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ASSESSMENT OF SPATIAL DISTRIBUTION AND ACCESSIBILITY OF PRIMARY HEALTH CENTRES IN ZURU L.G.A. KEBBI STATE

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Abstract

A Primary health centre (PHC) is the closest health facility to the community meant to serve everyone. The adequacy of PHCs depends on its close proximity to settlements which is also influenced by the spatial distribution pattern of the PHCs. This study aimed at assessing the spatial distribution pattern and accessibility of PHCs in Zuru. 6 wards were sampled out of the 10 existing wards in Zuru local government. Geospatial datasets which include geographical coordinates and existing road network datasets were used in this study. Average Nearest Neighbour, Euclidean Method and Network Analysis were used to analyse spatial distribution and accessibility respectively using Geographical Information Systems (GIS). Result showed that the PHCs in Zuru local government exhibit a dispersed pattern of distribution with a p-value of 0.041876, z-score of 2.034746 and Average Nearest Neighbour Ratio of 1.284260. Using 5km walking distance as a parameter to analyse accessibility, service areas of each PHC was determined using both the Euclidean Method and the Network Analyst. Settlement within the service areas can access a PHC within 5km walking distance while settlements outside the service areas travel more than 5km to the nearest PHCs and as such are regarded as the deprived settlements. Some settlements in Bedi and Tadurga wards were identified as deprived settlements and as such are in need of a PHC in other to enhance accessibility to primary health care services within Zuru local government.

Keywords: Spatial, Accessibility and Primary Health Centre.

Introduction

Nigeria is ranked the 187th position among 191 World Health Organisation (WHO) Countries in providing adequate health care system in terms of health expenditure per capita (WHO, 2017). The health sector is enlisted amongst the essential social infrastructures needed in community wellbeing and development (Salisu 2016). The idea of social service is important in providing social infrastructures although it is complex concept to describe because it constitute of different facilities that is targeted towards fulfilling the basic need of the society (Frolova *et al* 2016). Social infrastructure can be regarded as community facilities that are put in place to enhance community cohesion, wellbeing and development. Oyedele (2012) argued that it is the responsibility of the government to provide infrastructure and these infrastructure serve as an indicator of good governance. The primary health care system is a social infrastructure and also the lowest hierarchy in the national health system.

Egbewale and Odu (2013) defined Primary Health Care as; "an essential health care made available to all people where they live, work and play, which needs substantial community involvement for its success." Primary Health Centres (PHCs) are the facilities that ensure the sustainability of the national health system and as such they should be regarded as an essential social infrastructure (White, 2015). The sole aim of PHCs is to promote, improve and sustain health by delivering specified health care services to all people both in rural and urban settlements. The World Health Organisation in 2017 indicated that PHCs carryout preventive, curative and rehabilitative health services and responsibility (WHO, 2017). However, Emeka and Masemote (2011) stressed that the PHCs does not function independently but as a subset of the national health system saddled to carry out specific objectives. Such objectives include; sanitation, education, treatment of common disease, immunization, promotion of nutrition, maternal and childcare and provision of essential drugs.

WHO (2017) noted that the public sectors drives the Nigeria health care system. Idemudia and Victor (2010) argued that the political instability and poor leadership are the major challenges affecting the service delivery of PHCs. Oyedele (2012) agreed that the adequacy of social infrastructures generally is either caused by insufficient resources or/and competing political

agenda. White (2015) equally pointed out that, the complications and challenges faced by the PHCs in achieving its primary aim are limited by: inadequate resource allocation that will enhance affordability, accessibility and universality of primary health care services. Salisu (2016) stated that poor infrastructures in Nigeria will make sustainable social and economic development challenging. This can be related to the importance of primary health care facilities in attaining a sustainable health system.

As a solution to for adequate primary health care delivery Egbewale and Odu (2013) emphasized that distance have effect on the utilisation of PHCs. This means that the potential of a PHC been utilised can be predicted if it is accessible to the target settlement(s). Frolova *et al.* (2016) have identified spatial analysis as a reliable tool in spatial planning and management. Dejen *et al.* (2019) mentioned the used of travel time as a more efficient determinant of accessibility and the use of the Geographical Information System (GIS) in spatial analysis.

