd:element name="فيصل الملك مستشفى" type="K.F-H"/>
<xsd:element name="الصدرية الامراض مستشفى" type="xsd:string"/>
<xsd:element name="الاطفال مستشفى" type="xsd:string"/>
<xsd:element name="النفسية الصحة مستشفى" type="xsd:decimal"/>
</xsd:sequence>
</xsd:complexType>
```

ArcGIS software is used by the presented study to define all hospital demands location. These data are collected on city districts level. Therefore, GIS coverage is digitized at the Arcmap application, which is one of the main ArcGIS applications, using polygon-drawing tools that are located at the editor menu. After creating the required city district polygons in ArcGIS software, the following step was taken to enter the collected attributes about hospital demand. These include number of patients, age, sex and hospital utilization types (emergency clinics patients, specialized and general clinics patients and admitted patients). All of these data are linked to the demand coverage and used for the second issue of this application which is related to the classification of hospital demand. Figure 7 shows a Taif Hospital and local health service in turbah neighborhood center as XML *dia*gram and health service centers as XML code.

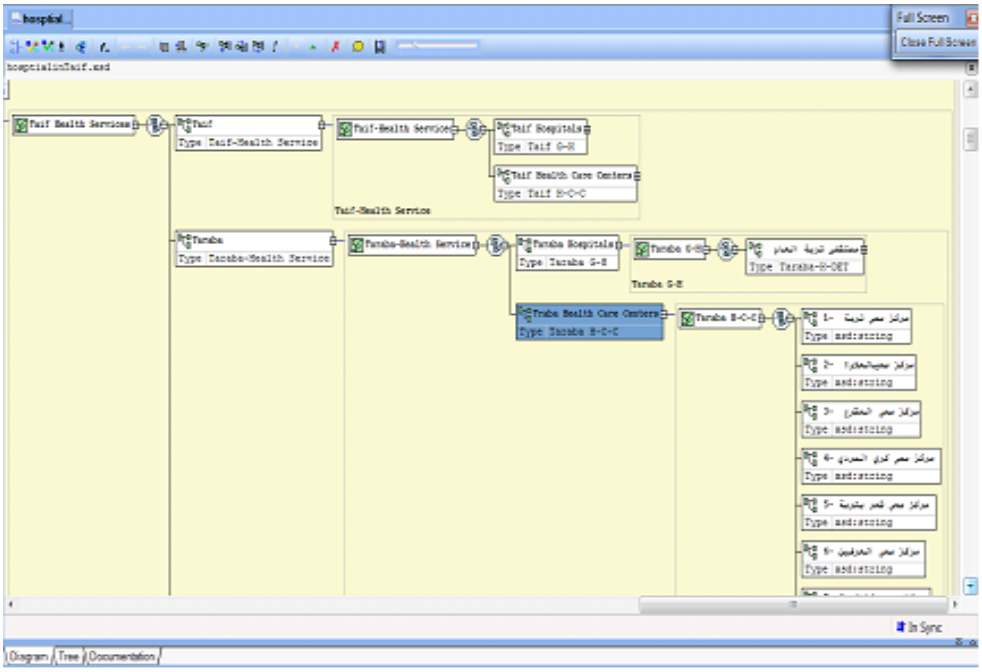

Figure 7: Taif Hospitals and Local Health Service in Turbah Neighborhood Centers as XML *Dia*gram

Turbah Hospitals and Main Health Services as XML code

```
<xsd:sequence>
<xsd:element name="Taraba Hospitals" type="Taraba G-H"/>
<xsd:element name="Traba Health Care Centers" type="Taraba H-C-C"/>
</xsd:sequence>
</xsd:complexType>
<xsd:complexType name="Taraba G-H">
<xsd:sequence>
<xsd:element name=" العام تربة مستشفى " type="Taraba-H-DET"/>
</xsd:sequence>
</xsd:complexType>

<xsd:complexType name="Taraba-H-DET">
<xsd:sequence>
<xsd:element name=" Date :1422" type="xsd:string"/>
<xsd:element name=" Teleph:028221555" type="xsd:string"/>
<xsd:element name=" Fax:028221683 " type="xsd:string"/>

<xsd:element name=" Manager:د/ سلطان مزيد المرزوقي " type="xsd:string"/>
<xsd:element name=" Owner:الصحة وزارة ملك" type="xsd:string"/>
<xsd:element name="
```

Turbah Health Care Centers as XML code

```
<xsd:complexType name="Taraba H-C-C">
<xsd:sequence>
```

```
<xsd:element name=" 1- تربة صحي مركز" type="xsd:string"/>
<xsd:element name=" 2- صحي العلاوة مركز" type="xsd:string"/>
<xsd:element name=" 3- الحشرج صحي مركز" type="xsd:string"/>
<xsd:element name=" 4- السردي كري صحي مركز " type="xsd:string"/>
<xsd:element name=" 5- بتربة شعر صحي مركز " type="xsd:string"/>
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<xsd:element name=" 7- الخالدية صحي مركز " type="xsd:string"/>
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</xsd:sequence>
</xsd:complexType>
```

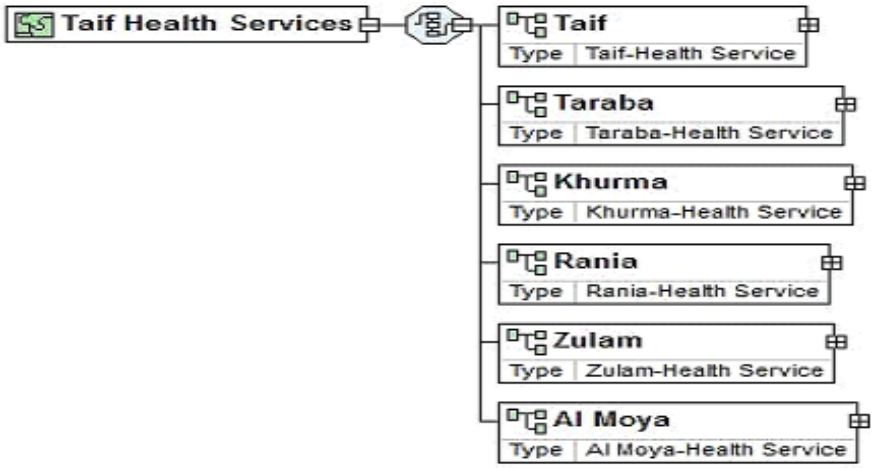


Figure 8: The Turbah Health Care Services Centers in Taif City and Neighborhood Centers

The third main issue of the presented application is related to defining hospital service area. This issue is covered using two main GIS techniques which are network analysis and overlay analysis. Network analysis is one of the ArcGIS modules that facilitates the modeling of spatial networks and can be used to determine the efficient paths and travel sequences. This module is used in the presented study for determining and calculating drive time to hospitals at Taif city. In general, a network is a system of interconnected linear features through which resources are transported or communication is achieved. The network data model is an abstract representation of the components and characteristics of real world network systems [12].

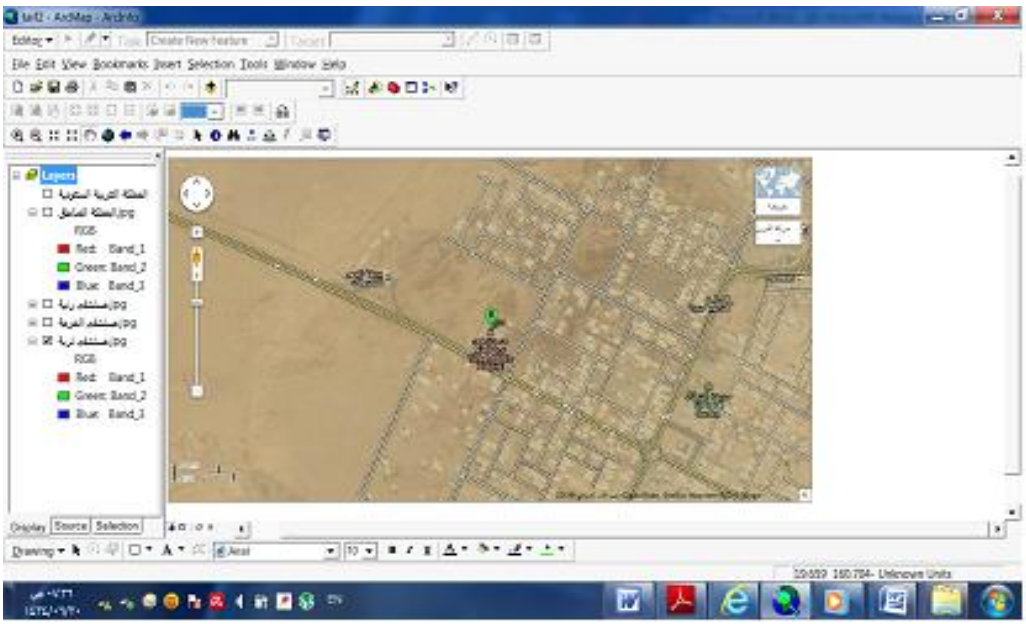
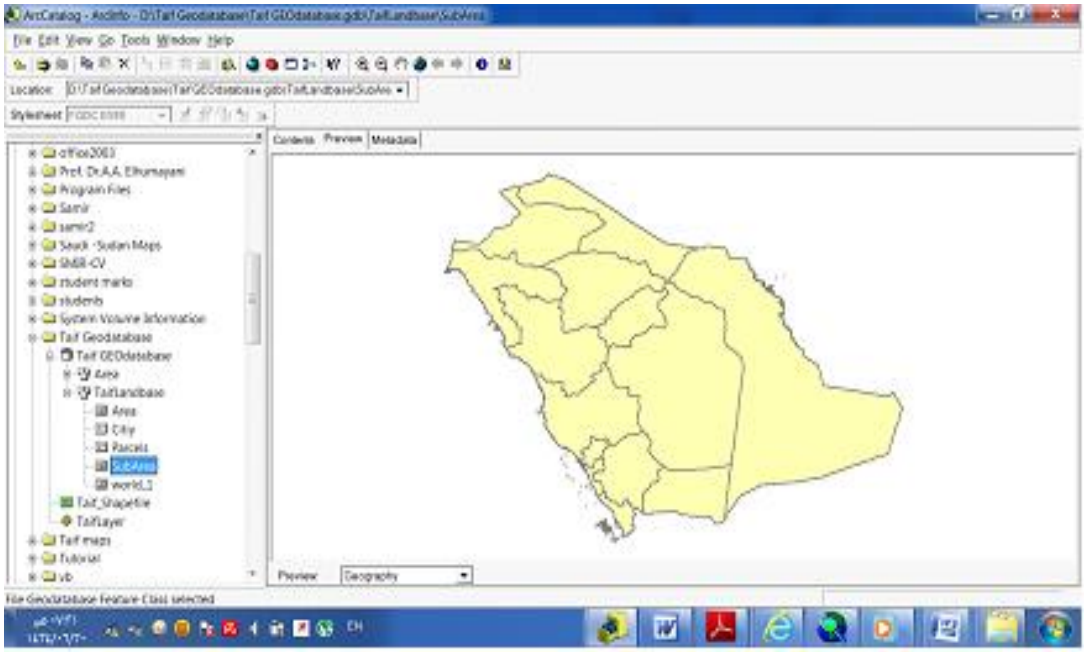


Figure 9: Turbah Google Earth Hospitals Location in ArgGIS 9.3



Preview of Saudi Arabia Subareas

THE IMPLEMENTATION OF THE SYSTEM

The information was edited into the geodatabase through the Map Editor in the ArcMap 9.3 platform. Filling the data from the tables of Subareas populations and hospitals ,...etc, the data of the length and names of streets were entered from the table of Distances between cities in both layers of High way streets and Major Streets, Using the tools of Editing in the ArcMap tools bar.

