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MODELING ACCESSIBILITY TO PRIMARY HEALTH CARE FACILITIES IN CHANCHAGA L.GA OF MINNA, NIGER STATE USING GEOGRAPHIC INFORMATION SYSTEM

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Abstract
The study attempts a method for identifying potential areas for siting new primary health care facilities in Chanchaga local government area of Niger state, Nigeria. This analysis was applied to twenty (20) primary health care facilities within the study area. Buffer analysis was used to determine localities with high and poor access to each of the primary health care facilities. Seven (7) localities were identified as potential areas for establishing new primary health care facilities. The result produced was in form of maps represented as models developed in order to enhance the dissemination of information to the health planners, and aid them in siting new health care facilities in areas they are mostly needed.

Key words: Modeling, Accessibility, Primary Health Care.

Introduction

Primary health care, is essential health care based on practical, scientifically sound and socially acceptable methods and technology, made universally accessible to individuals and families in the community through their full participation and at a cost that the community and country can afford to maintain at every stage of their development, in the spirit of self-reliance. Self-determination Primary health care (PHC) is an imperative strategy to providing *"health for all"* and is widely acknowledged as a universal solution for improving population well-being in the world (World Health Organization and UNICEF, 1978). PHC is crucial as it is a very cost-effective method of health care (more affordable and easier to deliver than specialty or inpatient care). Therefore, if PHC is equitably distributed, it can play important roles in preventing diseases and minimizing health inequality on a large scale in societies (Guagliardo 2004).

Public health and disease are major concerns for developing countries, and access to healthcare is an important factor for ensuring a healthy population. In fact, accessibility is one of the most important components of a health system, as it has direct impact upon the preponderance of disease afflicting many countries. However, despite various significant initiatives there are still gaps to be bridged as regards access to health care.

Access to health care facilities is a multidimensional concept that describes people's ability to use the necessary health care immediately wherever they are. There are two major dimensions for access, which are spatial and non spatial. Spatial accessibility implies that the service is available within the vicinity of a potential user. Non-spatial access, follows when socio-demographic factors for accessibility of health care facilities are considered. However, the number and the type of barriers to accessibility of health care facilities differ from country to country and from time to time. Penchansky and

Thomas (1981) categorized barriers into five types: availability, accessibility, affordability, accommodation and acceptability. The first two types are considered spatial in nature. The last three types are known as non-spatial.

Application of Geographic Information Systems (GIS) in health care has increased considerably in recent years. GIS has provided new solutions for measuring spatial access to health care, such as, modelling the health needs and detailing the accessibility levels to health care facilities. Geographical access models have enormous potential for informing policy development and grounding debate on how to achieve social equity of health care access.

Nevertheless, GIS can also facilitate our understanding of where the most vulnerable populations are more likely to be, and what types of health care services and professionals are close to them. Again, the idea of shortage and the visualization methods available in GIS can help to raise awareness of inequities in health care. For example, in developing countries, GIS can be used to highlight vulnerable populations, in particular places, where measures of health and well-being are low. In this sense, the spatial data, the GIS tools, and the images, or products of GIS visualization, can be used by citizens to demand accountability on the part of the government in reducing inequities

Statement of the Problem

Primary health care facilities were established to be universally accessible to individuals and families. But the spatial distribution of these health centers within Chanchaga local government differs in the number present in one location. This is as a result of inappropriate planning in siting new primary health care facilities which makes the health centers to be located at distances far from areas they are meant to serve. In literature, no GIS analysis has been carried out in the study area to examine the distribution of primary health care facilities.

Aim and Objectives

The study aims at the use of Geographic Information System (GIS) to develop a quantitative methodology to optimally site new primary health care facilities. This would be achieved through the following objectives.