Bello *et al.* (2014) claimed that Zuru town will experience overcrowding except if social infrastructures are provided in remote areas of the local government. This is due to the high concentration of infrastructures (pull factor) in Zuru town. Hence, this draws attention to the existing spatial distribution of social infrastructures such as the Primary Health Centres within Zuru local government. Frolova *et al.* (2016) argued that spatial distribution of social infrastructures shows government autonomy and also determine the level of development of any region.

The Study Area

Zuru local government area is located in the north western region of Nigeria and on the south east of Kebbi state. Figure 1 shows the spatial extent which lies between latitude 10.84°N to 11.84°N and longitude 4.45°E to 6.0°E (Bello *et al.* 2014). It has a total land mass of 653km^2. By the west it is bounded by Fakai local government, and by the east and north it is bounded by Danko/Wasagu local government. The south of Zuru local government is bounded by Sakaba local government.

Zuru local government has an undulating topography ranging between 350 to 1000m above sea level. The major primary economic activities include farming and rearing of animals. Zuru local government has an average rainfall

of 1,825mm and an average temperature of 27°c. The wet season starts from April to October while the harmattan is experienced from December to February (Bello *et al* 2014).

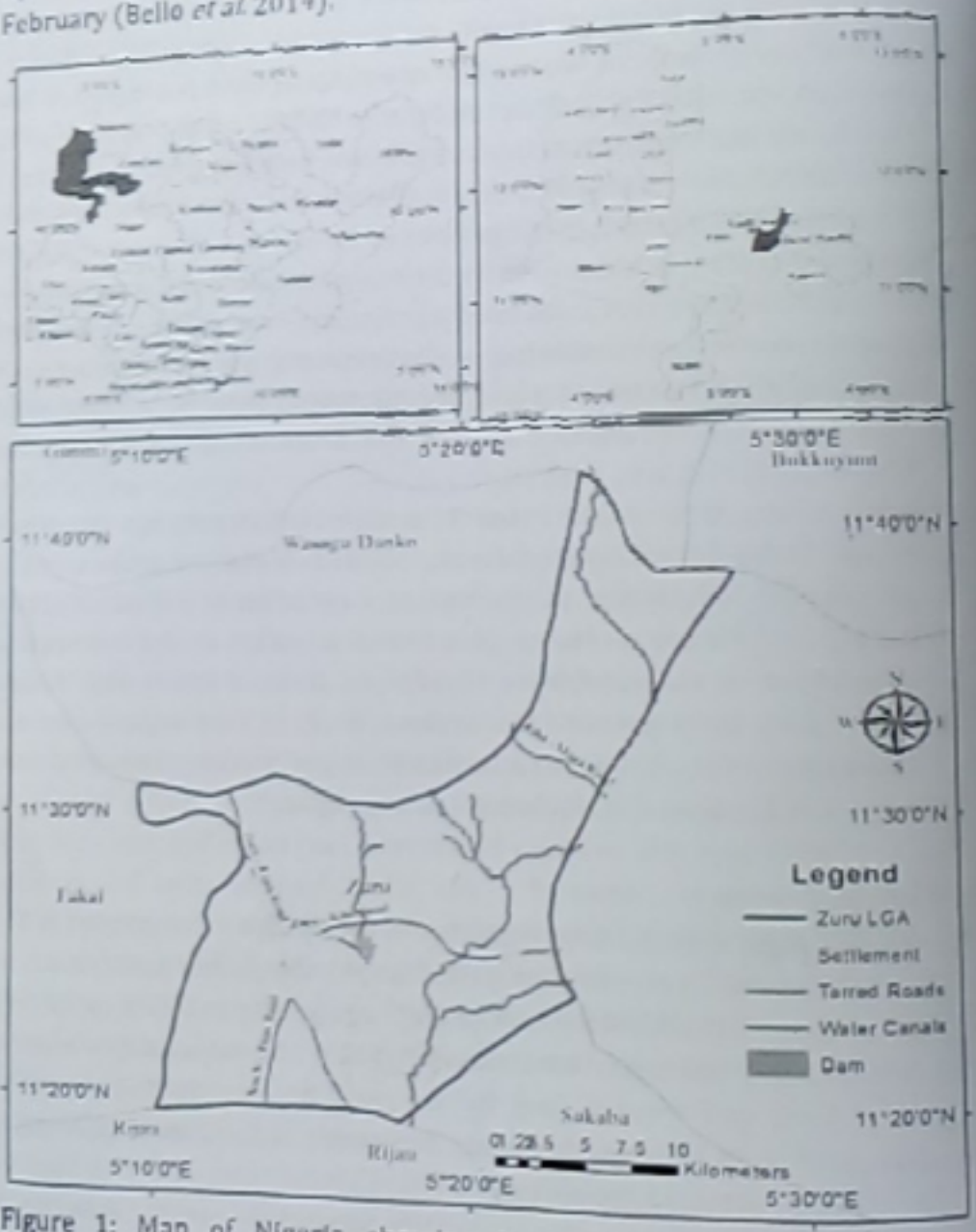

Figure 1: Map of Nigeria showing Kebbi, Kebbi Showing Zuru local government

Source: Author 2020

Zuru local government has a population of about 165,547 (National Population Commission, 2006). Zuru local government consist of ten wards as shown in Figure 2. These wards are used for political purposes and as a guide for several health sensitization and outreach programs. They are: Bedi, Isgogo Dago, Manga Lisbe, Senchi, Zodi, Tadurga, Dabai Seme, Rikoto, Rafin Zuru and Dabai wards.

Figure 2: Map of Zuru Local Government Showing the Wards within the Study Area
Source: Author 2020

Theoretical Framework

The Central Place Theory (CPT) was propounded in 1933 by a German geographer Walter Christaller in an attempt to explain the size and number of settlements and the spatial distribution of resources. It assumes that there are several hierarchies of settlement and each hierarchy a central location must exist known as the central place. Using two concepts of threshold and range to explain the minimum population needed for goods and services to be provided and the maximum distances individual will be willing to travel to benefit from such goods and services respectively.