The Selection Functions

ArcMap have selection tools by attributers and by location see the following figures

The Selection by Attributes

The selection tools by some attribute function allowing to select the database management systems function as shown in the following figures:

- Select from Subarea Layer Where populationNumber > 1000
- Select from Subarea Layer Where NumberOfHospitals < 150

Selection by Locations

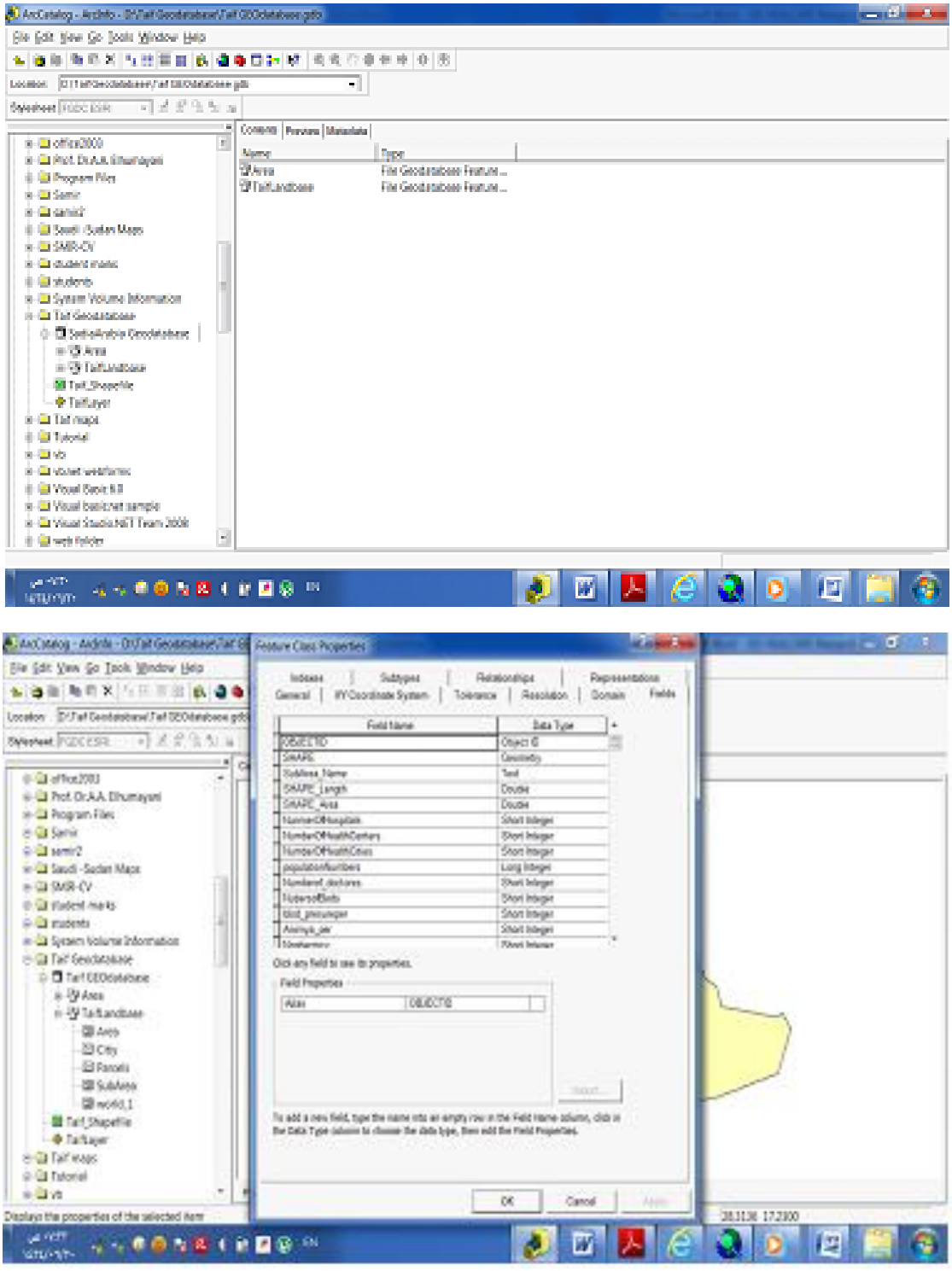
Selecting features from layers such as:

- Intersect
- Contains
- Are within
- Completely contain
- Are completely within
- Are identical to

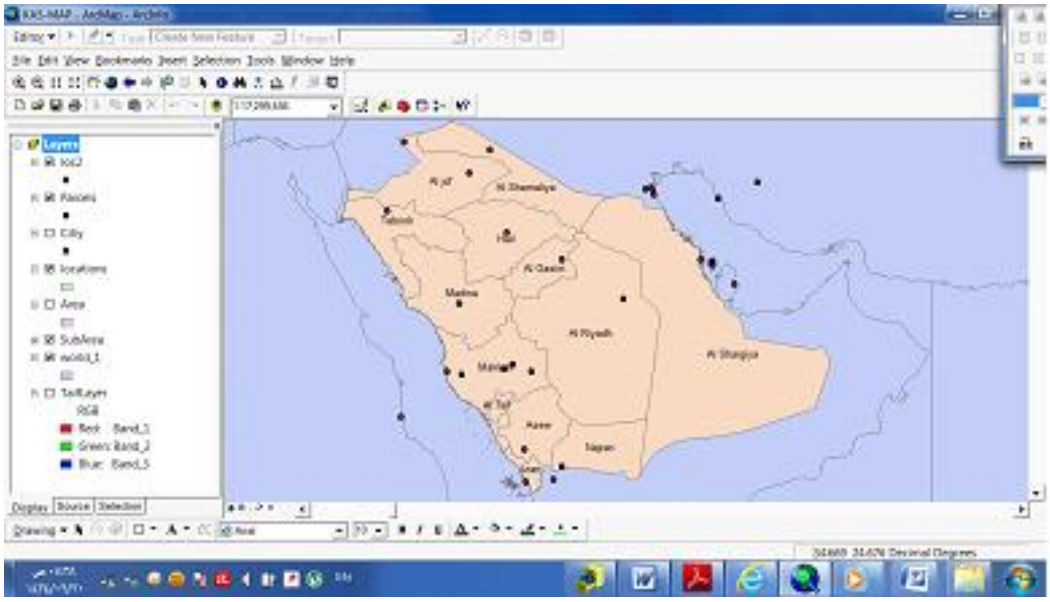
- Touch the boundary
- Share a line segment with
- The feature in layer name

Example

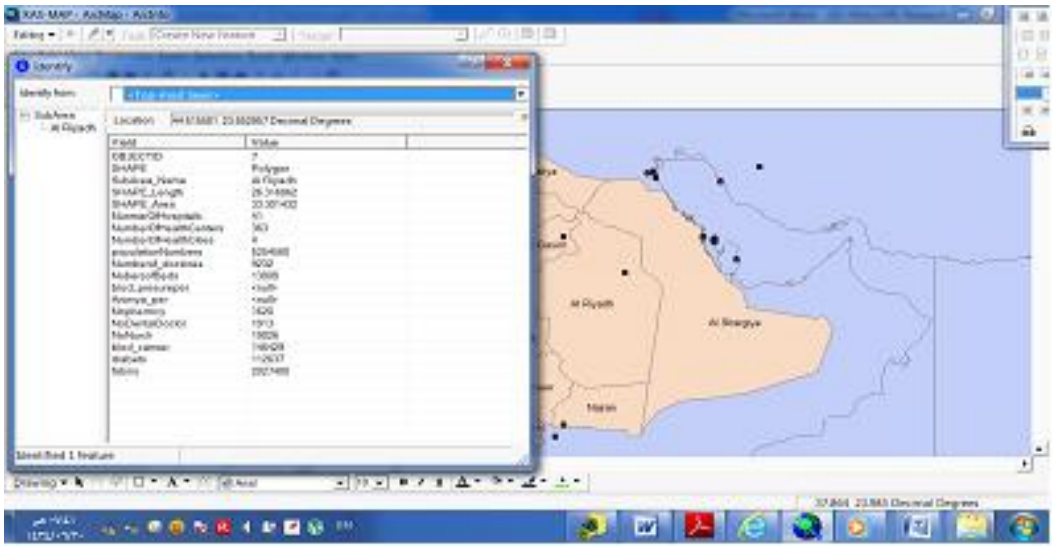
Select from High way street, Cities Layers are within subarea layer in the following figures, that shows those areas having cities and high ways.