(i) To identify the spatial distribution of primary health care facilities
(ii) To identify gaps in the distribution of primary health facilities in the area.
(iii) To Produce a vector map showing potential sites for new primary health care facilities

Justification of the Study

Measuring health care accessibility helps to shed light upon the performance of healthcare systems within Chanchaga local government area, thereby facilitating the development of evidence-based health care policies. Determining a community's health care access needs and testing interventions to improve access are difficult. This challenge is compounded by the task of translating the relevant data into a format that is clear and persuasive to policymakers and funding agencies. This now calls for the need to have a defined model stored in a GIS format for proper documentation and easy retrieval. Models are a critical resource that can be used by health service planners to prioritize the

location and allocation of health services. The modelling is fairly straightforward and new health services can be processed and existing service access models can be reprocessed quickly on computer systems, even for large data sets which helps in a gradual shift from paper work to geospatial database building that makes the dissemination of information faster. Geographic information systems can analyze and transform complex data from various sources into maps that illustrate problems effortlessly for experts and non experts.

Study Area

Chanchaga local government is located in Minna, Niger State. It lies in the middle belt of Nigeria, situated in the wet tropical or Guinea climate in the Guinea savanna zone. It extends on latitude 9^0 36 22N and longitude 6^0 33 15E as shown in figure 1. Chanchaga local government area is located within the hinterland of Nigeria between the tropical continental north and the sub-equatorial south climate regions. It therefore falls under the tropical continental wet and dry climate based on the Köppen classification scheme. Hence it has a distinct wet season as well as a dry season. Chanchaga local government area is invaded by two distinct air masses, one from the north; dry and continental in origin, the Sahara air mass. The other is from the Atlantic in the south; it is moist cool and equatorial maritime in nature. The weather depends to a large extent on the air mass which covers its area and depth. Annual rainfall distribution pattern shows a maximum of 1300mm rainfall and minimum of 900-1000mm. The rainy season is between April and October covering a period of six months. The month of September has the maximum rainfall.

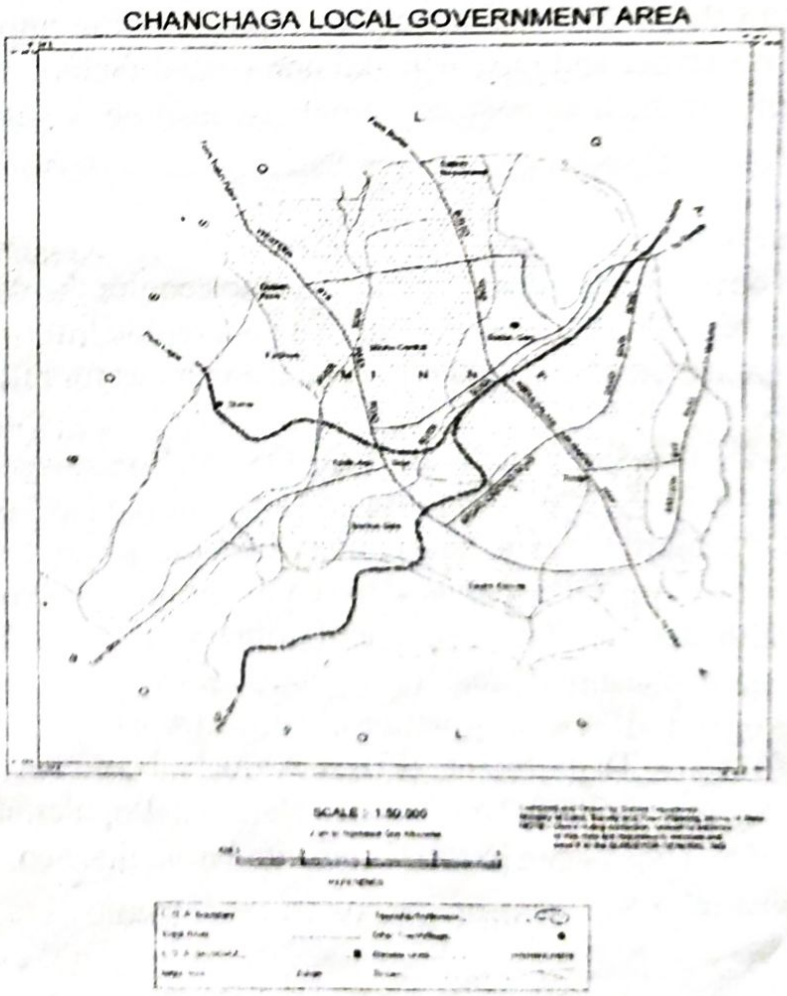


Figure 1. Map of study area. (Source Chanchaga LGA)

There is a considerable literature on the measurement and modelling of health care service provision in different parts of the developed world. The literature on service provision can be broadly summarized under two broad headings, the mapping of service provision and the modelling of accessibility to, and utilization of, services. Work in both these areas ranges from the original seminal work of Joseph and Phillips (1984) to recent studies in the UK, South Africa, the US and Australasia (Lovett *et al.*, 2002).

