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I. INTRODUCTION

The provision of health care centres in Nigeria is a concurrent responsibility of the three tiers of government in the country. However, because Nigeria operates a mixed economy, private providers of medical health care have a visible role to play in health care delivery. The federal government's role is mostly limited to coordinating the affairs of the university teaching hospitals, federal medical centres (tertiary health care) while the state government manages the various general hospitals (secondary health care) and the local government focuses on dispensaries (primary health care) which are regulated by the federal government. The total expenditure on health care is 4.6% of GDP, while the percentage of federal government expenditure on health care is about 1.5% (Wikipedia, 2009).

GIS (Geographic Information System) is a valuable tool to assist health research planning, monitor-

ing and evaluating health systems. GIS can be defined as the science and technology related to the gathering, storage, manipulation, analysis and visualization of georeferenced data (Burrough, 2001).

GIS has been used by several scholars to combine different data and generate information required for decision making in health management. In 1854; John Snow demonstrated the utility of mapping disease outbreaks to gain insights as to their cause. Snow, an anaesthesiologist, mapped the highest density of cases that occurred in households, which used the public pump on Broad Street as their water source (Law et al., 1998). Benachi and Yasui (1999) identified that there was a positive correlation between deprivation of health centres and mortality rate. In their analysis of 2,200 small areas of Spain, they obtained two indices of deprivation and they concluded that, there was excess mortality in deprived areas estimated at 35,000 deaths. Thus, they called for government intervention in the deprived small areas of the country. They also found that there are inequalities in other aspects related to health care, such as, waiting list times, or the access to preventive health services. Olajuyin et al., (1997) investigated the effect of location on the utilization of healthcare centres in Irewole local government area of Osun State, Nigeria. Data used in this research included population data, list of health centres and their locations, and distance of the settlements to each health centre. They found that health centres were unevenly distributed among the settlements and that the distance was a paramount factor.

Okafor et al., (1977) analyzed the spatial distribution and efficiency of health centres in the old Bendel (now Edo and Delta) State. He created a data base of all the health centres in Benin and found that there were discrepancies between the population distribution and the distribution of health centres. Adejuyigbe (1973) used GIS technique to demonstrate the relationship between distance and patronage of health centres in Ife. He noted that attendance at each health centre in Ife region is a function of both type of service available there and the distance from other centre providing similar services. Dzikwi and Abbas (2012) also used GIS to map the spatial distribution of rabies in Kaduna State, Nigeria. They used GIS to analyze record data obtained from the

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state ministry of agriculture and the archived map of the state to track the spread and management of the disease in the state.

The World Health Organization (2004), describes GIS as “an excellent means of analyzing epidemiological data, revealing trends, dependencies and interrelationships that would be more difficult to discover using traditional tabular approach”.

Site selection and distribution of health care centres are important components of an overall health system which has a direct impact on the burden of diseases that affect many countries in the developing world. The creation of health care centres database and mapping helps in showing the spatial distribution and information about location and their physical relations to each other. The purpose of using GIS in site selection and distribution of health care centres is that maps provides an added dimension to data analysis, which helps in visualizing the complex patterns and relationships. The use of GIS for measurement of physical distribution is well established and has been applied in many areas including retail site analysis, transport, emergency services and health care services (Wilkinson et al., 1998).

WHO (1997) specified criteria for health care planning for third world countries and indicated that each service area should cover a 4km catchment area with a population of 60,000.00 for primary health care in order to have adequate and equity of access to health centres.

In line with WHO (1997), this study therefore aimed to map the spatial distribution of health care centres as well as propose sites for new health centres in Chikun LGA of Kaduna state using GIS technique. This aim was achieved by identifying, mapping and creating a GIS database for public and private health centres in the study area. Sites were also proposed for new health centres to take adequate care of the population.