Vlonis and Papantoniou (2019) have acknowledged that, the CPT has undergone several modifications, critics and rejection in the past.

GIS approach Spatial Distribution Analysis

Adrain (2008) explained spatial distribution as the graphical representation of how a geo-referenced features, species or phenomena on the earth surface relates with one another. The uniform, clustered and random patterns are the three (3) types of spatial distribution pattern according to Adrain (2008). Each of these patterns is uniquely different from the other. A random pattern implies that, the location of each feature is not influenced by the other, while a uniform pattern often considered as dispersed shows a behavioural pattern as each feature tends to move away from the other. On the other hand, clustered pattern is formed when the phenomenon tend to clumped together. Konsfield *et al.* (2019) noted that the nearest neighbour analysis is a tool that describes the spatial distribution of spatial point features. The nearest neighbour analysis takes note of the distance between adjacent spatial features in testing the spatial randomness of the phenomenon. When the value is 2.15 it shows a dispersed pattern, 10 shows perfect randomness and bellow 1.0 show a clustered pattern.

The mathematical expression of the special analysis is as follows;

$$Rn = \frac{(d\sqrt{n})}{a}$$

Where;

Rn= the average nearest neighbour index

n= number of geographical features (PHCs)

a= the size of the study area

d= the mean distance between geographical features (PHCs)

GIS approach Spatial Accessibility Analysis

Accessibility as described by Eflong (2019) is the distance travelled between origin and destination. Accessibility analysis is a sensitive discourse and requires developing and selecting a technique that fits the nature of the problem and the aim of the study. Shanmathi *et al.* (2017) categorized accessibility models into four namely; provider to population ratio, distance to nearest provider, average distance to a set of providers and gravitational

models of provider influence. Where threshold population is used in the allocation of PHCs a provider to population ratio can be used to determine accessibility while the average distance to a set of providers is measured by either straight line distance (Euclidean Method) or road network distance (Network Analysis Method). Efiong (2019) agreed that the Euclidean and Network analysis are GIS techniques used in determining accessibility. In accessibility analysis, the deprived and the served settlements are determined.