Access is defined as 'the ability to secure a specified set of healthcare services, at a specified level of quality, subject to a specified maximum level of personal inconvenience and cost, while in possession of a specified amount of information'. The nearest to an agreed principle for equity is 'equal access to health care for those in equal need' (Tanser, 2004)).

Within core health geography texts, there is a further division of measurements of access into what might be referred to as 'spatial' and 'aspatial' elements (Joseph and Phillips, 1984). A key starting point for the modelling of acute hospital provision was the study carried out by Bagheri et al. (2005) in Illinois. They modelled the location of both acute general and specialist geriatric hospitals within the state against background demographic data on elderly populations. They used GIS to model accessibility to both hospital types using census block group centroids and five separate accessibility measures.

Wang and Luo (2004), in their work explained a new approach for calculating spatial accessibility to primary health care (PHC) services. Anderson (2002), considered both spatial and non spatial factors in examining accessibility to primary healthcare in Illinois. The result shows that spatial access emphasizes the importance of geographic barrier between consumer and provider, and non spatial factors include non geographic barriers or facilitators such as age, sex, ethnicity, income, social class, education and language ability.

Material and methods

The first step in developing a model using GIS is to acquire the data and place them into the computer system. The database system of a geographic information system provides the means to organize the spatial and non-spatial attributes for efficient storage, retrieval and analysis.

Most data used for this study include, IKONOS satellite imagery on Minna acquired 10:31 GMT, 7th February, 2005 and those collected during field survey in the study area which include GPS coordinates, personal interviews and questionnaires.

A handheld Garmin eTrex GPS was used to acquire ground control points for settlements and primary health facilities. Other source of primary data includes field visits, personal interviews and use of questionnaires.

Secondary data include all the information obtained from Chanchaga Local Government Primary Health Care Department (PHC) Minna, National Primary Health Care Development Agency (NPHCDA) Minna, National Population Commission (NPC) Abuja, the use of text books and journals consulted from the web. **ArcGIS 9.2: was used for Geo-spatial analysis.**

Methodology

The IKONOS satellite image was chosen because of its high spatial resolution, which is ideal for onscreen digitizing. **The IKONOS image was** geo-referenced using ArcMap version 9.2. The geo-referencing was done using the coordinates of known points on the image, which were obtained on ground with a handheld GPS. The Ikonos image was geo-referenced to ensure proper identification of correct location of features on the map just the way it is on the earth surface.

Digitizing

Digitizing simply refers to the conversion of a paper map, satellite image, raster data set to digital form. The process of digitizing was carried out after georeferencing and subsetting (preserving Chanchaga local government which is the area of interest) the satellite image to produce a road network map of the study area, although other features like rivers and settlements were identified. The different classes of features identified were structured into layers of diverse information called shape files.

Importing the GPS Coordinates

Microsoft excel was used to save the GPS coordinates so that they could be imported to the ArcGIS environment. The imported coordinates were converted into a shapefile to allow for buffering, database creation and geographical location of settlements and primary health care facilities.

Database Creation

The data base consists of information on; Name of the primary health facility, location of primary health care facilities with reference to ground control points, attribute data for example, number of doctors, community health workers, nurses, bed spaces, and year established e.t.c.

The attribute data were embedded in the spatial database to aid as a form of descriptive information about the stored spatial feature.

Creating Buffer Zones

One simple way to evaluate accessibility is by a buffer distance around a point. The buffer analysis was used to create a specified distance of 1km around each of the primary health care facility point feature to be able to identify areas that fall inside or outside the buffer zone.