The study area is Chikun local government area of Kaduna state, Nigeria. The local government covers an area of about 445,659km² with a population of 368,250 people as at 2006 (NPC, 2006). Chikun local government area lies within latitude 10°0'N to 10°50'N and within longitudes 6°40'E to 7°40'E. The study area covers Kujama, Kakau, Chikun, Nasarawa, Gwagwada, Sabon Tasha, Kasaya, Kamazou, Buruku and Sabon Gaya districts. Chikun LGA has experienced rapid urban growth, between the early 90s and 2004. The population had increased from an estimate of a hundred and fifty thousand (150,000) in 1994 to an estimate of three hundred and fifty thousand (350,000) in 2003 due to several reasons such which include the immigration of people into the area as a result of religious crisis in Kaduna north and Kaduna central (National Population Commission, 2004). The population of Chikun LGA is said to have risen from

three hundred and sixty eight thousand, two hundred and fifty (368,250) in 2006 to an estimated four hundred and twenty six thousand, nine hundred and two (426,902) in 2011 (FRN, 2007).

II. MATERIALS AND METHOD

The study used data containing the list of health care centres and their addresses in Chikun LGA. Administrative map of Chikun LGA was also sourced from the local government to serve as the base map. GPS was used to collect coordinate points of the health centres in the local government.

a) Procedure of data analysis

The administrative map of Chikun LGA was scanned and geo-referenced using Arc MAP 9.2. On-screen digitization was done with features such as roads, river, and rail-track in the study area digitized as line features. Districts and health care centers were digitized as polygon features. These spatial data were organized in layers.

b) Data base Creation

The following data were collected and used in the development of the database.

- i. The study area map
- ii. List showing health centre names and addresses as shown in table 1.1
- iii. Health care centres coordinates.

All the necessary information for each health centre was entered into its layer's/theme's attribute table. This was done by adding required number of fields (columns) to the table and entering the data for all the health centers in their corresponding records (rows).

The coordinates of the health care centres were copied in notepad and saved as a text (plain text) file format. This file was later imported into Arc Map environment.

Queries were performed using the query builder. The queries performed were

- How many private health care centres were in Chikun?
- How many public health care centres were in Chikun?
- Where can new health centres be located?

The criteria used according to WHO (1997) in selecting the proposed sites for health care centres were:

i. Proximity and Accessibility

According to World Health Organization (1997), the criteria for sitting new health centre based on proximity are as follows:

1. The health centre should not be more than 4km from residential areas.

2. The health centre should be of distance not more than 20m from the major road.
3. There should be easy accessibility to source of water which should not be more than 250m from health the centre.

ii. *Population Size*

The condition based on the size of population for sitting new health centre is that:

1. An area with a population of 500 people should have access to at least 1 health centre.

III. RESULTS AND DISCUSSION

The study identified the health centres on the field, collected the coordinates of the health centres and created a GIS database for both the public and private health care centres in the study area as shown in table 1.1.

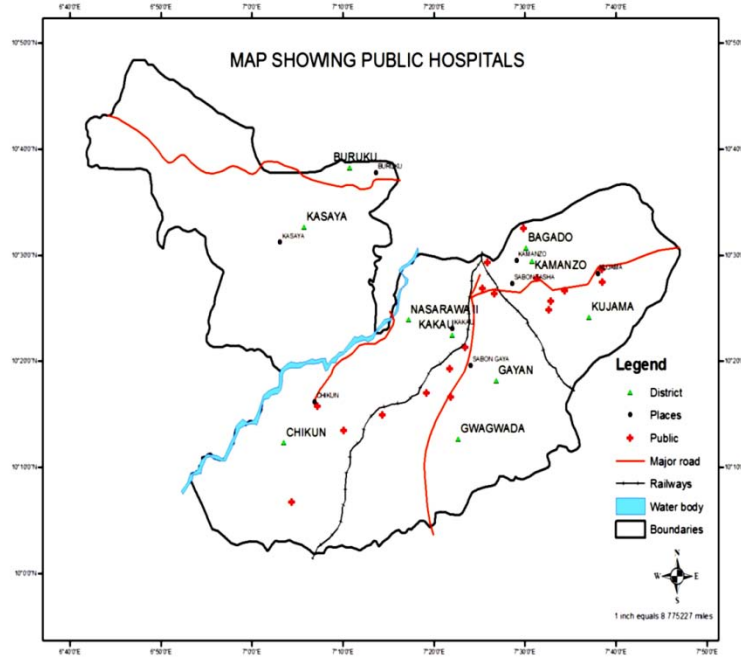
Table 1.1 : The database for Private and Public health care centers in Chikun LGA (2011).