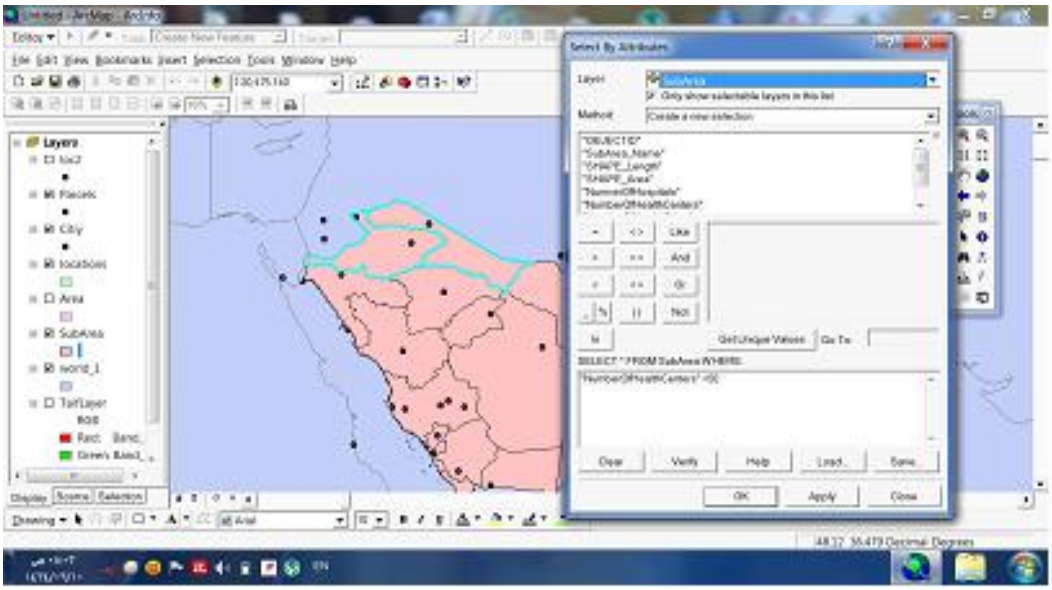
Subarea Filed Description in ArcCatelog 9.3



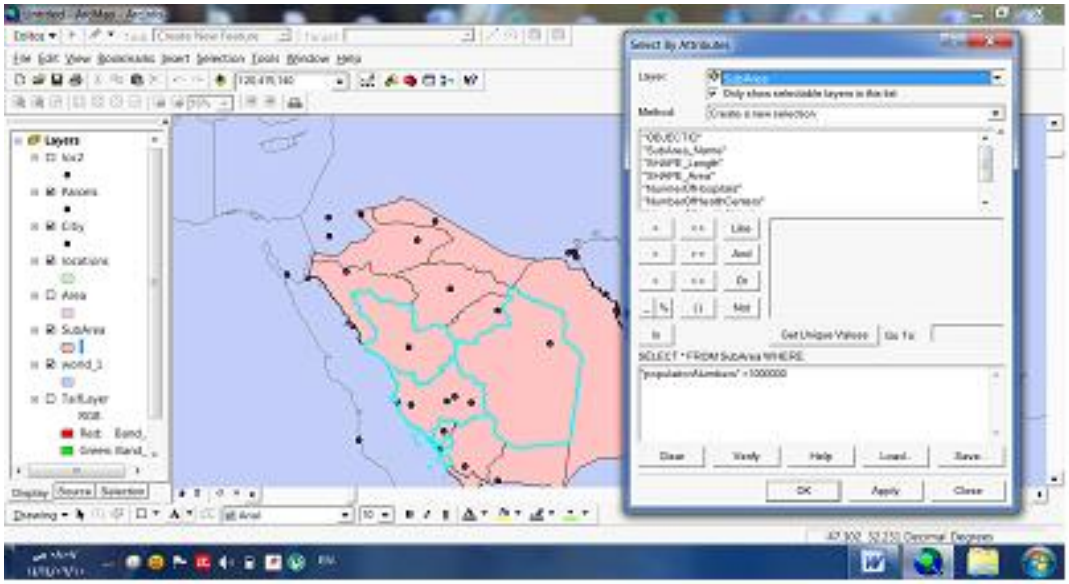
Saudi Arabia Subareas Layout at ArcGIS Platform



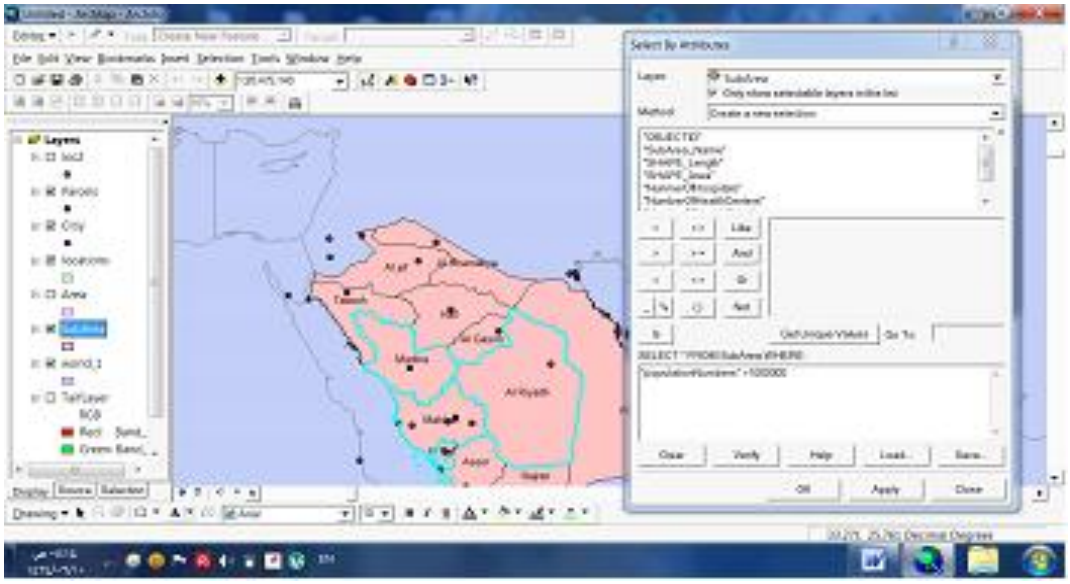
Saudi Arabia Subareas Field Content Shown by Identification Icon of Al Riyadh Subarea

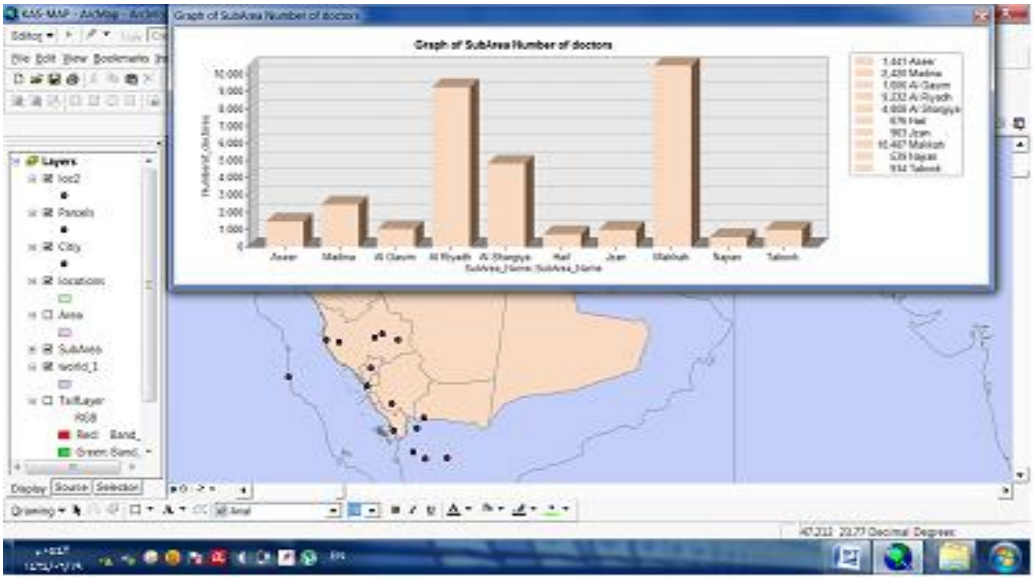


Selection of Subareas in Saudi Arabia where Heath Centers Less than 150

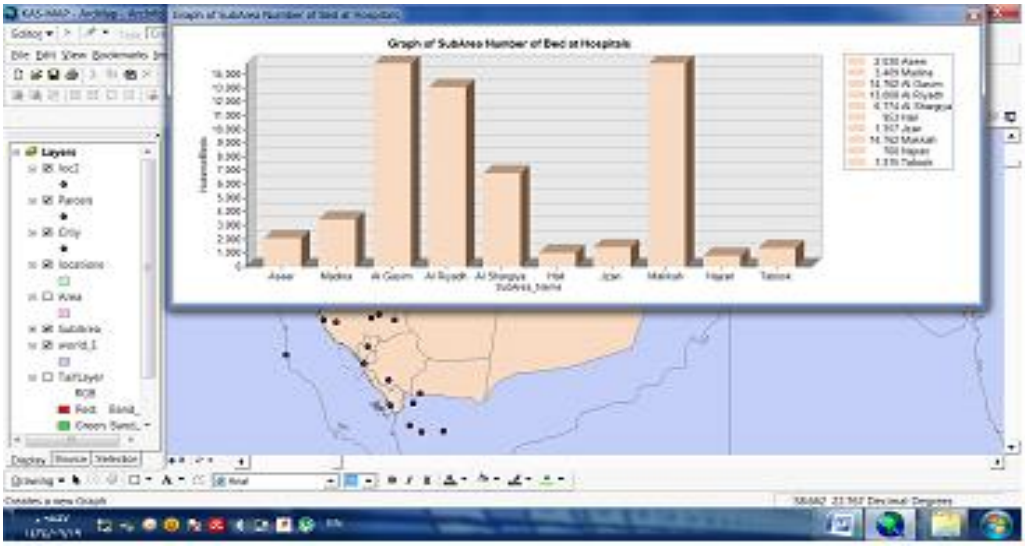


Selection of Subareas in Saudi Arabia where Populations are Greater than > 1000000

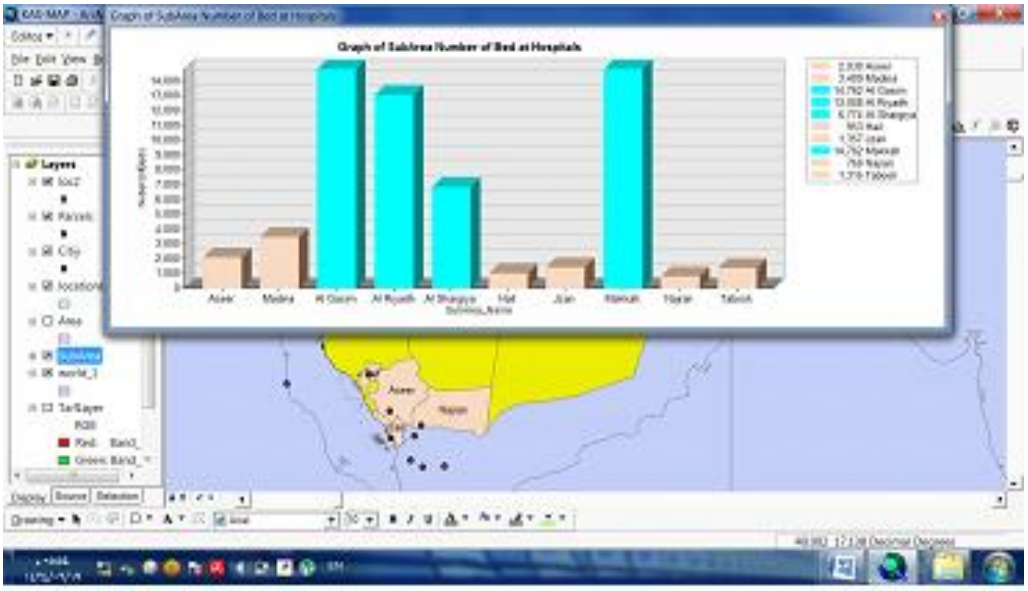




Graph of Number of Doctors in Each Sub Area



Graph of Number of Beds in Hospitals in Each Sub Area



Sub Areas Weds Here Numbers of Beds at Hospitals Greater than 5000 Beds

Final Reports

The key to produce successful network models is in understanding the relationship between the characteristics of physical network systems and the representation of those characteristics by the elements of the network model [12]. Each network coverage is formed with several elements such as links, nods, stops and turns. These elements are used together to perform the required GIS functions. Therefore, before using any of network analysis functions it is necessary that all users should understand the process of these elements and make sure that the parameters of these elements are satisfied. One of the important elements that need to be covered before calculating network travel time is called the link impedance. It refers to the cost associated with traversing an entire network link.