Dos Anjos - Luis and Cabral (2006) argued that, the Euclidean method underestimates the nature of accessibility compared to the using the actual road distance in network analysis method. The differences are usually caused by topographical nature of the study area and the presence of natural barriers to communication such as water bodies and mountains. Phiri and Munthali (2019) indicated that one hour is the acceptable travel time to the nearest PHC recommended by the World Health Organisation (WHO). One hour travel time is also estimated as 5km walking distance which can be used as a parameter to analyse accessibility of PHCs (Phiri and Munthali 2019).

Methodology

Cross sectional study design was used for this study. Geospatial data was the essential variables for this study and this included coordinates of PHCs and the road network dataset of Zuru local government. A GPS (Geographical Positioning System) device was used to obtain the coordinates of respective PHCs while the road network dataset was sourced from Open Street Map (OSM) online platform. Other data were digitized from Google maps.

Six wards were selected from the ten wards found in the study area. The criteria for selecting the sample were the location of PHCs within the local government borders. Although Zodi, Isgogo Dago, Dabai Seme and Senchi wards are part of the local government, the location of their respective PHCs were sited outside the borders of the local government. This is because the spatial extent of these wards extended into bordering local governments. Efiong (2019) argued that in spatial analysis it is of paramount importance for every member of the sample to be accounted for. In this regard, every PHCs existing in the six wards selected and also within the borders of the study area was used in the data analysis.

ArcGIS 10.1 was used to analyse the data sourced for this study. The toolboxes used for the analysis in the ArcGIS 10.1 environment include spatial statistics, analysis tool, data management tool, conversion tools and OSM toolbox. Q2Gis was used in devolving Shapefiles too and are integrated and remodelled in ArcGIS 10.1 environment.

RESULTS AND DISCUSSION

Existing PHCs within the Study Area

The number of Primary health Facilities within the selected wards amounted to fourteen (14) as shown in table 1. Each primary health facility located within the borders of the sampled area are presented alongside with its respective coordinates that signifies its actual geographical location in table 1. From the table 1 equally, it can be depicted that there are variations in the number of primary health facility allocated to each ward. For instance, Rikoto ward has one and Dabai ward has four. The names of the health facilities are either given the name of the ward or the settlement where they are sited. This suggests the potential of each PHC to be responsible for meeting the health demands of a target settlement.

Table 1: The Existing Primary Health Facilities

Index	Infrastructure Name	Ward	Latitude	Longitude
1	Dabai PHC	Dabai	11.47892667	5.27746
2	Kwesge Clinic	Dabai	11.48746667	5.258278333
3	Kwendo PHC	Dabai	11.483875	5.315813333
4	Sembelubelu PHC	Dabai	11.50534167	5.353406667
5	Bedi MDG/PHC	Bedi	11.41650333	5.349665
6	Doma B Clinic	Bedi	11.404185	5.353763333
7	Bedi Clinic	Bedi	11.42178667	5.3555
8	Manga PHC	Manga Ushe	11.37817333	5.24878
9	Godadi Health clinic	Manga Ushe	11.35025333	5.25998
10	Akumu PHC	Manga Ushe	11.35029333	5.292303333
11	Doma A PHC	Manga Ushe	11.37199	5.316958333
12	Zuru PHC	Rafin Zuru	11.430855	5.235495
13	Rikoto PHC	Rikoto	11.448345	5.231681667
14	Primary Health Care Facility	Tadurga	11.53640167	5.362778333

Source: Author, 2020

In figure 3 the actual location of PHCs was mapped using the longitude and latitude of each PHC presented in table 1. Figure 3 also showed the relative position of a PHC from one another and how they relate to other geographical features (drainage and tarred road). Graphically PHCs that are close to the arterial roads can be identifies and likewise those that are in remote part of the study area. It also means that at every place a PHC is sited there are settlements benefiting from the primary health care program.

