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Spatial analysis of health facilities in Yola, Nigeria, using GIS

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INTRODUCTİON

One of the main goals for spatial health care facility planning is to achieve equitable *geographic distribution*.

However, public policy on health care provision in Nigeria over the years addresses the distribution and spatial equity question mainly at the gross/regional level while neglecting the distribution of such facilities within towns/cities.

As such, their provision within towns/cities level are haphazardly distributed due to lack of tangible and reliable planning information, and the lack of knowledge of such tools like GIS which will help the planners in resource allocation and decision-making process.

INTRODUCTİON (CONT...)

Therefore, this study explores the possibilities of using GIS to model the spatial pattern and accessibility of health care delivery system in Yola.

The specific objectives of the study are:

- To carry-out an inventory of all the public and private health facilities in Yola.
- To characterize and display spatial pattern of the health facilities.
- To carry out service mapping in health facilities
- To model the accessibility to health facilities in Yola.

THE STUDY AREA

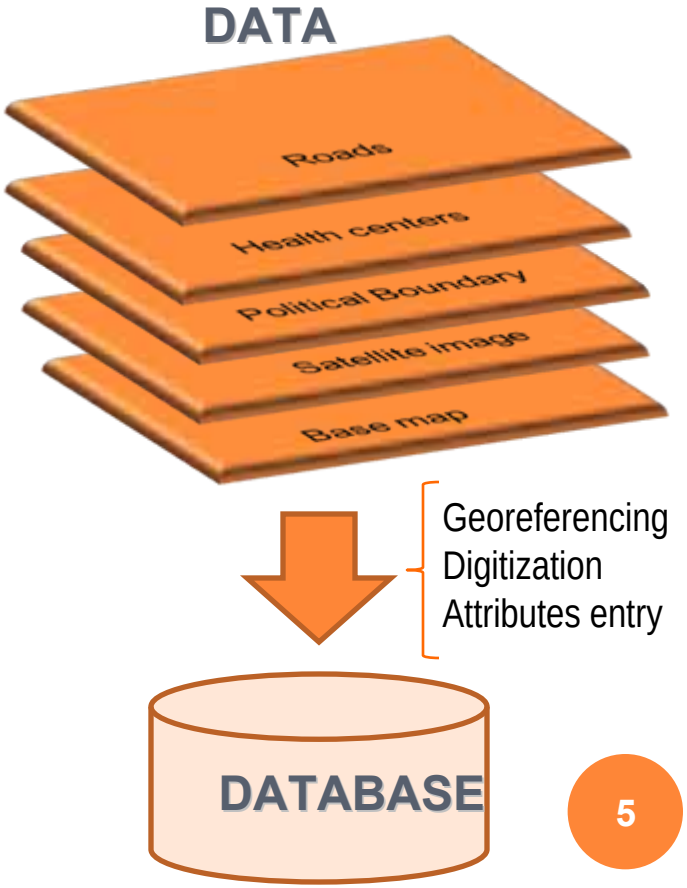
- Yola is the administrative headquarter of Adamawa State, Nigeria.
- It lies on **9°13′ 48″ N, 12° 27′ 36″ E/ 9.23° N, 12.46°E**.
- It has a population of **399,598** (2009 projection).

MATERİALS AND METHODS

DATA PROCESSING

This study utilized *ArcGIS 9.3*. Both analogue and digital data were collected. The analogue data were transformed into digital format for input to the *ArcGIS* and the followings layers/database was created:

- *Road network:* name, class, surface condition, and length.
- *Locations of health centers:* size, no. of physicians, pharmacists, nurses/midwives, medical technicians, and service area.
- *Political ward boundaries:* basically used as service areas of health centers.
- *Population:* 2006 census projected to 2009 according to wards basis using the 2007 voters registered data since the the population data was only provided as general total.



ANALYSİS METHODS

In this study four techniques were used for the analysis, namely:

- Symbology
- Kernel density estimation (*KDE*)
- Buffer
- Raster calculator

Symbology is a set of conventions, rules, or encoding systems that define how geographic information is represented with symbols on a map. Symbology comes in many different forms, e.g. graduated colors, graduated symbols, dot density, proportional symbols, bar and pie charts, and custom symbols.