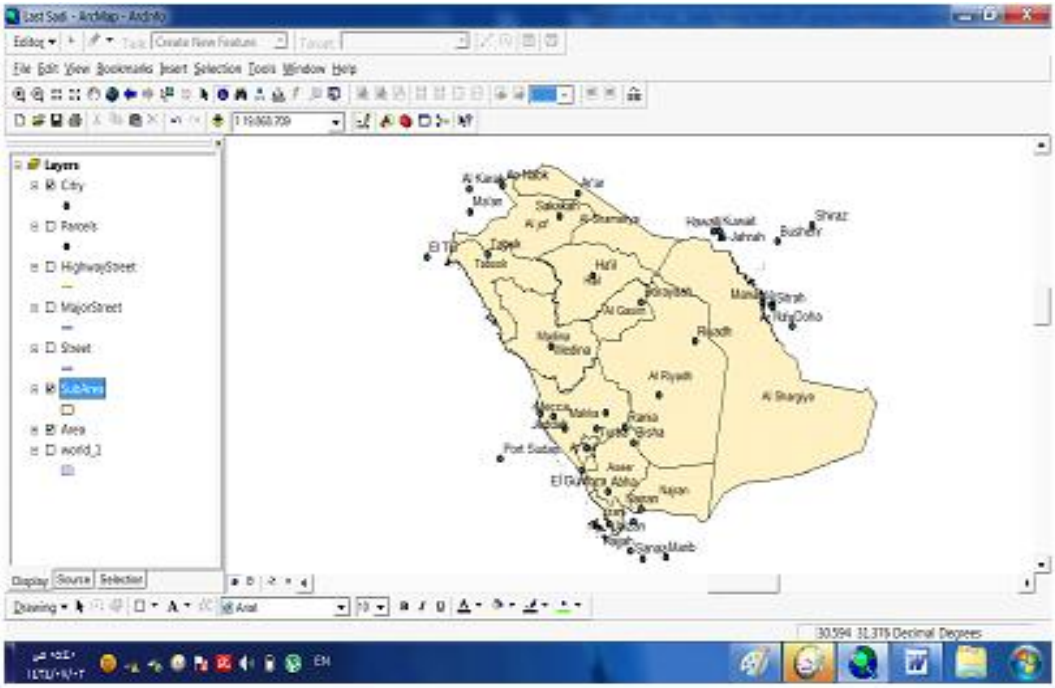


Figure 10: Subarea of Saudi Arabia

The presented study has calculated travel time for each arc based on the average driving speed along each arc and based on the arc length. The resulted cost is saved as an arc attribute and used during the process of creating drive-time service area of the selected hospital. The second main GIS analytical technique that is used within the hospital service area

issue is called overlay analysis. This technique is used at different studies and for many purposes [13–15]. Overlay analysis manipulated spatial data organized in different layers to create combined spatial features according to logical condition specified in Boolean Algebra [16]. The logical conditions are specified with operands (data elements) and operators (relationships among data elements).

The most well used overall functions are called union, intersect and identity. This study has used the intersect function to analyze health demand which falls inside the created drive-time hospital service area. This overlay function creates a new output coverage that has only city districts that falls inside hospital service area. There are several potential uses for overlay analysis functions. One of these uses is related to defining health demand of a selected service area and which is covered by the presented study.

Health facilities in general and hospitals in particular are faced with different challenges related to their locations, their market service areas and their demand status. This part of the paper presents a GIS application that is created for one private hospital at Taif city. The application is designed to be as a spatial decision support system for health demand of the selected hospital. There are several studies that cover public hospital demand including [8]. Using GIS in health care planning studies is well acknowledged by the western European researchers and it is used for various health care issues at the developed countries.

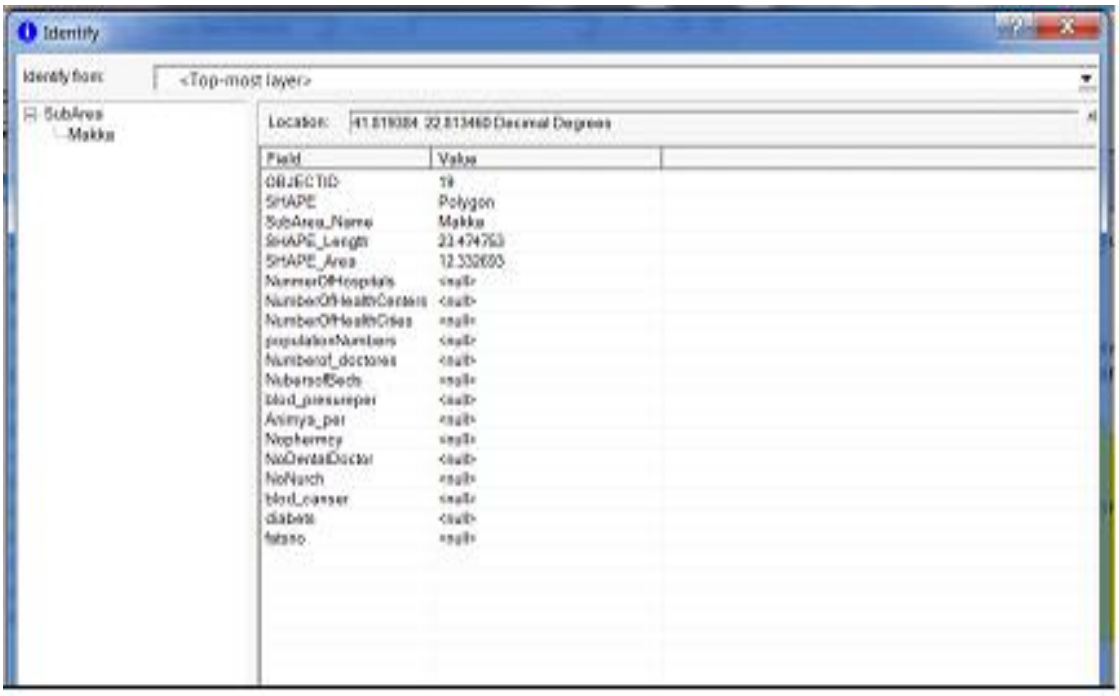


Figure 11: Identification of Makkah Subarea in Saudi Arabia Map

However, in Saudi Arabia this technology is still not very well explored by health authorities and researchers. Therefore, the created application provides a good example for explaining how to use GIS by health planners and officers in Saudi Arabia and/or in any other developing country.

This application is considered as a new GIS-based system that covers private hospital demand in Taif city. The created application covers three main demand related issues which are spatial distribution of health demand, types and classes of health demand and accessibility of hospital location between cities in Saudi Arabia. Table 3 illustrates the important distances between Cites in Saudi Arabia to determine the shorting location for patients health care services centers.