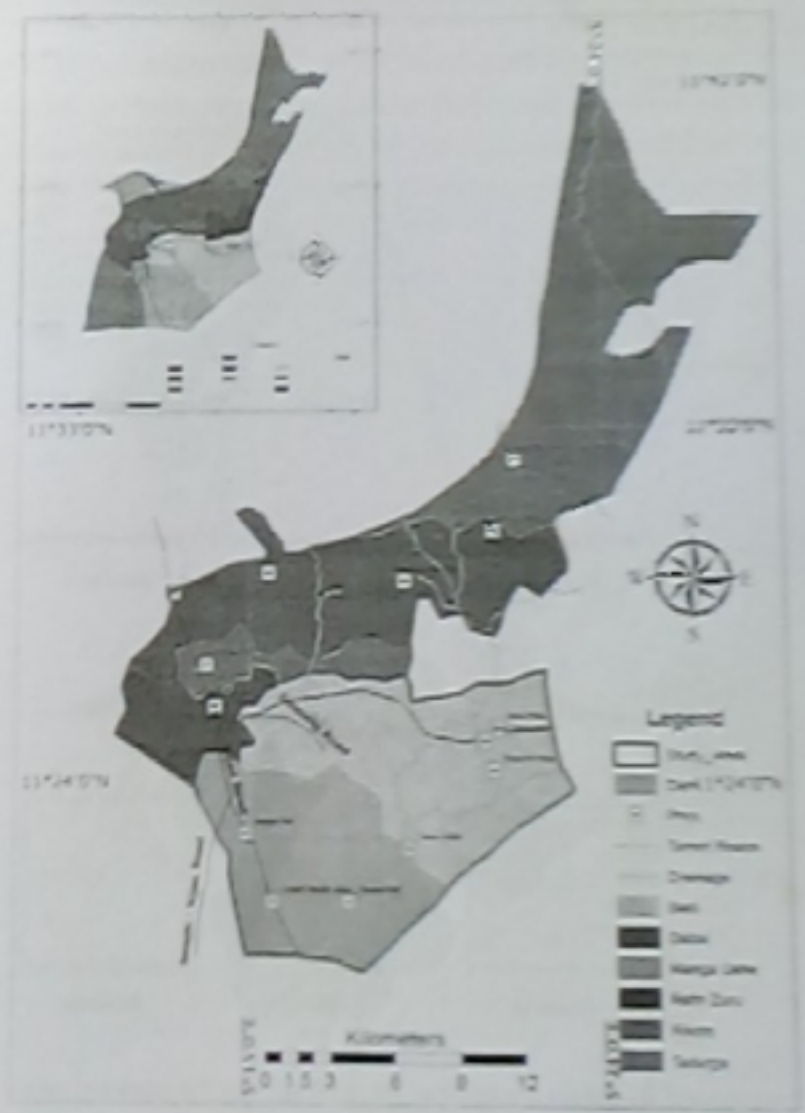

Figure 3: Map of Showing the Existing PHCs within the Study Area
Source; Author 2020

Spatial Distribution of PHCs

The result of the spatial distribution using the Average Nearest Neighbour in ArCGIS 10.1 revealed a p-value of 0.041876, z-score of 2.034746 and an Average Nearest Neighbour Ratio of 1.284260. The expected mean distance is 0.020771 degrees while the observed mean distance is 0.026676 degrees. This means that, the pattern of spatial distribution of PHCs within the study area is dispersed as shown in figure 4.

