

# A Study of Health Services Coverage in Khartoum State Using GIS

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**Abstract**--Under the Health and Social Care Act 2011, the code of practice health and adult social care on the prevention and control of infections and related guidance requires all trusts to have clear arrangements for the effective prevention, detection and control of healthcare associated infection, including the procedures to be taken in the event of an outbreak of infection<sup>[9]</sup>.

Turkish colonization 1821 established Khartoum as a capital of Sudan. Since that time, it began to extend through different epochs and governments<sup>[13]</sup>. It consists of three towns Khartoum, Omdurman and Khartoum north. In recent years, Khartoum state received, many migrations, from rural areas and some large cities. They either look for wider job opportunities or better health and education services. Now Khartoum is one of the eighteen states of Sudan. Although it is the smallest state by area (22,142 km<sup>2</sup>), it is populous more than 7 million. So it is the most populated city in the country<sup>[5]</sup>. First hospital in Khartoum was established in 1904 by foreign government at that time. In nineteenth of the last century national government encouraged special sector to invest in health service. The first non-governmental hospital was established in 1997.

This research was oriented to study the health services coverage and its distribution in Khartoum State (2016) using GIS. Khartoum city was taken as a sample of the three cities forming the state. For the purpose of this study, institutions responsible of health and population in addition to field visits were used as the main sources of data. Also, GIS package used to create the maps and link the obtained descriptive information beside the required analysis. Results showed that about 16 per cent of the total health service covered by non-governmental services. Declination of health service coverage is indicated by decreasing of health service coverage ratio in recent years. Moreover, the study reflected that the southern part of Khartoum suffer lack of health service coverage.

**Keywords**--GIS, GPS, Health service coverage, Khartoum State.

## I. INTRODUCTION

Khartoum is located where the Blue and White Niles merge to form the Nile between latitudes 15°26' and 15°45' N and longitudes 32°25' and 32°40' E at an average altitude of 382m above sea level. The city is actually made out of three distinct cities; Khartoum, Khartoum North (Bahri) and Omdurman which are divided by the Nile and its two arms.

According to present political states boundaries, it is bordered on the north and the east by the River Nile State. North-west by the Northern State, and to the east and south-east by states of Kassala, Gedaref and Gezira.

The city of Khartoum - which is the capital of the state as well as the national capital of Sudan - contains offices of the state, governmental and non-governmental organizations, cultural institutions, and the main airport.

Ibrahim Pasha, the ruler of Egypt, founded Khartoum in 1821 as an outpost for the Egyptian Army. The settlement grew as a regional center of trade, including the slave trade.

The city fell to the Mahdists on 1885 and Omdurman became the new capital. In 1899, Khartoum became the capital of Anglo-Egyptian Sudan. When Sudan became independent in 1956, Khartoum became the capital of the new country<sup>[5]</sup>.

Throughout the 1970s and 1980s, Khartoum was the destination for hundreds of thousands of refugees fleeing conflicts in neighboring nations such as Chad, Eritrea, Ethiopia and Uganda. From the mid-1980s onward, large numbers of South Sudanese and Darfuri internally displaced from the violence of the second Sudanese civil war and Darfur conflict have settled around Khartoum.

## II. GEOGRAPHICAL INFORMATION SYSTEM

Geographic Information System (GIS) is an Information System for creating, maintaining, managing and using geographic knowledge. GIS is a complete platform for working (editing, data management, mapping, spatial analysis and visualization) with geographic information. GIS is applied for many fields like: socio economic field, infrastructure, land use/land cover and environment.

GIS is used to produce maps from different data sources as imageries after the latter are digitally processed. Also it is used to overlay several map layers for spatial visualization and analysis using vector or raster data or both.

GIS was a tool for individual projects and departments in the past but in recent years it has moved very fast from being a tool to become the framework for sharing information among organizations and across society. GIS illustrates relationships, connections and patterns in data.