Id	Easting	Northing	Name of health care centres	Address of health care centres	Ownership
1	7°4'20.282"	10°6'44.925"	Public Health Center Katarma	Katarma Village	Public
2	7°10'3.823"	10°13'31.309"	Health Center Gadani	Gadani Village	Public
3	7°7'7.863"	10°15'41.185"	Public Health Center, Chikun	Chikun Village	Public
4	7°14'15.194"	10°14'50.91"	Public Health Center, Gwagwada	Adjacent Primary School, Gwagwada	Public
5	7°198'.461"	10°174'.975"	Health Center, Kajari	Opposite Sarki House	Public
6	7°215'1.853"	10°163'1.459"	Health Center, Bakin Kasuwa	Adjacent Primary School, B/Kasuwa	Public
7	7°213'9.284"	10°191'9.04"	Health Center, Sabon Gaya	Sabon Gaya	Public
8	7°214'3.474"	10°192'3.229"	Public Health Centre, Sabon Gari	Adjacent ECWA Church, Sabon Gari	Public
9	7°23'24"	10°211'6.347"	Public Health Center, Kakau	By Railway Station, Kakau	Public
10	7°252'1.329"	10°265'1.509"	Public Health Centre, Sabon Tasha	Adjacent LEA Primary School, Sabon Tasha	Public
11	7°264'5.12"	10°262'2.182"	Public Health Center, Romi	Near Police Station, Romi	Public
12	7°255'0.656"	10°292'6.521"	Public Health Center, Narayi	Opposite Bayan Dutse Primary School, Narayi	Public
13	7°294'5.269"	10°323'0.86"	Taimako Clinic	Dan bushiya	Private
14	7°312'1.628"	10°275'0.162"	NNPC Industrial Hospital	NNPC Quarters	Public
15	7°383'3.149"	10°284'4.626"	Public Health Center, Tudun Wada Kujama	Behind Kujama Market	Public
16	7°382'8.96"	10°272'9.214"	Public Health Center, Tokache	Opposite Gidan Sarki	Public
17	7°342'1.778"	10°263'8.94"	Brethren Clinic	Opposite Deeper Life Camp	Private
18	7°324'5.419"	10°254'0.287"	Public Health Center, Dokan Mai Jama'a	Behind LEA Primary School, Dokan Mai Jamaa	Public
19	7°323'2.85"	10°245'0.012"	Iyali Clinic	Janruwa Kamazou	Public
20	7°55'2.451"	10°162'4.032"	Washiri Clinic	Opposite Market, Chikun Village	Private
21	7°141'9.384"	10°16'7.273"	Sungungye Clinic	Near Railway Station, Gwagwada	Private
22	7°243'9.434"	10°191'5.802"	Aboki Clinic and	Sabon Gaya	Private