Table 3: The Important Distances between Cites in Saudi Arabia

Nagran	Gezan	Hail	Al-Gasim	Tabook	Abha	Taif	Damam	Ryadh	Madinah	Makka	jeddah	City
905	710	777	863	1024	625	167	134.3	949	420	79	0	Jedah
912	685	790	876	1037	627	88	1265	870	358	0	79	Makka
1270	1043	432	518	679	985	446	1343	848	0	358	420	Madinah
950	1272	640	330	1304	1064	782	395	0	848	870	949	Ryadh
1345	1667	1035	725	1729	1495	1177	0	395	1343	1265	1343	ADamam
864	763	957	936	1204	561	0	1177	762	446	88	167	Taif
250	202	1402	1488	1649	0	561	1459	1064	985	627	625	Abha
1929	1722	664	974	0	1649	1204	1729	1304	679	1037	1024	Tabook
1280	1561	310	0	974	1488	936	725	330	518	876	863	Al Gasim
1590	1475	0	974	664	1402	957	1035	640	432	790	777	Hail
482	0	1475	1561	1722	202	763	1667	1272	1043	685	710	Gezan
0	482	1590	1280	1929	280	864	1345	950	1270	905	905	Nagran

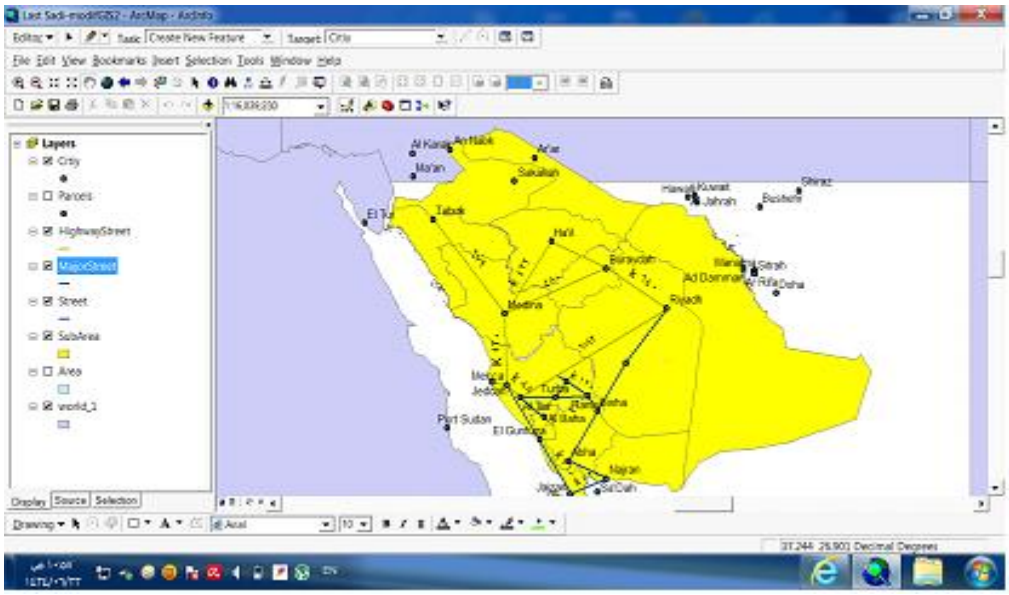


Figure 12: Saudi Arabia Subareas Layout Locations by Using ArcGIS Platform

DISTRIBUTION OF HOSPITAL DEMAND

Almost every hospital has a database about its existing patient and saves such data in different Management Information Systems (MIS). These systems are used for finding needed information about patient number or recording file and for reviewing the medical history of every patient. One of the main limitations of MIS is related to the lack of their spatial presentation of these data. Health administrators are used to work with MIS but are still not very well aware about the importance of using Spatial Information Systems (SIS) with their patients data. This result is found at Taif city. Many health managers who were interviewed during the stage of data collection did not realize the benefits of using GIS or SIS at their organizations [25-28].

Accordingly, the presented study has created a GIS application that can be used as a guide for identifying some of the benefits that health planners will gain from using GIS at their health organizations. One of the main issues related to health demand is regarding defining its location within the city. There are several methods that can be used in GIS for identifying location of any feature. For example, a GIS function called Geocoding can be used to create points features on a map from a table having x, y coordinates of any addresses. On-screen digitizing is another GIS function that can be used for data entry purposes. It uses different draw tools such as point, line and polygon tools for identifying feature location. The presented study has used this method (On-Screen digitizing) for the purpose of identifying hospital demand location. Based on the collected data, hospital demand is aggregated into city districts level. Therefore, GIS coverage is created for

showing location of every city district and then the attributes data of health demand are entered as records in the coverage table. After building the database of health demand, the next step was to use GIS for identifying spatial distribution of patients. This step is achieved using the graduated color function that subdivides numerical data into a set of classes. There are five main methods for classifying numerical data in GIS. These are natural breaks classification, defined interval classification, equal interval classification, quintile classification and standard deviation classification [17].

Transportation Networks Layers

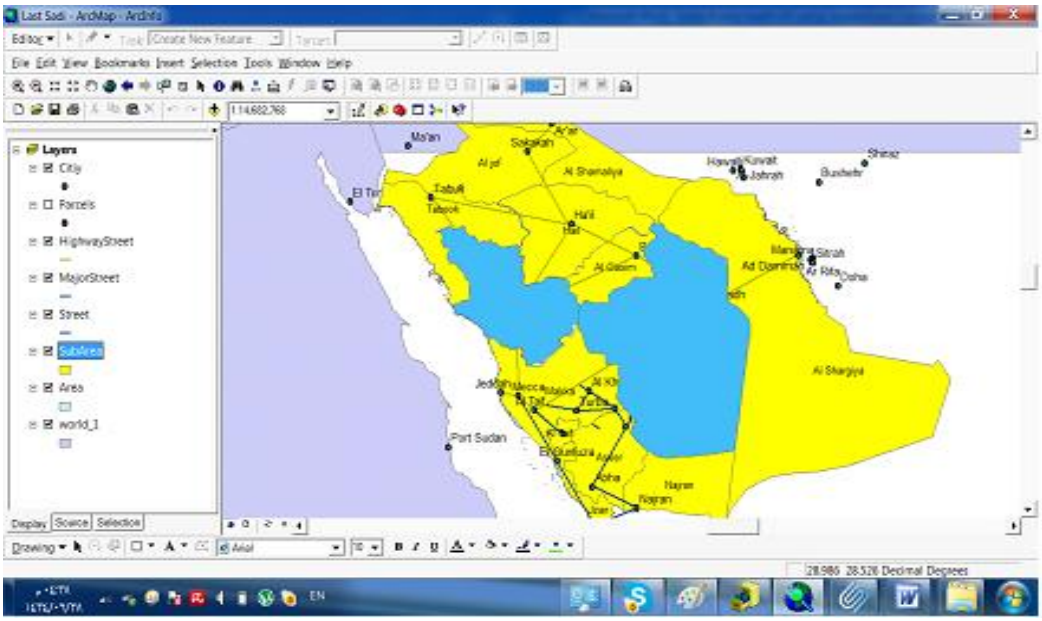
High way layers geodatabase consists of

- Object , shape length , shape area,
- Street name, Street Length and street type

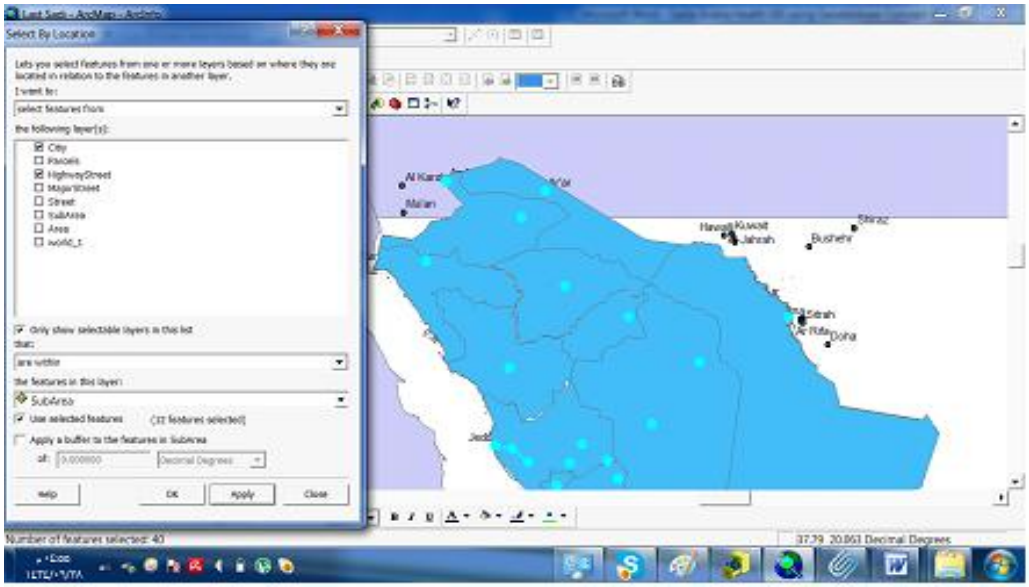
Major Street layers geodatabase consists of : Object , shape length , shape area, From the Streets layers distances and streets name can be found to help in going to the nearest hospital or health centers for patients on high way streets, major Street and normal layers.

The Subarea Layer

The Subarea layer is the layer that contain the health care information's field discussed in the paper, the calculations were taken from the table 5: produced by the Reference. Each subarea has ;layer name, shape length, shape-Area, Population-Number, number of hospitals, number of health care centers, number of Beds-in-Hospital' Number-of-Doctors, Number-of-urses,Number-of-Dentals-Doctors and number of pharmacies. Each one of these classification methods can be applied on health demand data for grouping and subdividing data purposes. The presented study has used the natural breaks method that minimizes the variance within class and maximizes the variance between classes [18]. For example, the general and specialized clinic patient group is related to those patients that use this hospital for specific health treatment. Meanwhile, the hospitalized patient group is referred to patients who were admitted for health care treatment in the same hospital. One of the benefits of using GIS with health data is related to its ability of showing more than one attribute data in one view. This tool is known as multiple data classification method that lets the user use two renders at once on a feature layer [18]. It is also called the bi-unique value render in the ArcInfo object model.