There are many different GIS packages available around the world. These vary in their capabilities and features. The growth of the GIS industry as a result of technological innovations has been exponential. According to a press release from Directions Magazine Online, in 2001, worldwide GIS software revenue reached \$1.1 billion, a growth of 14.3% over the previous year. ESRI and Intergraph accounted for nearly half of the industry's total software revenues<sup>[12]</sup>.

**GIS integrates five key components:**

- Hardware: Hardware is the computer on which a GIS operates. Today, GIS software runs on a wide range of hardware types, from centralized computer servers to desktop computers used in stand-alone or networked configurations.
- Software: GIS software provides the functions and tools needed to store, analyze, and display geographic information. Key software components are Tools for the

input and manipulation of geographic information A database management system (DBMS)Tools that support geographic query, analysis, and visualization graphical user interface (GUI) for easy access to tools

- c. Data: Possibly the most important component of a GIS is the data. Geographic data and related tabular data can be collected in-house or purchased from a commercial data provider. A GIS will integrate spatial data with other data resources and can even use a DBMS, used by most organizations to organize and maintain their data, to manage spatial data.
- d. People: GIS technology is of limited value without the people who manage the system and develop plans for applying it to real-world problems. GIS users range from technical specialists who design and maintain the system to those who use it to help them perform their everyday work.
- e. Methods: A successful GIS operates according to a well-designed plan and business rules, which are the models and operating practices unique to each organization.

### III. DATA COLLECTION

The health services data in Khartoum such as hospitals, governmental health centers and non-governmental health centers were acquired from the Ministry of health of Khartoum state government. It included the health service names, type or level of service and date of establishment. Because there was no map showing the distribution of health service location, a hand-held GPS receiver used to collect location data of health service in Khartoum in form points (X, Y). Table (1) below demonstrates the collected data of health service in Khartoum and its locations.

Table 1: Health service in Khartoum.

ID	Health Service Name	Location		Type*	Date*
		X(m)	Y(m)		
1	Khartoum	449934	1724454	Hospital	1904
2	Al Sajanah	449471	1722742	G. H. C.	1929
3	Toti	447022	1727095	G. H. C.	1935
4	Ophthalmogy_Eyes	451279	1726155	Hospital	1952
5	ALshaab	450148	1724488	Hospital	1959
6	Abo Aglah	453268	1725589	G. H. C.	1960
7	Al Jerif East	455253	1720929	G. H. C.	1960
8	Al Mayqoma	449690	1721373	G. H. C.	1960
9	AlskaHadid	449242	1723867	G. H. C.	1960
10	Al Qwoz	448714	1721623	G. H. C.	1962
11	Sameer	450576	1719195	G. H. C.	1968
12	Al Shejarh	446095	1718440	G. H. C.	1969
13	Alsnaat	448608	1723413	G. H. C.	1970
14	Al Zohwr	450659	1722107	G. H. C.	1974
15	Soba EL gamiy	459752	1714605	Hospital	1975
16	Al Salamabi	453418	1723790	G. H. C.	1976
17	West Al Sahafh	449826	1717976	G. H. C.	1976
18	Police	452728	1725992	Hospital	1980
19	IbnSina	450993	1722234	Hospital	1985
20	Ibrahim Malek	452020	1717991	Hospital	1990
21	ALzara	449585	1724464	Hospital	1990
22	Khartoum Dental	450228	1724544	Hospital	1990
23	Omer Ibn Al Khatab	453109	1718045	G. H. C.	1990
24	Jabra Block 3	449291	1717111	G. H. C.	1990
25	Saad Abu ELela	451111	1720559	Hospital	1991
26	State	449522	1725124	G. H. C.	1992