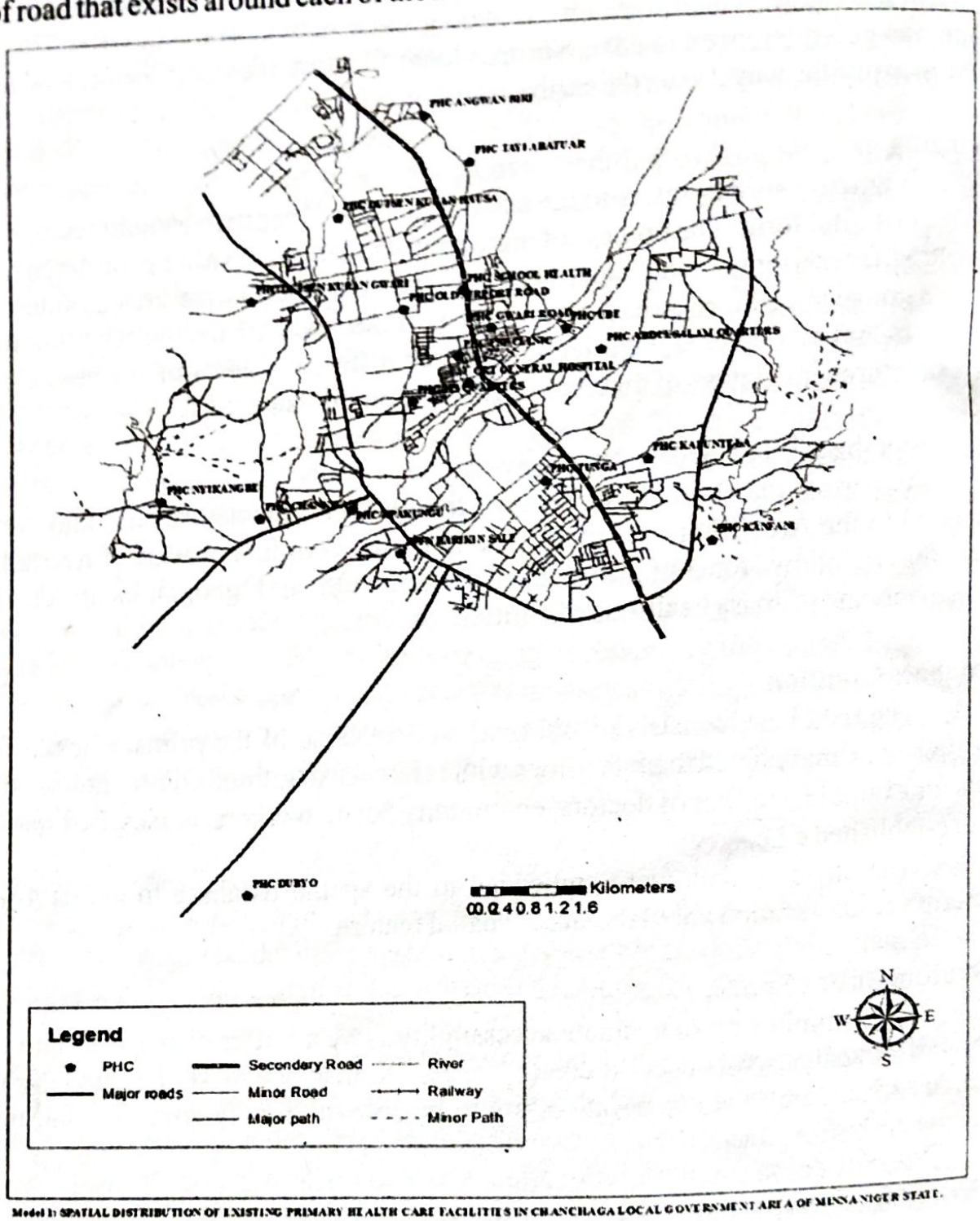
Discussion of Result

Following the geospatial analysis carried out, the results is presented in form of vector maps. These maps show the spatial distribution of primary health care facilities, selected settlements, buffer zones and the road network map of Chanchaga local government area.