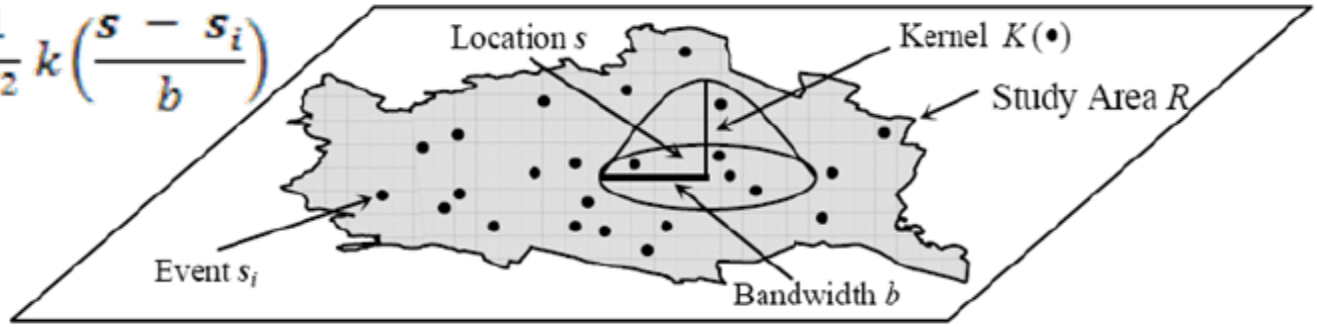
Buffer is applied to define proximity to health facilities. Areas within the buffer are considered accessible to a facility, while those outside are assumed inaccessible to it. Areas where there is abundance of overlapping buffers might represent areas of over service and vice-versa.

Raster calculator is used to perform some mathematical operations from the outputs generated from *KDE* analysis.

ANALYSİS METHODS

Kernel density estimation is a nonparametric technique which estimates the probability density function (pdf) directly from the data without any assumptions about the underlying distributions.

$$\hat{\lambda}_{\tau}(s) = \sum_{i=1}^{n} \frac{1}{b^2} k\left(\frac{s - s_i}{b}\right)$$



where *k( )* is the kernel, *b* is the bandwidth and the adaptive bandwidth is taken as:

$$\tau(s_i) = \tau_0 \left(\frac{\hat{\lambda}_g}{\tau(s_i)}\right)^{\alpha}$$

where $0 \leq \alpha \leq 1$ is the sensitivity parameter, and $\hat{\lambda}_g$ is the geometric mean of the pilot estimates $\hat{\lambda}(s_i)$ at each s_i

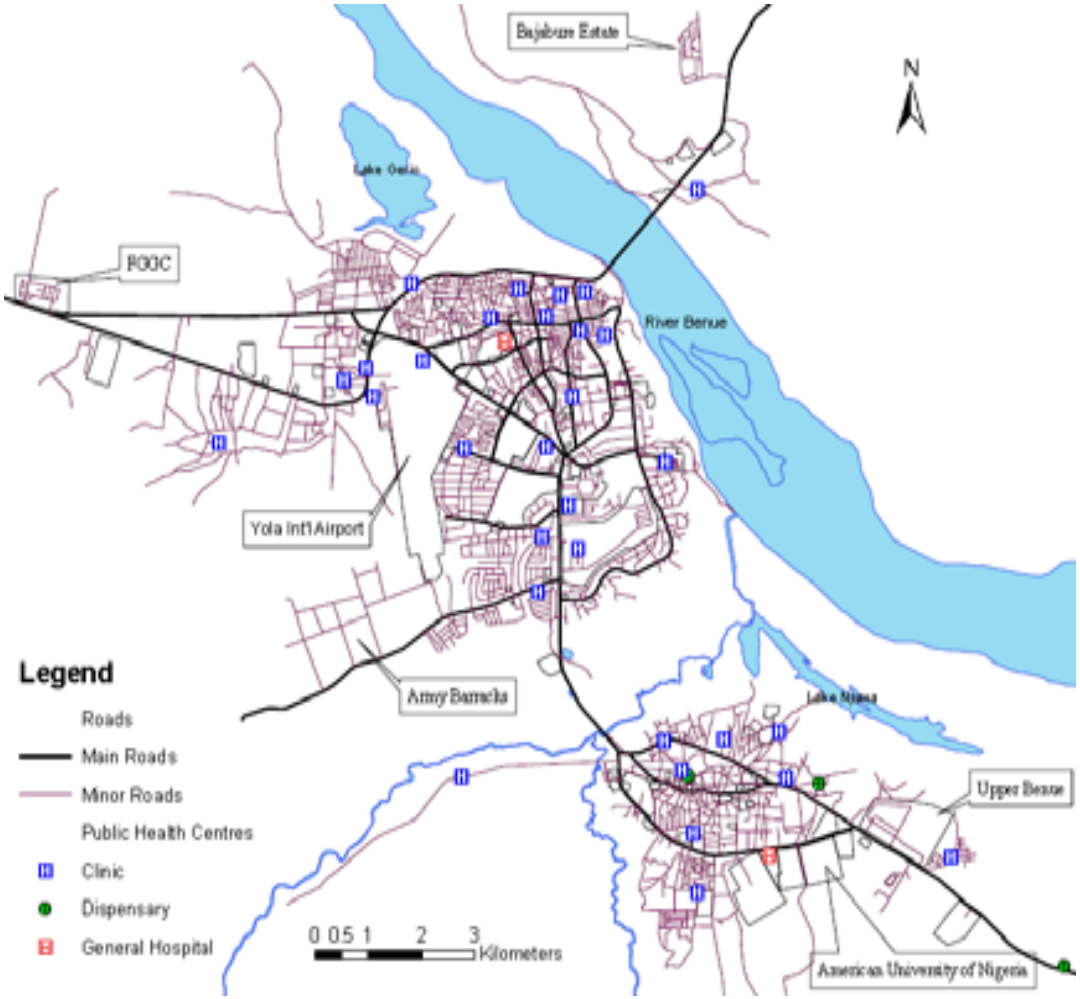
ANALYSIS AND DISCUSSIONS

Classification and spatial distribution of health facilities in Yola:

Three categories of health facilities were identified in Yola, namely:

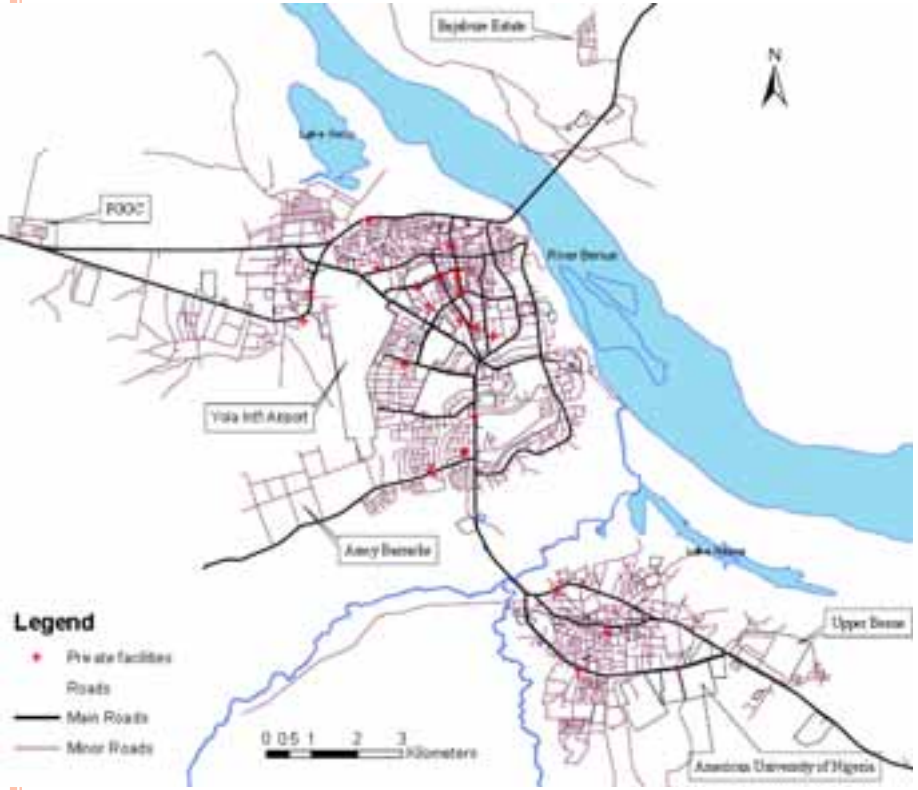
- ✓ *Primary - dispensaries*
- ✓ *Secondary – clinics*
- ✓ *Tertiary - general hospitals*

Ownership of these facilities is divided among federal, state, and local governments, and private individuals/organizations.