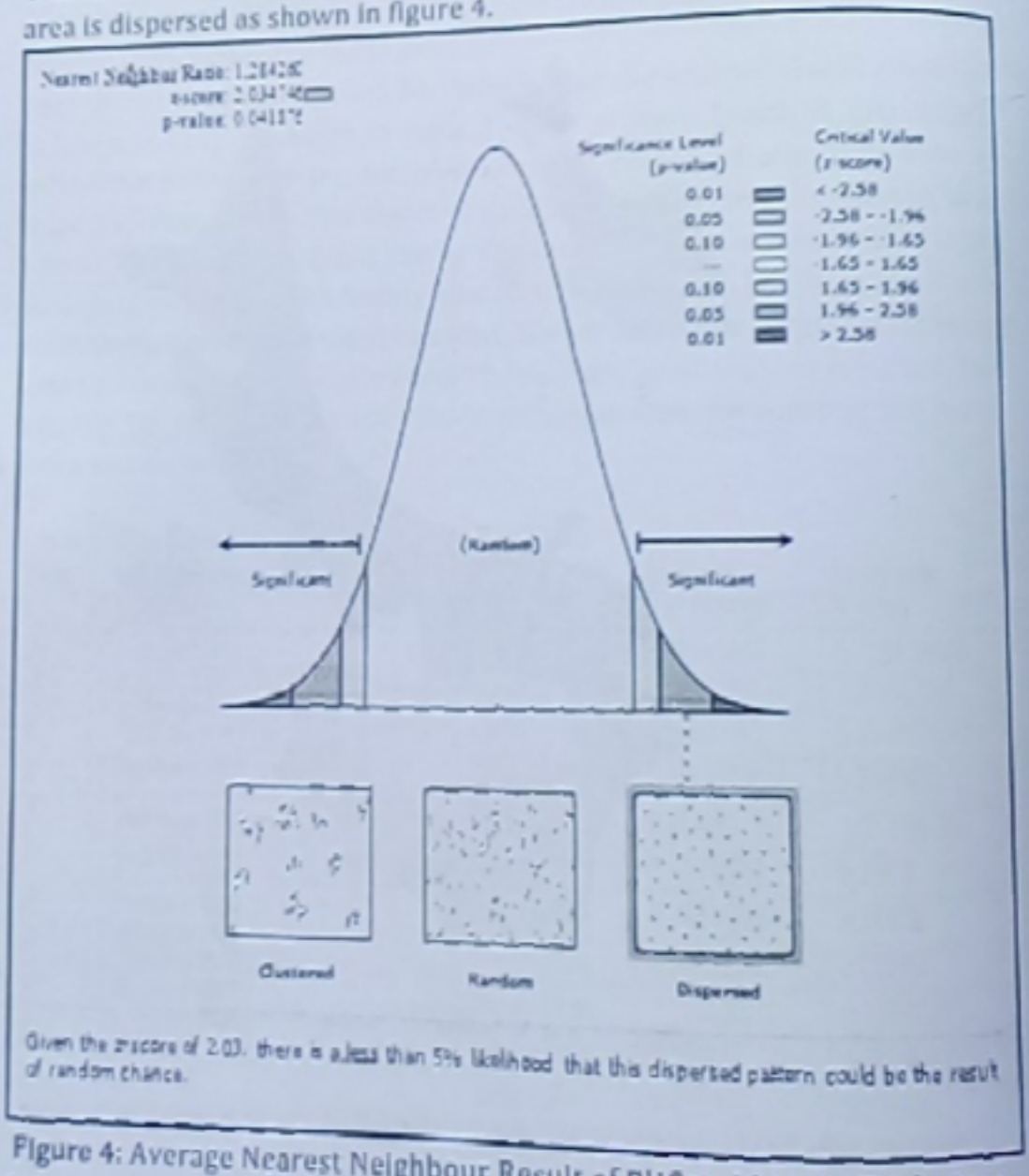

Figure 4: Average Nearest Neighbour Result of PHCs within the Study Area
Source; Author 2020

Spatial Accessibility of PHCs

Accessibility was analysed using both the Euclidean and the Road Network methods. The Euclidean method adopts the use of straight line distances to determine the catchment areas of the PHCs and this result is shown in figure 5. Using straight line distances as the service radius buffers where establish at 1km interval to show where PHCs have overlapping service areas and the effect of distance decay. The figure 5 shows the settlements that are within the 5km service radius of the PHCs. Settlements not covered by the 5km buffer are areas that travel more than five kilometres to the nearest primary health care facility and as such regarded as the deprived communities. In figure 5, the deprived settlements are notably found in Tadurga and Bedi wards.