Spatial Distribution of Primary Health Care Facilities

Model 1, shows the spatial distribution of existing primary health care facilities within the study area. This was achieved using the hand held Garmin eTrex GPS to

provide an exact positional information of the facilities. The result of this procedure shows the existing primary health care facilities, their locations and distribution. It was observed that the facilities are not evenly distributed within the study area. The point features of the facilities were overlaid on the road network of the study area to identify the type of road that exists around each of the health facilities.



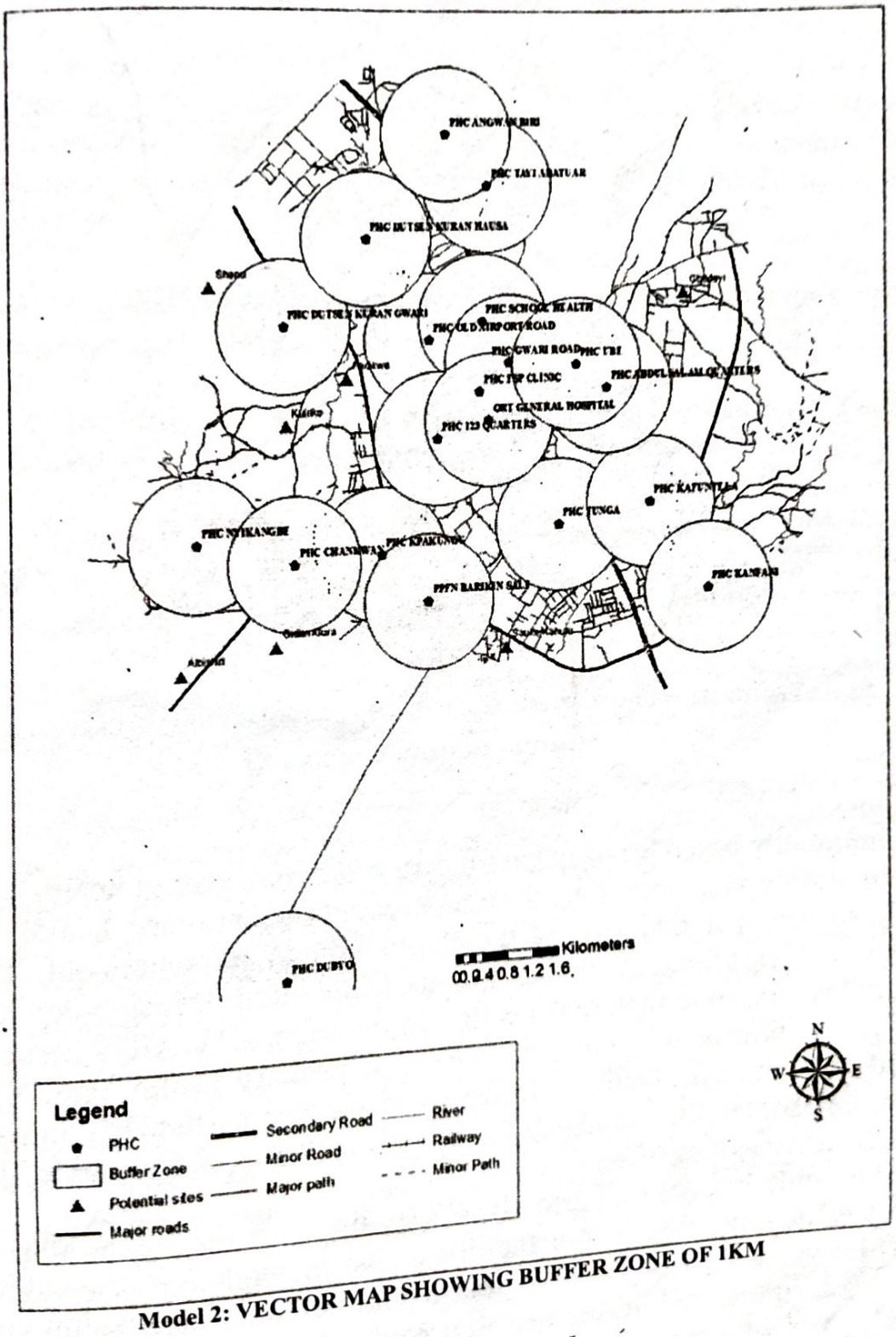
Model 1: SPATIAL DISTRIBUTION OF EXISTING PRIMARY HEALTH CARE FACILITIES IN CHANCHAGA LOCAL GOVERNMENT AREA OF MINNA NIGER STATE.