The Results of Selecting Populations in Subarea where Population Greater than 1000000



The Selection by Location of Cities and Highway Streets

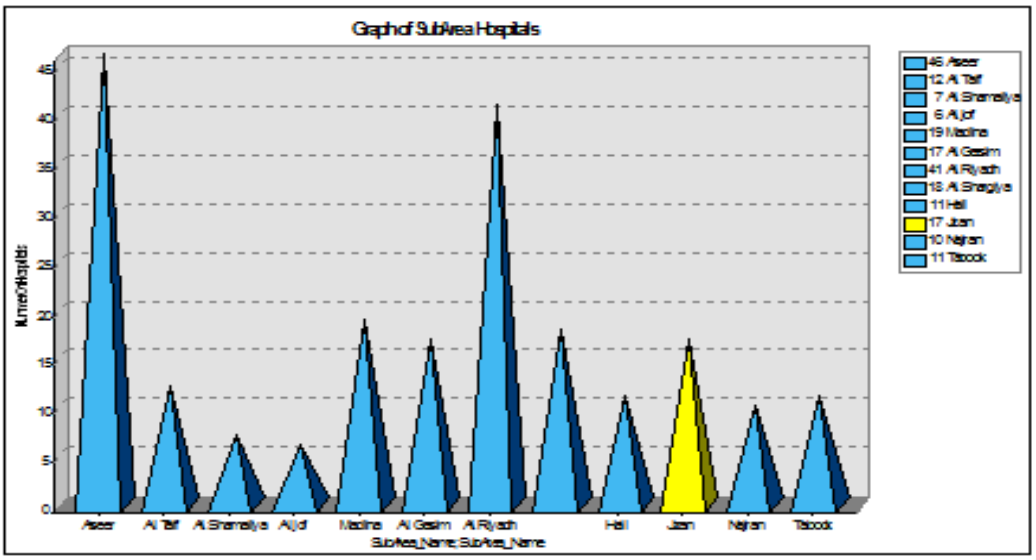


Figure 13a: This Chart; Show the Numbers of Hospitals in Each Subarea

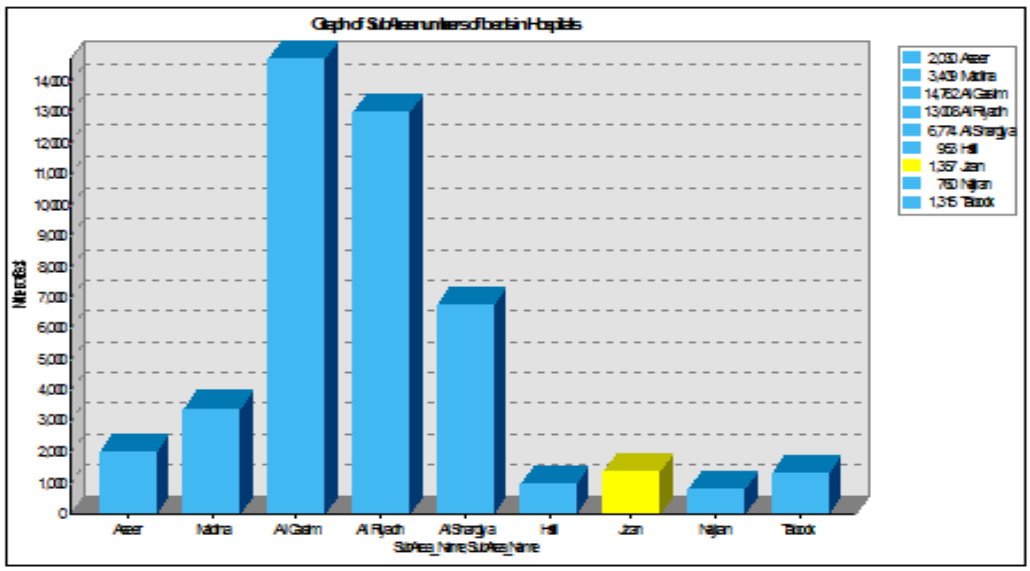
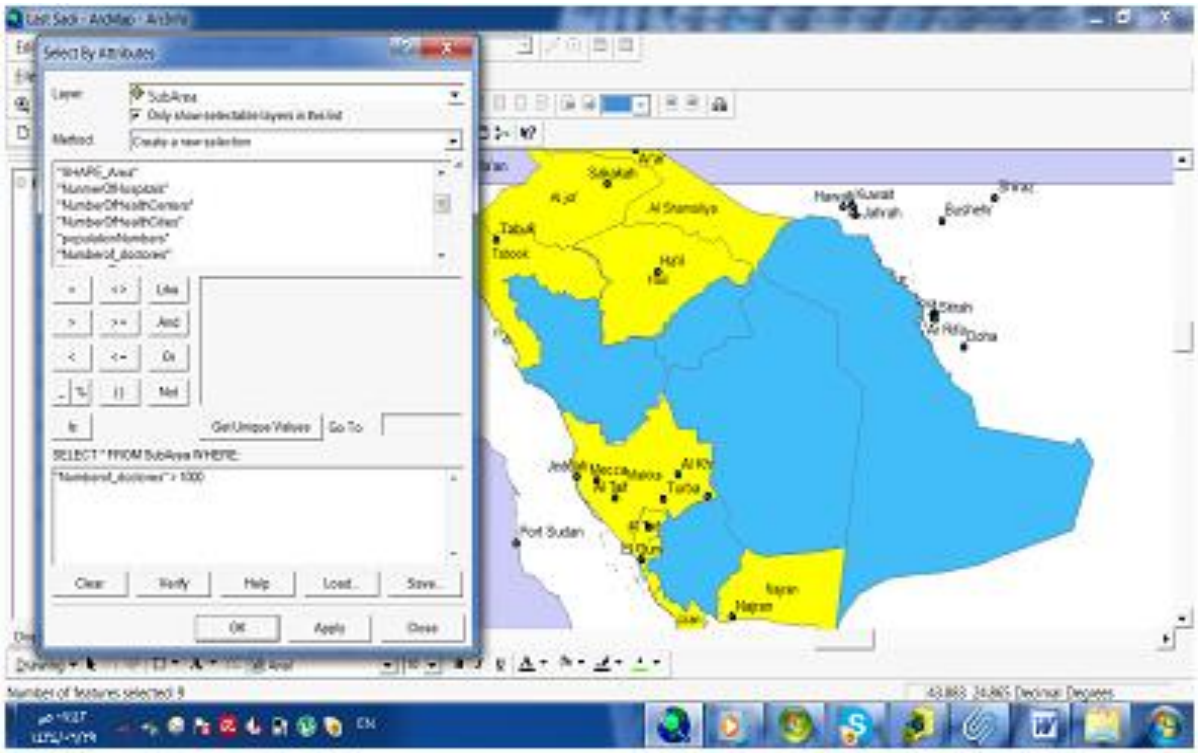


Figure 13b: This Chart; Show the Numbers of Beds in Hospitals in Each Subarea

THE COMPRESSION BETWEEN THE HEALTHCARES CENTERS

By using the statics tools in ArcMap compressions between Number of hospitals , number of healthcares centers and other health factors was done

- Building the graph of the number of hospitals in the different subarea was done shown in figure 13a, b. From this figure; the former finds that Al Riyadh and Asser cities are having the most number of hospitals in Kingdom of Saudi Arabia. While Hial, Aljof and Sharkia areas have the lowest number of hospitals.
- Another comparison graph was built between numbers of beds in hospital in the subareas as shown in figure 14.



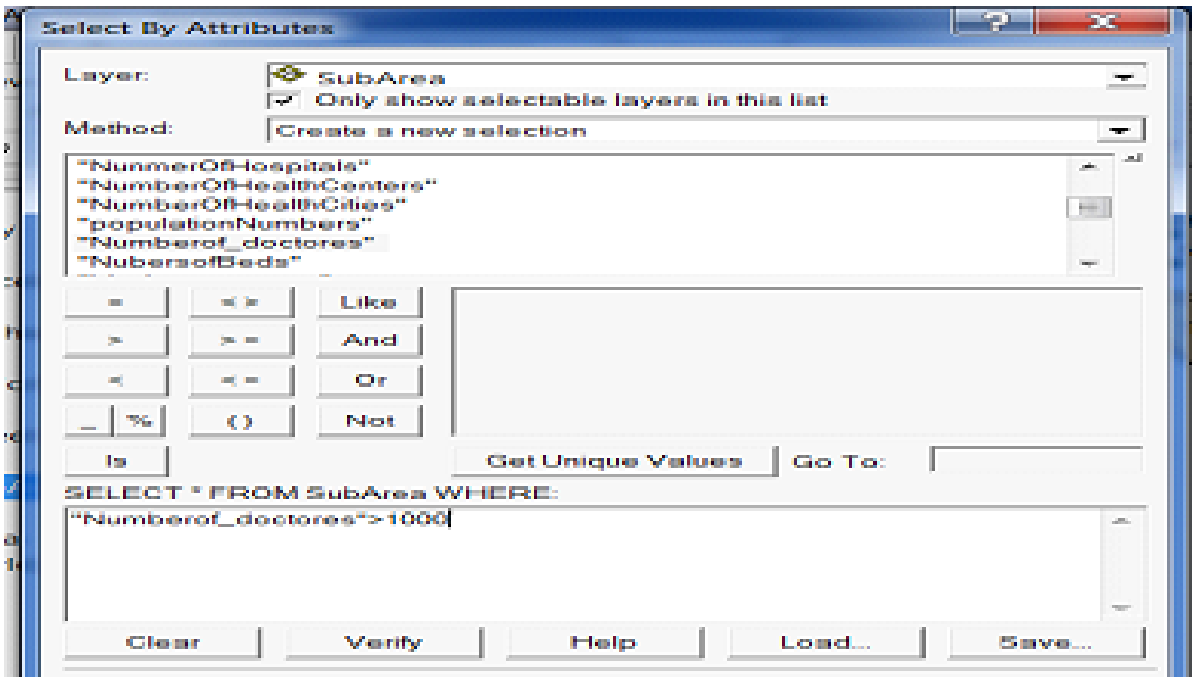


Figure 14: Shows the Numbers of Doctors Greater than >1000 and >3000

Statistical Tools

By using the statistical tools in ArcMap compressions between Number of Doctors , number of dental doctors ,nurses; and pharmacies as shown:

- Building of Statistics for the number of Doctors in government hospitals in the different subarea was done shown in figure 14. The former finds that Al Riyadh, Asser Al Gasim, and Al-Madinah are having more than 1000 doctors in governments hospitals.