			Maternity		
23	7°222'9.558"	10°202'7.024"	Mission Clinic and Maternity	Kakau	Private
24	7°163'7.638"	10°241'7.448"	Public Health Center, Nasarawa	Behind Primary School, Nasarawa	Public
25	7°191'6.84"	10°252'0.291"	Freed Medical Lab	No. 18 Kaduna road. Nasarawa	Private
26	7°213'9.284"	10°263'5.702"	Salasi and Maternity	No. 4 Zaria road. Nasarawa	Private
27	7°232'8.212"	10°25'3.533"	Shalom Clinic	Hayin Rail, Gonin-Gora	Private
28	7°245'6.192"	10°242'1.638"	Zaitun Clinic	Buwaya, Gonin-Gora	Private
29	7°273'9.583"	10°252'0.291"	Ramadan Maternity	No. 20 Fulani Street, Nasarawa	Private
30	7°304'3.923"	10°263'5.702"	Adoro Clinic and Mternity	36, Abuja road, Sabon Tasha	Private
31	7°322'0.282"	10°265'2.461"	Lafia Clinic	Maraban Rido	Private
32	7°254'2.277"	10°271'7.598"	ECWA Clinic and Maternity	C6, Matazu road, Nasarawa	Private
33	7°261'9.982"	10°282'0.441"	Elshadai Clinic	Narayi Village	Private
34	7°271'4.446"	10°275'1.114"	Alheri Clinic and Maternity	66, Post Office road, Sabon Tasha	Private
35	7°272'2.825"	10°29'6.525"	Covenant Clinic	Adjacent Primary School, Narayi	Private
36	7°285'0.805"	10°281'2.062"	Maternity Clinic	Ungwan Baro	Private
37	7°37'5.169"	10°293'1.663"	Methodist Clinic	Tudun Wada, Kujama	Private
38	7°401'7.888"	10°284'5.578"	Sunday Dental Care	Kujama market	Private
39	6°482'0.88"	10°415'7.398"	Akiya Maternity Health Clinic	Kuriga Ungwan Uwaisu	Private
40	7°112'3.424"	10°35'2.635"	Hauwa Clinic and Maternity	Dantata, Quarters Buruku	Private
41	7°111'5.045"	10°374'6.027"	Alheri Clinic and Maternity	Tsohon Titi, Buruku	Private

The result of the data set for private and public health centres is as displayed in table 1.1. It shows the coordinates, names and addresses of the 41 health care centres in the study area. From table 1.1, it can be observed that there were more private health centres 23 (56.1%) than public health centres 18 (43.9%). The spatial distribution of the public health care centres as mapped is also shown in figure 1.1 while that of the private health care centres as mapped is shown in figure 1.

Figure 1.1 : The spatial distribution of public health centres in Chikun LGA (2011).

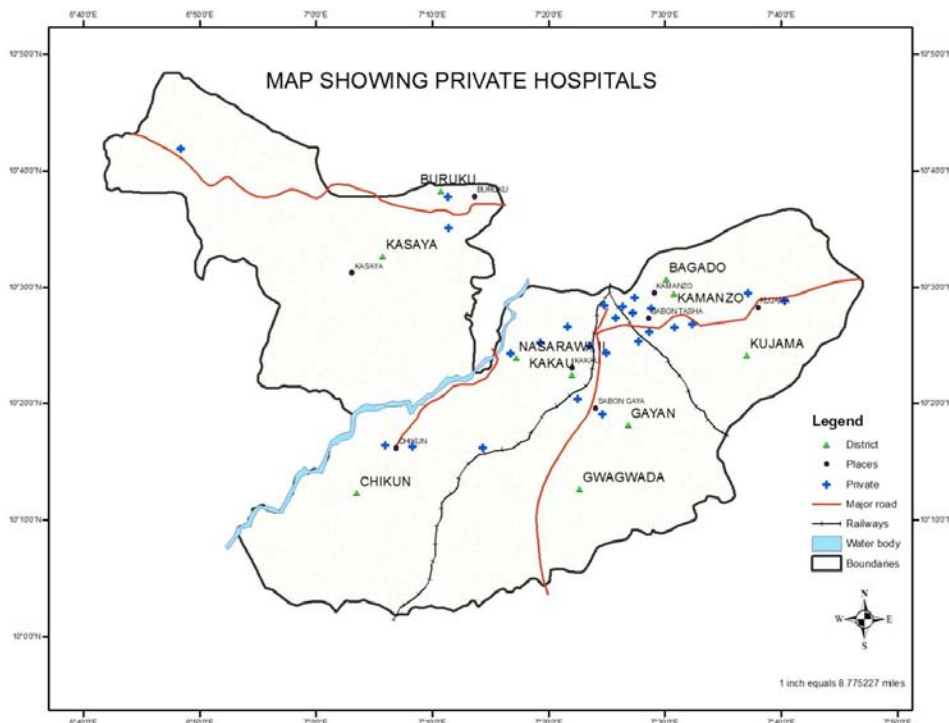


Source : GIS Analysis

From table 1.1 and figure 1.1, it can be observed that out of 41 health centres, there were 18 (43.9%) of public health centres spatially distributed in Chikun LGA. 12 (66.7%) of the public health centres were found to be clustered along the Eastern part of