Vector Map Showing The Buffer Analysis

The ArcGIS network analysis was used to buffer out a walking distance of 1km from each of the primary health care facilities (Model 2). The buffer zone also represents the accessibility zone that was represented with a circle making it possible to establish areas with high and poor accessibility to any of the primary health facilities. Some of the accessibility zones are overlapping each other, especially in the central part of the study

area where the access zones of eight (8) of the primary health care facilities were overlapped with each other.

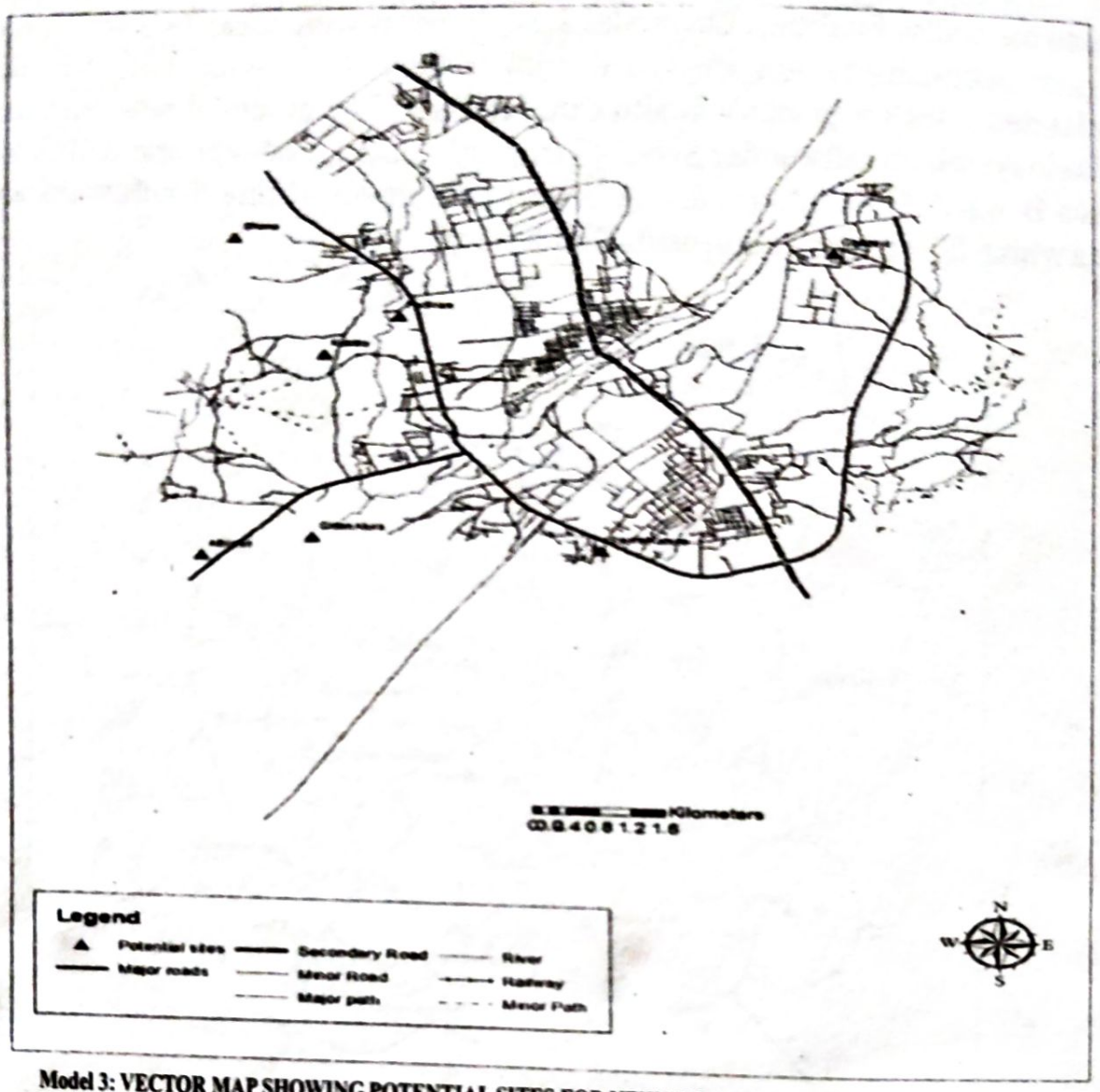
This goes on to show that populations found within this area would have high access to the health facilities. On model 2, settlements were identified with circle. Areas with poor accessibility are identified with triangle to provide ease for identifying potential new sites for primary health care facilities. The potential new sites discovered are Gbadnayi which falls under Sabon Gari ward, Shanu, Fadukpe and Kutriko all under Limawa B ward, Gidan Alura and Albishiri falls under Minna South ward and Sauka Kahuta which falls under Tudun wada South ward.