27	Alengaz	449555	1725134	G. H. C.	1992
28	The Ministry of Finan	449161	1725510	G. H. C.	1993
29	The Ministry Trade	449507	1725521	G. H. C.	1993
30	The Ministry Cabinet	448581	1725599	G. H. C.	1993
31	West Soba Center	462773	1714376	G. H. C.	1994
32	Tax	448964	1723160	G. H. C.	1994
33	Academic	450925	1719445	Hospital	1997
34	Al-AmalToti	447584	1726551	N. H. C.	1997
35	Al Mogtarebin	451444	1719251	G. H. C.	1997
36	Gabir Abu EL ezz	449926	1723021	Hospital	1998
37	Al Remaylah	447449	1721239	G. H. C.	1998
38	Al Farouq	456574	1719371	N. H. C.	1999
39	Al Sheakh Al Burai	454772	1716987	G. H. C.	2001
40	HawadisALatfal KRT	450124	1724700	Hospital	2002
41	Jabrah	448673	1716645	N. H. C.	2003
42	AlsherogAlkhairi	460558	1712833	N. H. C.	2004
43	Al Lamab	446843	1720177	G. H. C.	2004
44	Alshaheed Khalid	448089	1717354	G. H. C.	2006
45	Buri Al Lamab Mosque	455082	1725076	N. H. C.	2007
46	AltakhtitAlstrategy	448933	1725408	G. H. C.	2007
47	Al Osharh	449751	1718810	N. H. C.	2008
48	Zahratnabri	453959	1718318	N. H. C.	2009
49	Alfardos	455586	1718536	G. H. C.	2009
50	Alrahmaalkhairi	455052	1722265	N. H. C.	2010
51	Alriad	454144	1723206	G. H. C.	2012
52	Shawamel Charity	454910	1719822	N. H. C.	Closed
53	Al Hekmah	462304	1714231	N. H. C.	Closed
54	Al Amal Charity	447990	1716107	N. H. C.	Closed
55	Al Moqran	446983	1724832	G. H. C.	Closed
56	Jabra 14	447021	1715410	G. H. C.	Closed
57	Soba Allawta	460760	1712997	G. H. C.	Closed

\*Type:  
G. H. C. : Governmental Health Center,  
N. H.C. : Non-Governmental Health Center.  
\*Date: Date of Establishment.

Beside the data collected about health service, a population data of Khartoum city was also acquired. Population of Khartoum from 1995 up to 2016 as provided by central statistical organization arranged as shown in table (2) bellow.

Table 2: Population of Khartoum

Year	Population
1995	415,099
2000	501,444
2005	587,790
2010	680,906
2016	777,381

### IV. RESULTS AND ANALYSIS

The collected above data was entered in Arc GIS as an attribute table and a map of Khartoum showing the distribution of health services created as shown in figure (1) below.

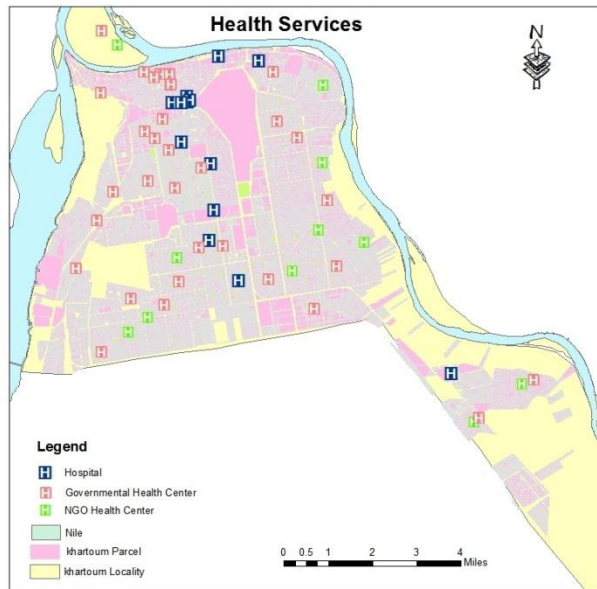


Figure 1: Health services distribution in Khartoum.

health service didn't meet increment in population growth. The ratio reduced to be 1/15,000.

Table (4) Health service coverage ratio

Year	Population	No. of Health Service Locations	Coverage Ratio
1995	415,099	32	1/12,972
2000	501,444	38	1/13,196
2005	587,790	43	1/13,670
2010	680,906	50	1/13,618
2016	777,381	51	1/15,243

Figure (2) below demonstrates how health service coverage going decreasing.