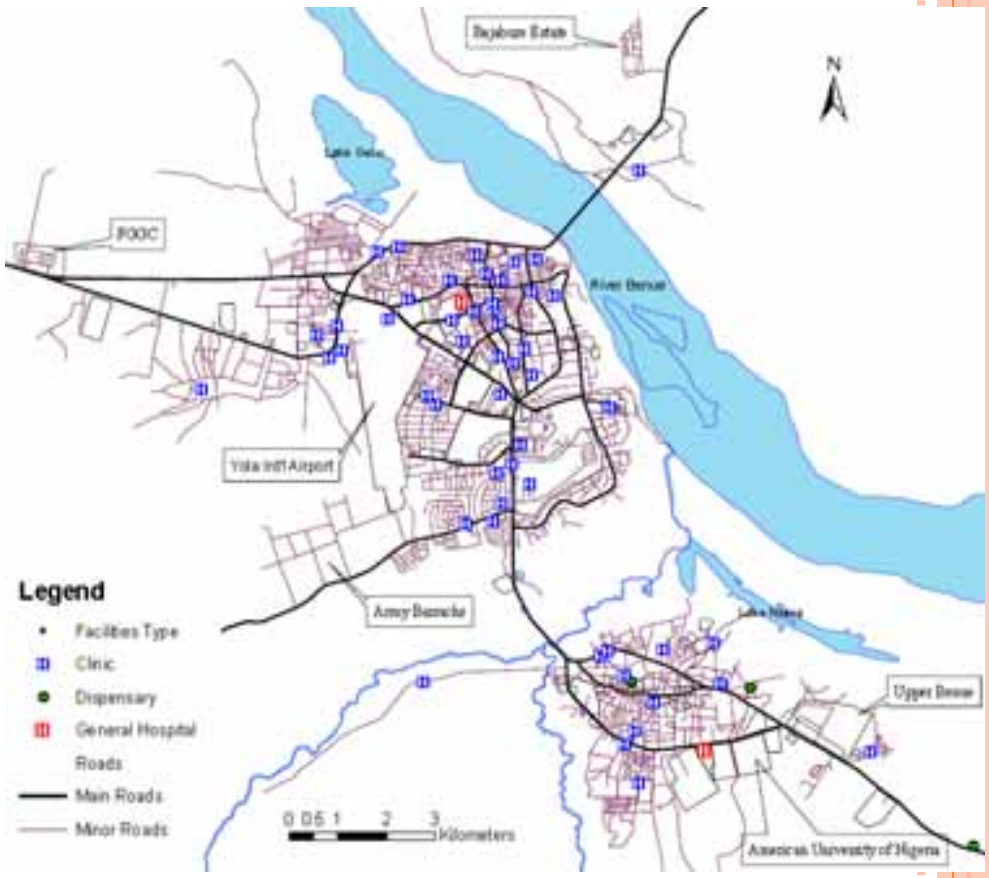


Public health facilities in Yola

CLASSIFICATION AND SPATIAL DISTRIBUTION OF HEALTH FACILITIES IN YOLA (CONT...)



Private health facilities in Yola

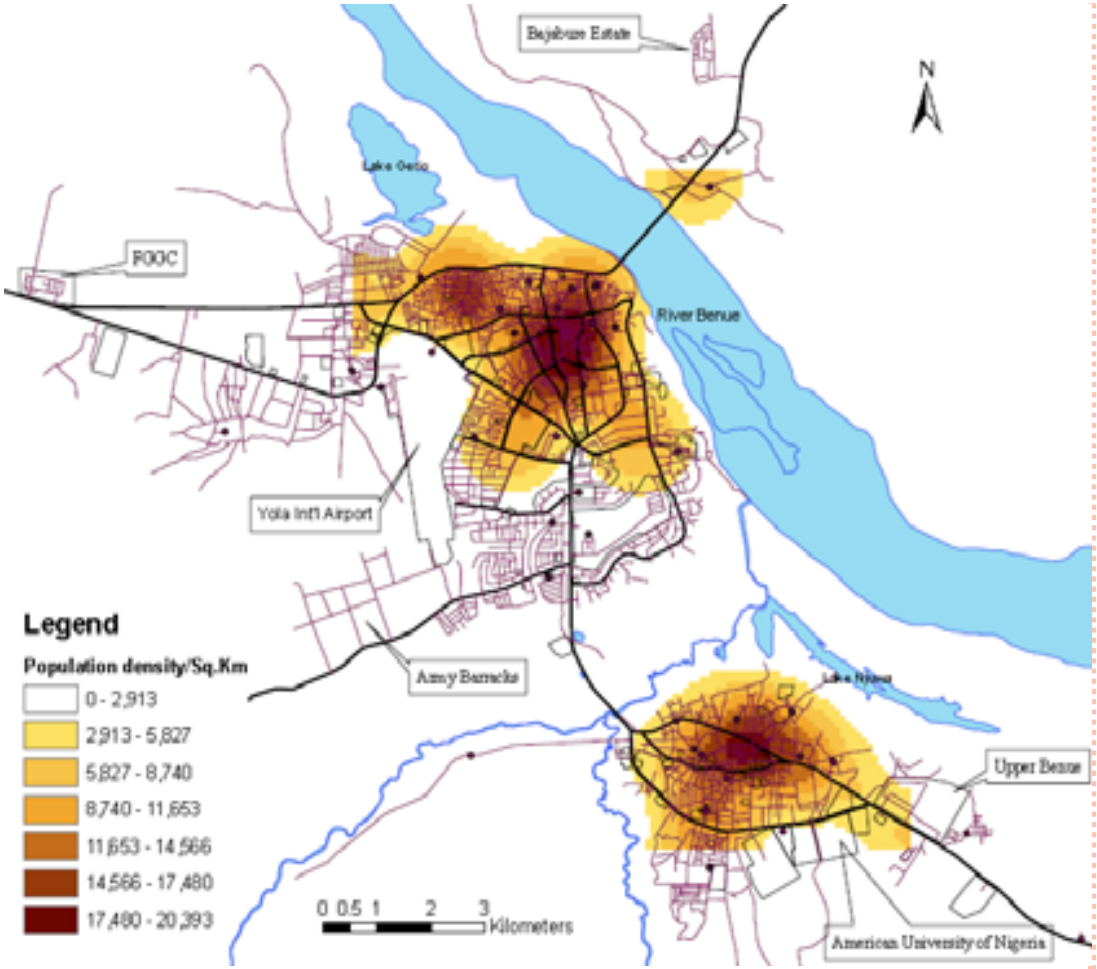


Spatial distribution of health care facilities in Yola

POPULATİON DİSTRİBUTİON

- Knowledge and understanding of demography is very essential for health services development and delivery, as it allows for planning and targeted service provision.