Chikun LGA in Kamazou, Kujama, Kakau, Sabon Gaya districts while 6 (33.4%) of the public health centres were found at the southern part of the study area in Chikun and Gwagwada districts and none existed at the north western part of the study area.

Figure 1.2 : The spatial distribution of private health care centres in Chikun LGA (2011).



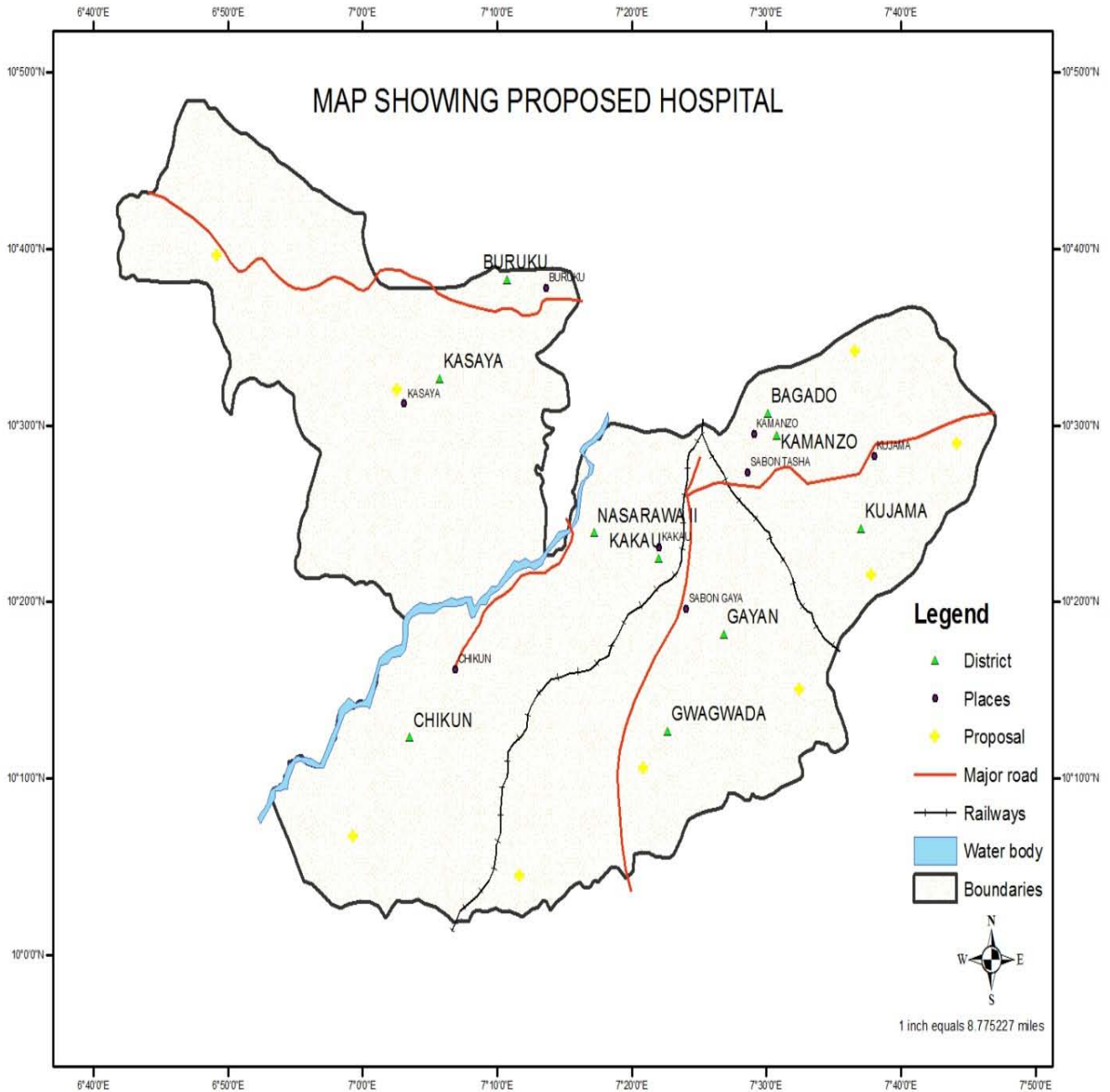
Source: GIS Analysis

From table 1.1 and figure 1.2, out of 41 health centres there were 23 (56.1%) private health care centres spatially distributed in Chikun LGA. It can also be observed that 17 (74%) of the private health centres were concentrated along the eastern part of the LGA in Nasarawa, Kakau, Sabon Tasha, Kamazou districts, 3 (13.1%) were located in the southern part of the study

area in Chikun and Gwagwada districts while 3 (13.1%) were found along the north western part of the LGA in Buruku and Kasaya districts.

In proposing the sites for the location of new health care centres in Chikun LGA, WHO (1997) criteria were taken into consideration. The proposed sites are as shown in figure 1.3.

Figure 1.3 : Proposed sites for new health centres in Chikun LGA.



Source : GIS Analysis.

From figure 1.3, 9 sites were proposed for new health centres based on criteria set by World Health Organization (WHO) in 1997 as stated earlier.

IV. DISCUSSION

The administrative map of Chikun LGA, list of health centres and the addresses were used in the analysis to generate several map layers and database as illustrated in chapter four.

Table 1.1 shows the database of all the health centres in Chikun LGA as at 2011. There were 41 health centres in Chikun LGA both public and private. From table 1.1, the coordinates of health centres are shown.

In figure 1.1, the map of Chikun LGA shows the spatial distribution of public health centres in the study area, there were 18 (43.9%). More public health centres 12 (66.7%) were located and clustered at the north eastern part of the study area and few health centres 6 (33.4%) were at the southern part of the study area and none at the north eastern part of the study area. It is obvious that the public health centres in Chikun LGA were not equally distributed. Some factors that could be responsible for these inequalities were population size of the people. For example, the areas where the health centres were located predominantly fell within urban Chikun while areas with sparse health centres fell within rural Chikun. Other factors that might have influenced the location were political influence and accessibility of the area to infrastructure.