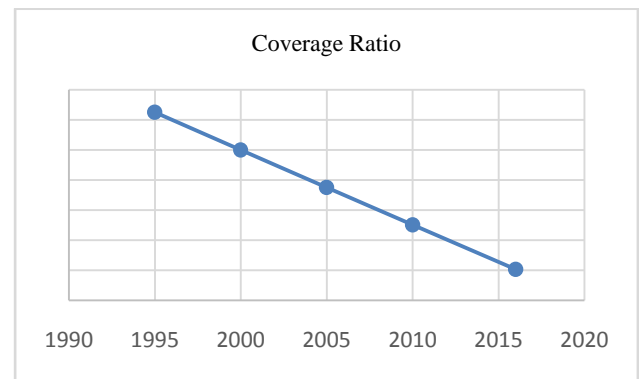


Figure 2: Health service coverage ratio.

By analyzing the collected data it can obviously found that on year 2016, Khartoum town includes 57 health service locations. 13 of them are governmental hospitals, 33 governmental health center and the rest 11 are non-governmental. Six health services locations were closed. Three of them were governmental and rest three were non-governmental.

Governmental health services was begun since 1904 by establishment of Khartoum hospital. Where, Alamal-toti was established in 1997 as the first non-governmental health service center. Development in health service during 1996 up to 2016 was analyzed as shown in table 3 below.

Table 3: Percentage health services development in Khartoum.

Year	Governmental	Non-Governmental	Total	Development %
Before 1996	32	0	32	-
1996-2000	36	2	38	12
2001-2005	39	4	43	10
2006-2010	42	8	50	14
2010-2016	43	8	51	2

From the above analysis of development in health service it can be found that, 14% was the maximum rate of development. It was happened during 2006 to 2010. In which non-governmental health service represent about 16% of the total service.

No development in non-governmental health services coverage during 2010 to 2016. Although, non-governmental health services gradually increase, government doesn't stop extension in health services. From table (2) and table (3) above, health service coverage ratio was computed to be approximately 1 to 13,000 during years 1995 up to 2010. During 2010 to 2016 increment in

Table (5) demonstrates a comparison of population growth with the health services development. It can be noted that during the all periods of study, health services development is less that population growth especially in the latest five years.

Table (5) Percentage population development via health service development

Years	Percentage Development	
	Population	Health service
1996 - 2000	20.8	13
2001 - 2005	17.2	13
2006 - 2010	15.8	16
2011 - 2016	14.1	2

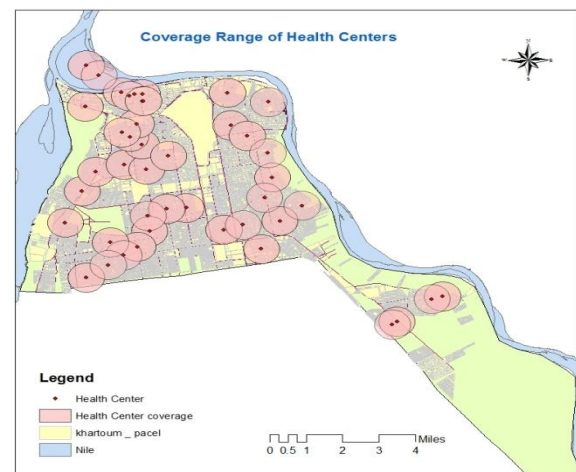


Figure 3: Coverage ranges of health service.

Finally distribution of coverage rang was also tested as shown in figure (3). The figure obviously shows that southern part of Khartoum suffer lack of health service.

### CONCLUSION

By referring to the collected data and analysis carried out on this research work, it can be concluded by the following points:

- In spite of continuous encouragement of special sector to invest in health services, government still try to cover new areas.
- Now Non-governmental health service represent about 16% of the total service.
- No development in non-governmental health services coverage during the resent years.
- Health service coverage ratio was 1 to 13,000 during years 1995 up to 2010 where, the ratio reduced to be 1/15,000in 2010 to 2016.
- Always health services coverage development less that population growth especially in the latest five years.
- Health service coverage going decreasing.
- The southern part of Khartoum suffer lack of health service coverage.

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