- To assess the existing health facilities in Yola, a 1500 m band width and 100 cell size of Kernel density estimation was applied.



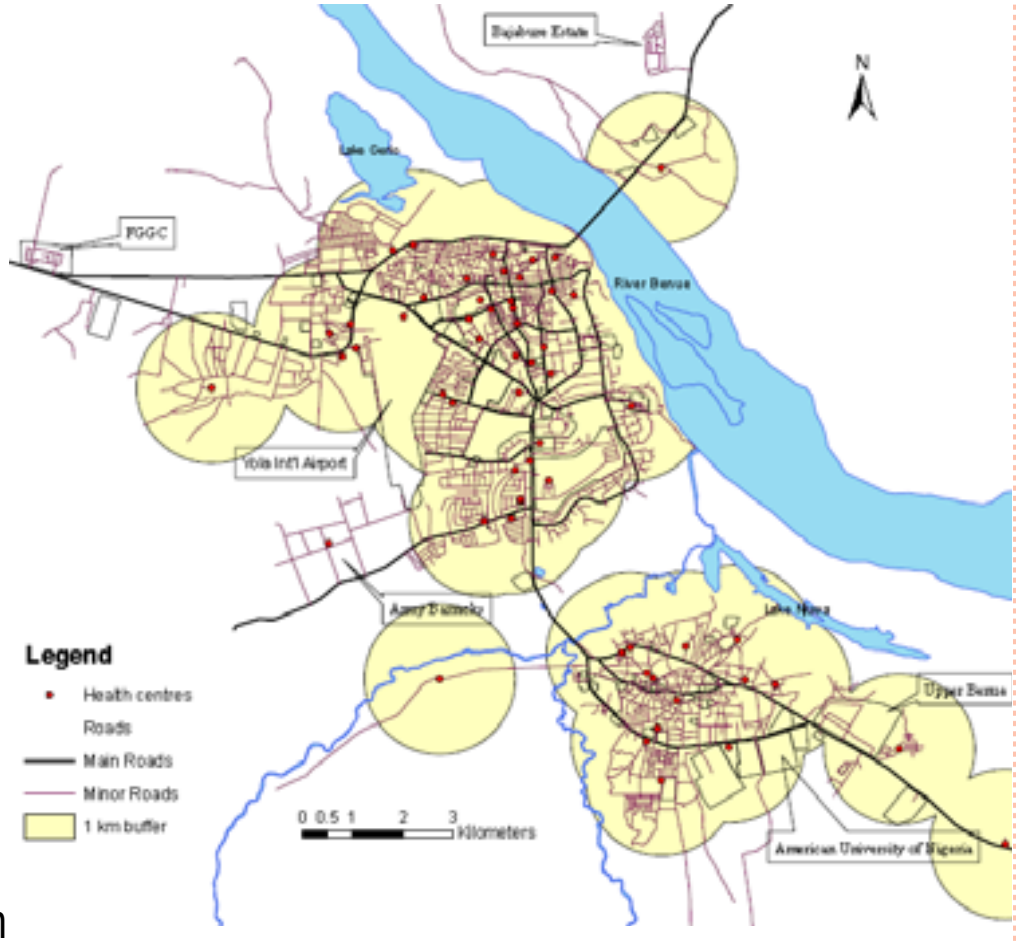
Population density surface of Yola

EXAMINING HEALTH FACILITIES ACCESSIBILITY

The simplest definition of accessibility of a given location is in terms of how easy it is to get there. Defining accessibility to health centers is one important task for health planners. The accessibility models built for Yola are based on the following indicators:

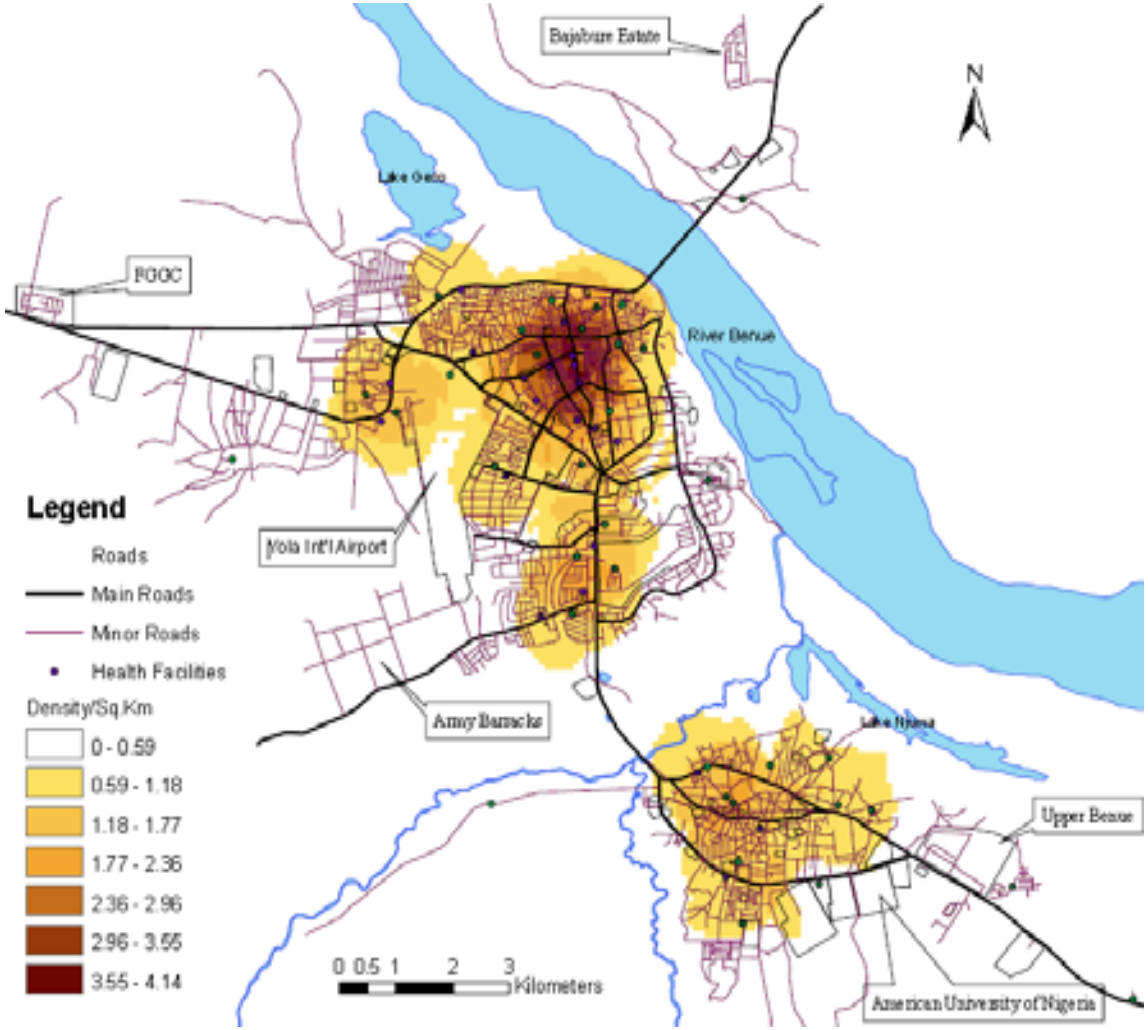
- ✓ Distance to the nearest health centre,
- ✓ Density of health facilities,
- ✓ Density of physicians,
- ✓ Health facility-to-population ratio, and
- ✓ A combined health care accessibility indicator.

Proximity to health facilities: Based on Municipal planning standard of 1 km service areas a buffer was applied.