From figure 1.2, the map of Chikun LGA shows the spatial distribution of private health centres in the study area. The private health centres were 23 (56.1%). The figure displays the existence of more private health centres 17 (74%) at the north eastern part of the study area, 3 (13.1%) private health centres at the southern part of the study area and (3) 13.1% at the north western part of the study area. Factors responsible for this distribution may be because the public health centres were not sufficient to meet the demand of the populace hence private investors established private health centres as a business outfit considering the fact that the population size especially in districts that fell within urban Chikun was good for business. The rural Chikun had fewer private health centres due to its population and lack of infrastructure.

Figure 1.3 shows the proposed sites for new health centres. 9 health centres were proposed and sites selected for them based on the criteria of the World Health Organization (WHO) in 1997 that include population size of the area, proximity and accessibility to major roads, residential area and water source.

V. CONCLUSION

It has been revealed by this study in Chikun LGA that serious inequality existed in the distribution of health care centres by both private and public sectors among the districts.

This study has effectively showcased the capability of GIS as a veritable tool for decision support system for site selection for new health centres. It is cost

effective and fair method of selecting sites and it should be encouraged and adopted for policy making and implementation.

Finally, GIS technology has the potential to revolutionize health surveillance. It gives health professionals quick and easy access to large volume of data. GIS is valuable in strengthening the whole process of epidemiological surveillance information management and analyses. Moreover, this system provides analytical support for the planning, programming, and evaluation of activities and interventions in the health sector.

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