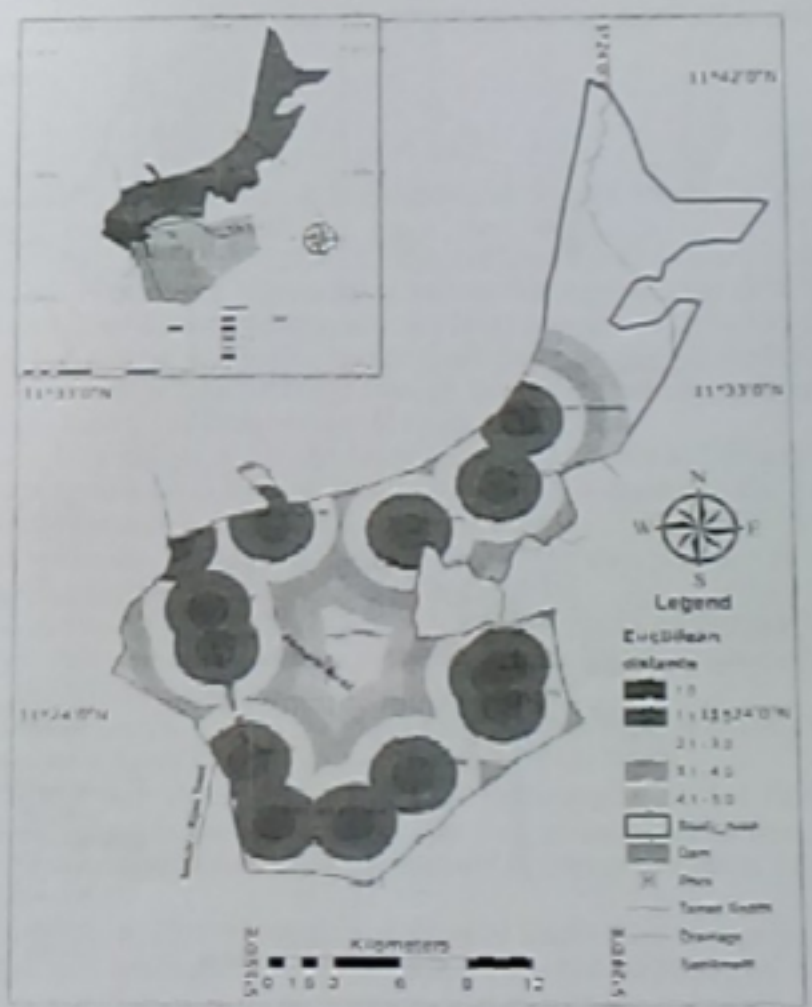

Figure 5: PHCs Service Areas using the Euclidean Method
Source; Author 2020

On the other hand, using the Road Network Analysis method to analyse the accessibility of PHCs within the study area yielded a more pragmatic result in terms of actual road distance covered to access these PHCs. Figure 6 shows the result of the analysis where each road network ends at 5km to show the extent of the road network service areas. Settlements where these 5km road network service areas are found are settlements that can reach to the PHC within a 5km walking distance. However settlements where the road network lines are deleted from the existing road network dataset signifies deprived settlements where the walking distance to the nearest PHC is greater than 5km. These deprived settlements are found in Tadurga and Bedi wards and are marked by a red polygon.

Figure 6: Road Network Service Areas of PHCs
Source; Author 2020

CONCLUSION AND RECOMMENDATION

This study shows the relevance of GIS technology spatial analysis. From the disperse distribution pattern of the existing PHCs it can be depicted that PHCs within Zuru tends to spread out from one another. As such they are neither randomly distributed nor uniformly distributed. However the spatial distribution of these PHCs influenced the accessibility such that settlements within the service areas benefit from. There are still some identified inadequacies in terms of spatial accessibility in Zuru local government. It is recommended that these deprived settlements should be provided with a primary health care facility that will be accessible to the deprived region. Notwithstanding, there is still the need to further research on the political, economic and social attributes that influence spatial accessibility and distribution.

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