Model 2: VECTOR MAP SHOWING BUFFER ZONE OF 1KM

Vector map showing potential sites for new primary health care facilities.

Model 3 shows seven (7) localities that are suitable for establishing new primary health care facilities



Model 3: VECTOR MAP SHOWING POTENTIAL SITES FOR NEW PRIMARY HEALTH CARE FACILITIES

Source: (authors analysis)

Conclusion

Community based primary health care is the mainstay of health care delivery to persons in developing countries. In these countries, primary health care must be accessible to the vast majority of the population to be successful. The successful attainment of at least three of United Nation's Millennium Development Goals, (reduce child mortality, improve maternal health, and combat HIV/AIDS, malaria, and other diseases) is contingent on improved access to primary health care. This makes the placement of health care facilities in deprived settings particularly important and it is therefore vital that facilities are sited in such a way that as many people as possible have access to the services they offer.

This study has devised a methodology that aids the health planner in efficient placement of new primary health facilities. The methodology successfully identified seven (7) localities for new facilities that would maximize accessibility to health care. The same principles used in this research could also be applied in other settings. The methodology is of practical value in health research and practice and provides a

framework for optimizing location of new primary health care facilities.
It is recommended that there is need to establish Primary health care facilities in the newly identified localities to increase population access from their home or place of work.
The government and other interested agencies should as much as possible provide adequate funding to promote increased utilization of these primary health facilities together with properly trained health workers.

References

Anderson R.M (2002). *The application of geographical information systems to important public health problems in Africa International Journal of Health Geographics*. 1, (4).

Bagheri, N., Benwell, G. L., Holt, A. (2005). *Measuring spatial accessibility to primary health care. In: Whigham PA, editor.* The *17th annual colloquium of the Spatial information research centre.* (2005) November, 24-25 Dunedin, New Zealand: University of Otago, (2005), (103-108).

Guagliardo, M. F., (2004) *Spatial accessibility of primary care: concepts, methods and challenges, International Journal of Health Geographics,* 3, (3).

Joseph, A. & Phillips, D. (1984). *Accessibility and utilization: Geographical perspectives on health care delivery. New York: Harper and Row.*

Lovett, A. A., Haynes, R. M., Sünnenberg, G. and Gale, S., (2002). Car travel time and accessibility by bus to general practitioner services: *A study using patient registers and GIS", Social Science & Medicine,* 55, (97-111).

Penchansky, R., Thomas, J. W., (1981). *The concept of access: Definition & relationship to consumer satisfaction.* Med Care, 19(2),127-140.

Tanser, F. C. (2004). *A methodology for optimizing location of new primary health care facilities in rural communities: a case study in KwaZulu-Natal, South Africa." Journal of Epidemiology and Community Health.*

Wang, F., Luo, W., (2004). *Assessing spatial & non spatial factors for healthcare access: Towards an integrated approach to defining health professional shortage areas.* Health and Place, 11(2), 62-63.

WHO (World Health Organization).*Alma-Ata (1978). Primary health care.* Report of the international conference on primary health care, Alma-Ata, union of soviet socialist republics, 612 september (1978). geneva: World health organization; (1978).