Proximity to health facilities in Yola using Euclidian buffer

HEALTH FACİLİTİES DENSİTY

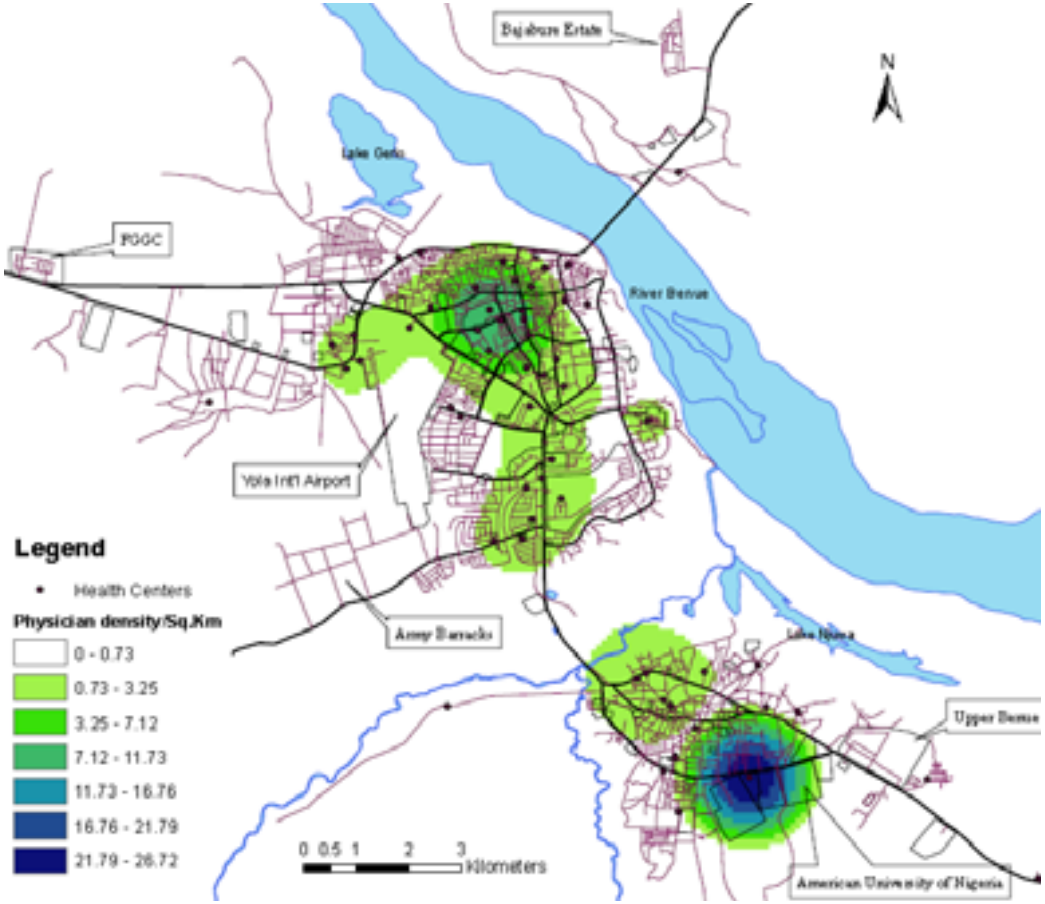


Density of health centres in Yola

DENSİTY OF PHYSİCİAN

- The number of available physicians in area can really contribute a lot in improving health care services to the people.

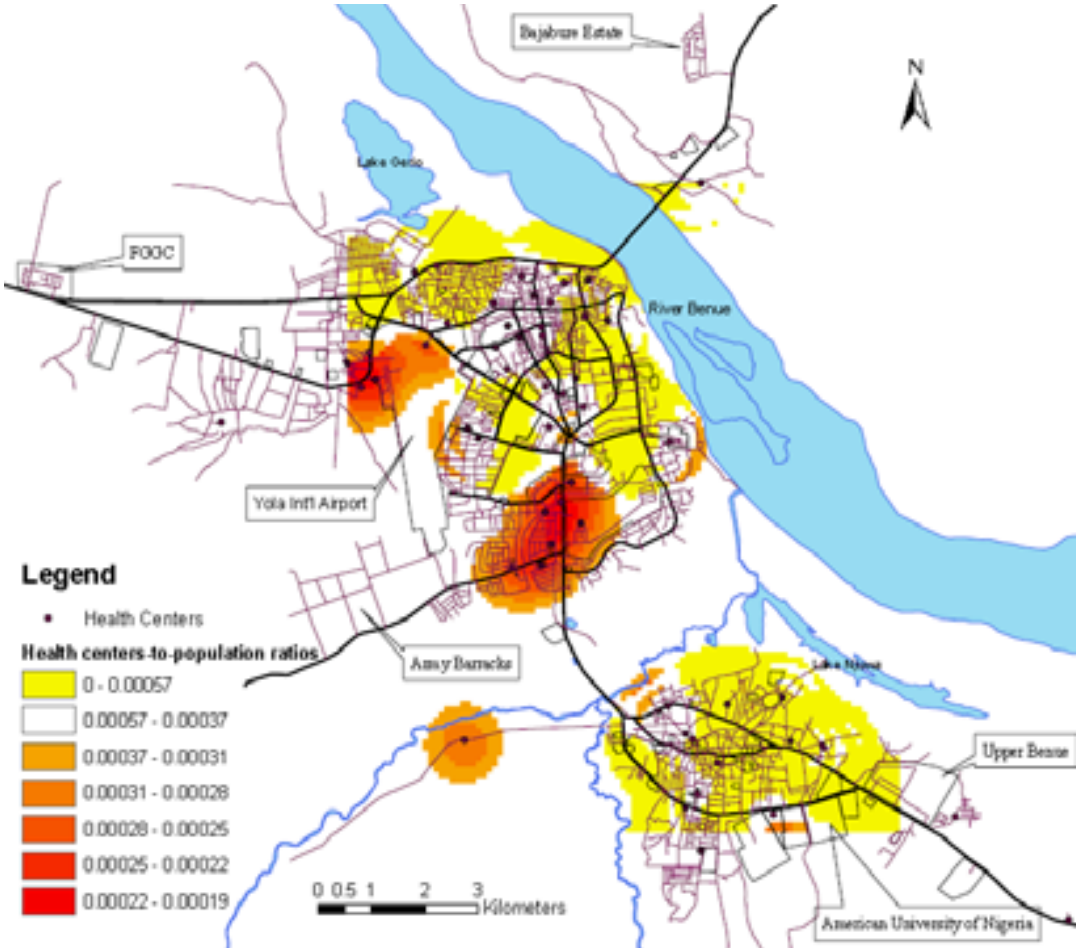
- A 1000 m band width of kernel density estimation was applied on the number of physicians in each health facility.