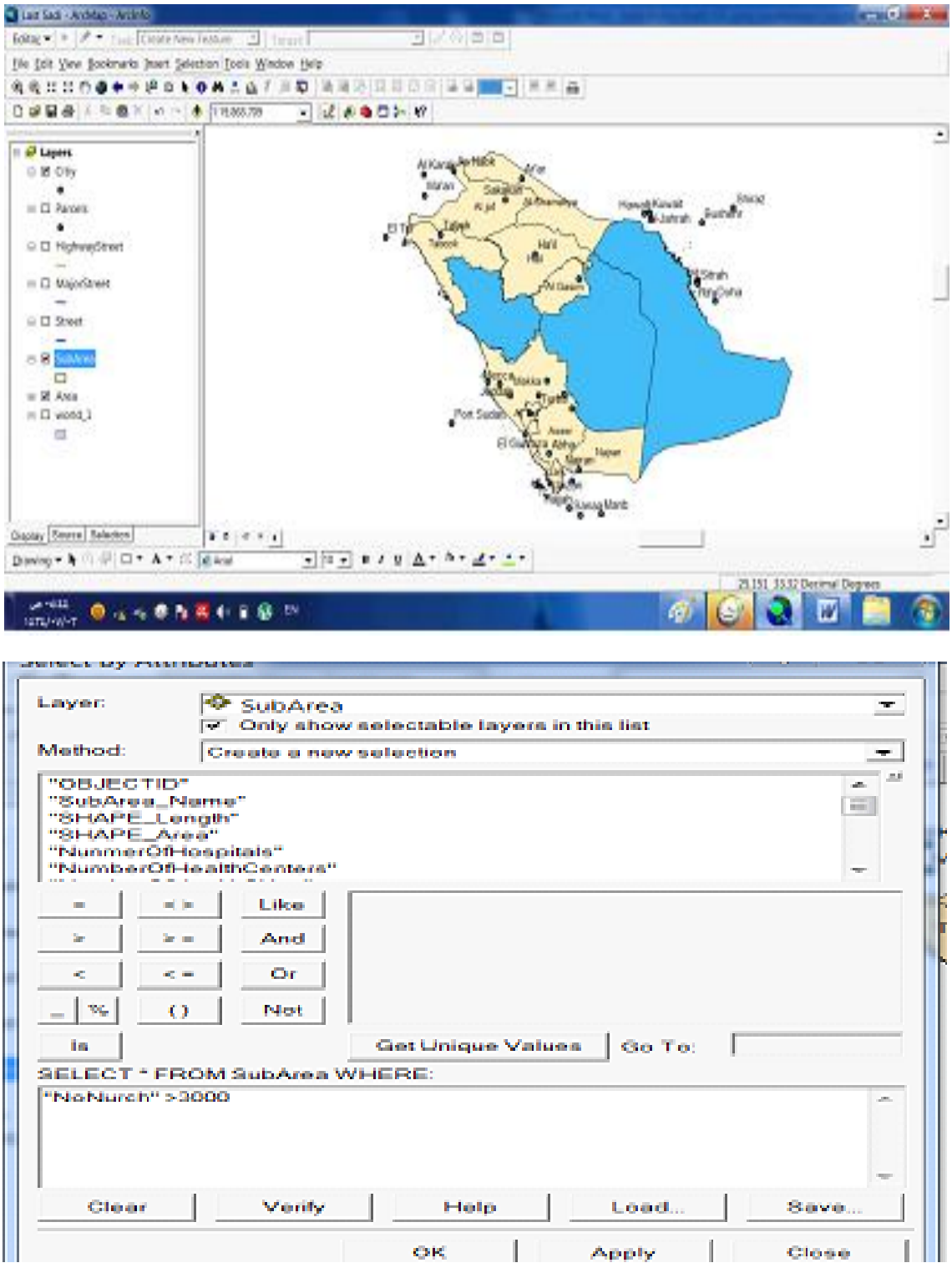


Figure 15: Shows the Numbers of Nurses Greater than > 3000 in Government Hospitals

- Comparison of numbers of nurses was greater than > 3000 in government Hospitals built between the subareas as shown in figure 15.

Comparisons of Diseases Spread in Sub Areas

- Comparison of statistics was built between numbers of patient of blood censer as shown in figure 16.

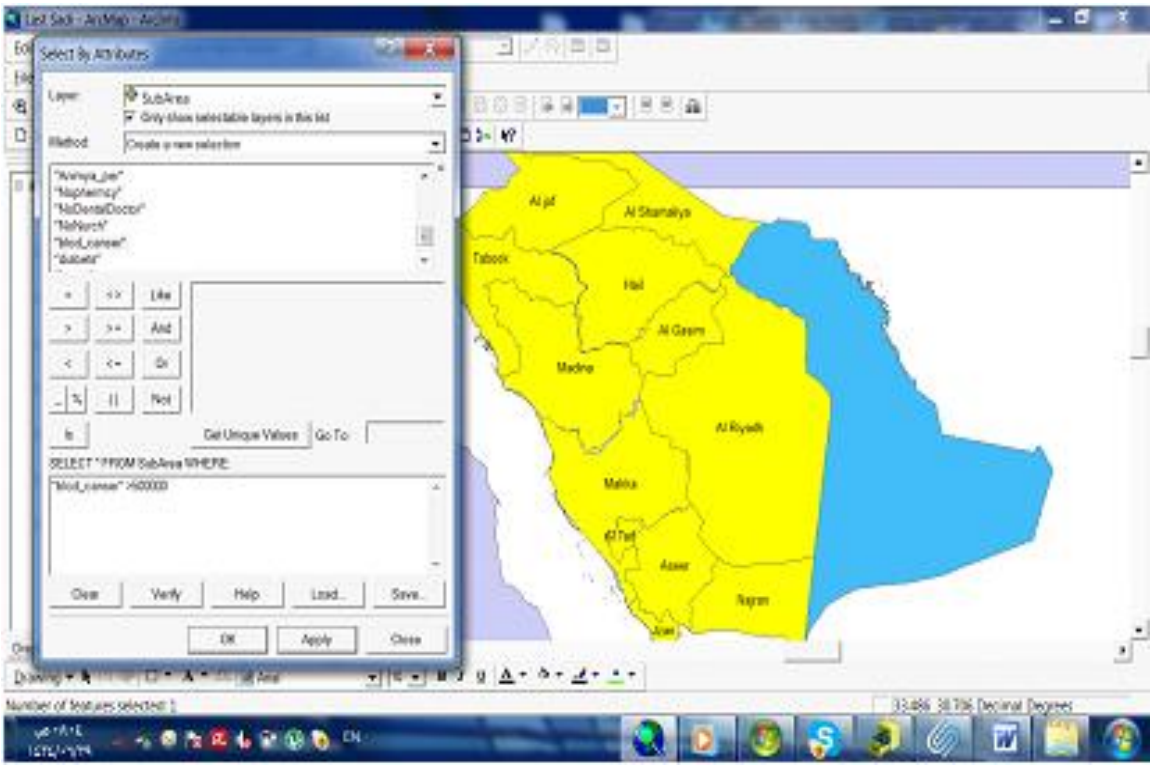


Figure 16: Shows the Patient of Blood Cancer Area Greater than> 500000

- Comparison of Blood Sugar patients numbers of the subareas as shown in figure 17.

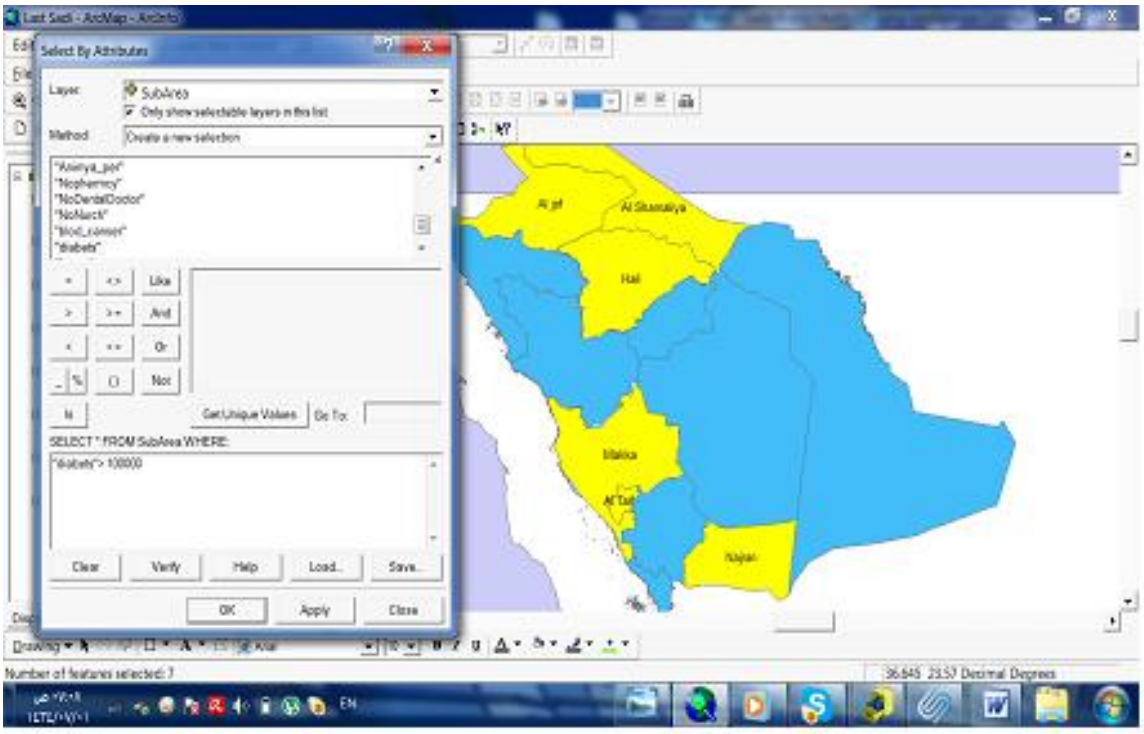


Figure 17: Shows the Patient of Blood Sugar Area Greater than > 100000 Person

SELECTION TRANSPORTATIONS LAYERS BY LOCATIONS

Selection According to the Specific Distance

The former Selects the Subarea Layer Street Length from layers of Highway Streets where, Street length less than < 50 KLM (KiloMeters). This Selection is highest way street between the Cities layers as shown in figure 18.