Density of physician per square kilometer

HEALTH CENTRES-TO-POPULATİON RATİOS

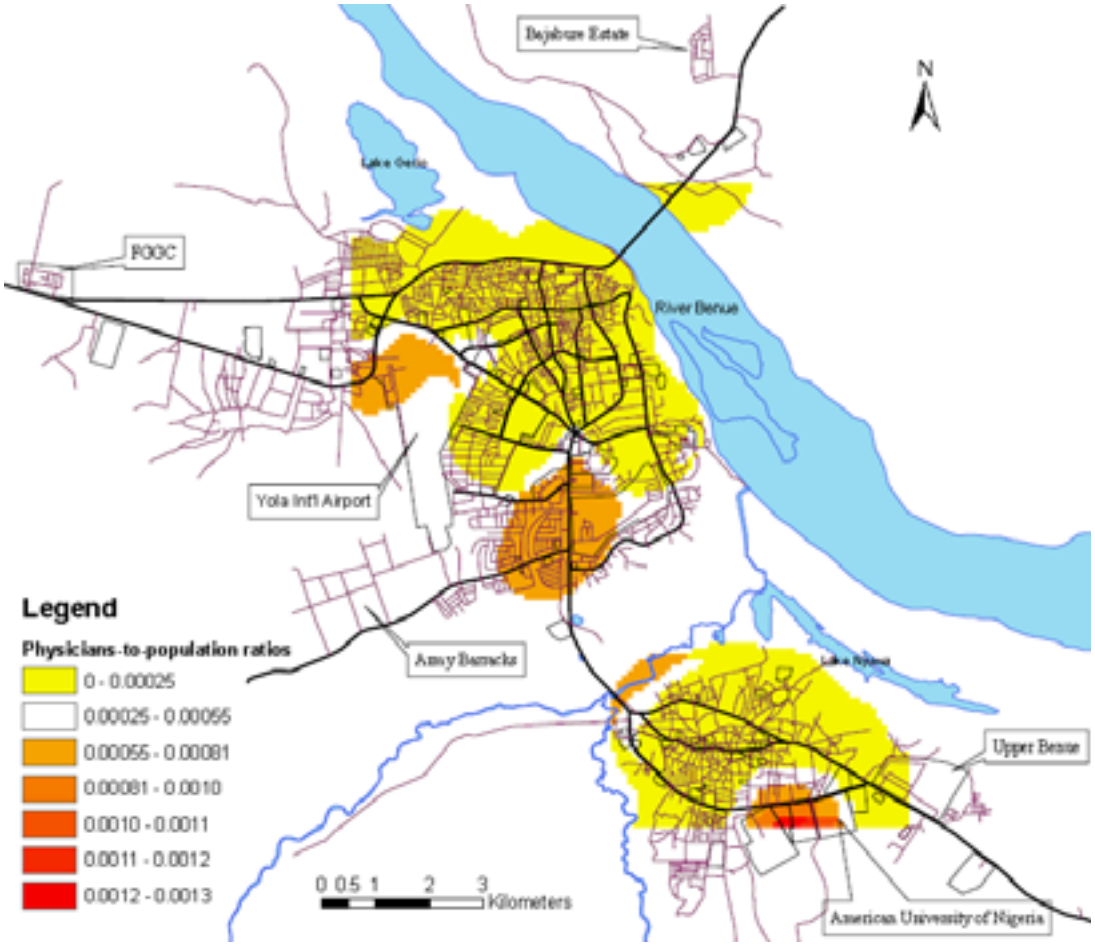
- Availability of **health facilities** is commonly expressed in terms of the number of persons dependent on one unit.
- This measure is useful for gross comparisons of supply between geo-political units or service areas, and it is used by policy analysts to set the minimum standard.
- Using raster calculator, arithematic operation was performed on: population and health facilities density output to come-up with this result.



Health centres-to-population ratios

PHYSİCİAN-TO-POPULATİON RATİO

- Using raster calculator, arithematic operation was performed on: population and physician density output to come-up with this result.



Physicians-to-population ratios

CONCLUSİON AND RECCOMMENDATİON

The study concluded that:

- there is gross inadequacy both in terms of health facilities and physicians.
- GIS is an inevitable tool with several functions that can help health care planners in decision making process.

Therefore, the study recommends the need for an urgent improvement of health care delivery system in Yola for the betterment of people's lives and the adoption of GIS technology by health care planners in Yola.

THANK YOU
FOR
YOUR ATTENTION!