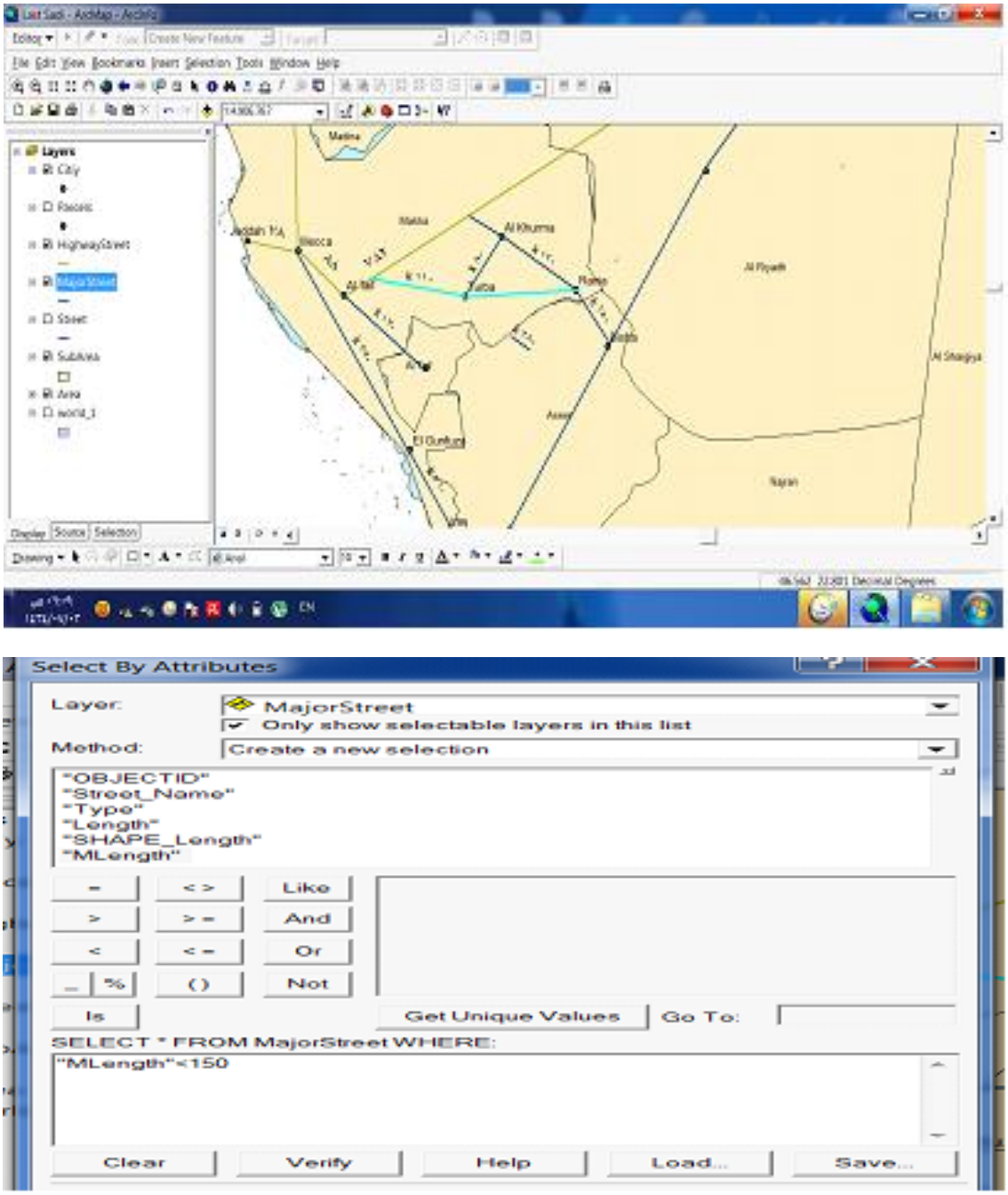


Figure 18: Shows the Major Street < 150 klm in side of Taif Area Map

Selection of the Nearest Distance to the City

For a patient to find the distances and the nearest to a health service, this system can be helpful as shown as figure 19. GIS is being used by public health administrators and professionals, including policy makers, statisticians, epidemiologist, medical and district medical officers. Some of its applications in public health are to: find out geographical distribution and variation of diseases, analyze spatial and temporal trends, identify gaps in immunization, map populations at risk and stratify risk factors, document health care needs of community and assess resource allocations, forecast

epidemics, plan and target interventions, monitor diseases and interventions over time, monitor the utilization of health centers, route health workers and equipments supplies to service locations, publish health information using maps on the internet and locate the nearest health facility.

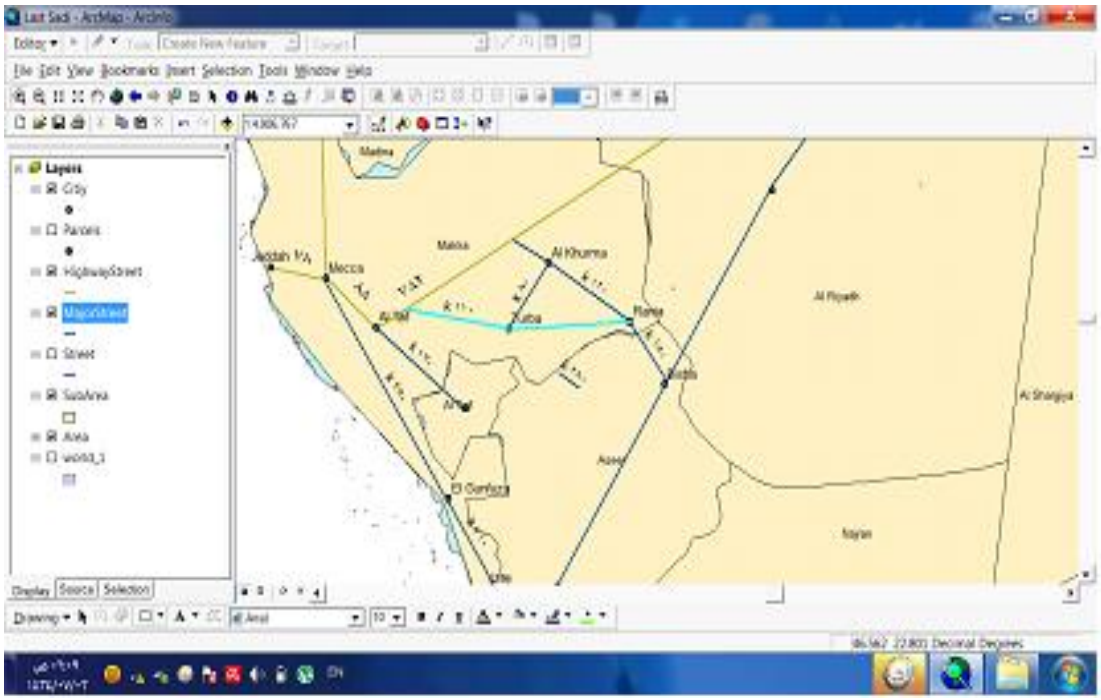


Figure 19: Shows the Major and High way Street in Side Taif Area Map

Special Selection in Taif Area and Neighborhoods Cities

- Comparisions to find most tallest Major street to reach Taif city from a local health services in neighborhood cities named; Trubha, Rania and Khurma Using select by major locations tools
- Select the shortest distance of the Major street to Al Taif city for patient at neighborhood cities such as named, Trubah, Rnia and Khurma even from Biasha and Al Baha health care services as show in figure 20

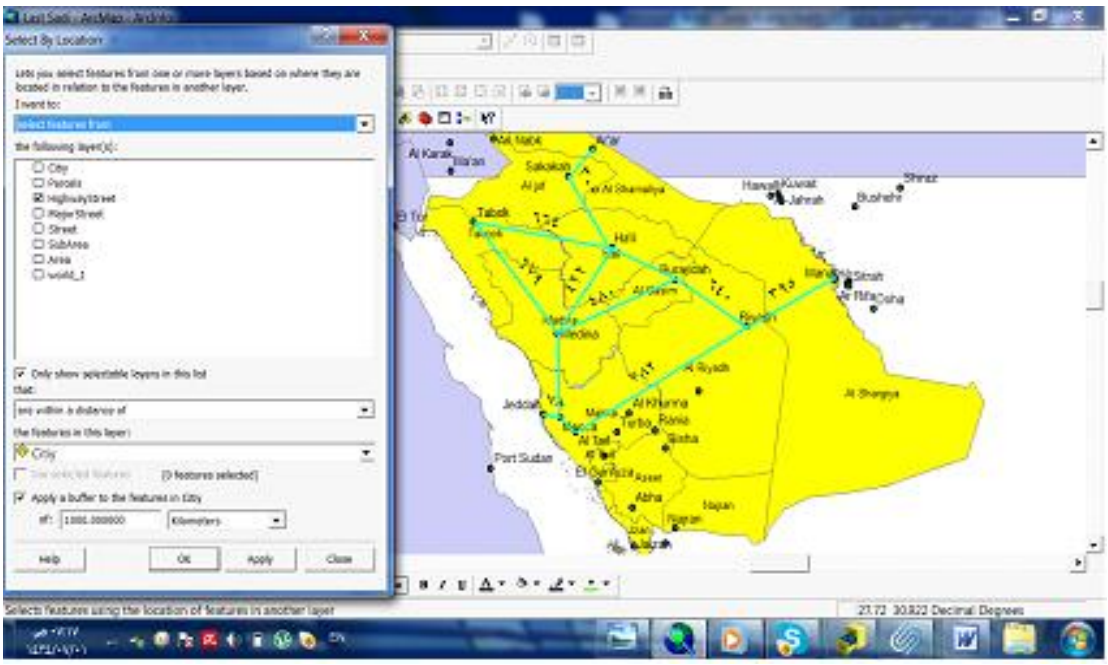


Figure 20: Shows the Major Location with Neighborhoods Cities within 1000 klm

Because of difficulties in having these rates at a micro-scale in Taif city and neighborhood cities, this study has used the data about hospitalized patients as an index for health status in Taif. Ideally hospitalized rates for any area should be based on all hospitals located within the city. However, due to difficulties in having this data for all hospitals (public and private) in Taif the collected data of the selected hospital are used as an example for defining hospitalization rates in Taif and neighborhood cities.

CONCLUSIONS

Health care planning is a challenging field that depends on spatial data such as location and characteristics of health centre demand. Today, health planners have several tasks to cover to assure that health services are provided at the best location. Epidemiology and accessibilities are two important issues in local health planning. The present study has covered these issues by using GIS for Makkah region especially for Taif health centre and neighborhoods cities. GIS is used to analyze the centre catchment as well as studying the spatial data analysis of some diseases such as of blood cancer and blood sugar or fitness patients. The results of this application are very useful for health planners and demands on a micro-scale and explores the possibilities of using GIS for health care services in hospitals at Saudi Arabia subareas. because they evaluate the level of service provision at the selected area. It is found that the existing health supply of Saudi Arabia Subareas comparison was done for health care activities and the relation between populations and geographical areas, transportation criteria was taken to help reaching to neighborhood health care services. The same technique can be applied at the other health centers of other Saudi Arabia subareas , and by doing so health care planning and demanding would be more effective in Taif City and other neighborhood cities named; Trubah, Rania and Al Khurma. Finally; GIS can be considered part of the decision-support systems for people who formulate and follow health policy. Also, GIS is a new technology that staffs with GIS training and skills are in high demand.

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