GEOGRAPHICAL INFORMATION SYSTEM APPLICATION IN SITE SUITABILITY ANALYSIS FOR HOSTEL DEVELOPMENT IN AHMADU BELLO UNIVERSITY, ZARIA.

BY

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Abstract

This paper investigates the application of GIS in site selection analysis with the aim of selecting the most suitable site for developing a new hostel block within the ABU Samaru campus space. To achieve this, a spot-5 image of ABU Zaria Samaru campus was used to bring out the land use and land cover of the area so as to determine the available and suitable spaces. The study created weight maps for each factor and a digital elevation model was created to determine aspect and slope. This study identified seven vacant sites in ABU Samaru campus, which were ranked based on the suitability factors of; distance to roads, distance to academic areas, the presence of existing hostel facilities, distance from gullies, distance from water bodies and the size of the area. This study recommends the space by the North Gate that extends to just behind quarter 3, the space between drama village and staff school and the space and the space between the school gym and NUGA gate as highly suitable, very suitable and suitable respectively in descending order.

Key words: ABU Zaria, GIS, site suitability, site selection, hostel.

Introduction

Land development is defined as modifying a parcel of land to fit as environment for a desired human activity (Dion, 2002). Site selection for new settlements is a complicated task, dealing with different variables such as accessibility, and zoning, proximity to facilities and businesses, and demographic factors. One important work of a land developer is finding an appropriate site to construct a project. Site selection in land development requires dealing with interrelated factors simultaneously, which includes finding a location that provides the demands of their target occupants, economically feasible to operate, and contributes to the betterment of the community Since a number of problems that development projects encounter in executing projects are location-dependent, a system that contains the most updated information regarding a location of interest and tools that let decision makers manipulates the information to suit their need for details may be of high utility. The process of site selection for facility development may be made easier if development projects will be provided with tools that will help them make decisions based on some understanding of their environment.

Efforts have been made to support the decision-making process of land development using a more scientific approach. However, many of the studies on acquisition of geographical data have

been done using very limited parameters and spatial techniques (Church and Murray, 2009).

The choice of a location should be directed by predetermined objectives. These objectives call for evaluation that combines facts with good judgment. The key process step in the site-selection process is to initiate an assessment of technical and environmental issues early. In that way facilitating compliance with associated regulations and preventing or at least identifying site-selection problems can be identified and addressed before they occur (Church and Murray, 2009).

Site Selection indicates the practice of new facility location, both for business and government. It involves measuring the needs of a new project against the merits of potential locations. The practice came of age during the 20th century, as governments and corporate operations expanded to new geographies on a national and international scale (Church and Murray, 2009). Suitability studies and site selection procedures using GIS as tool are very important in decision making especially with regards to selecting the most suitable site for hostel development. GIS has the ability to integrate different layers of data into a single composite to bring out a final product in the form of a map to aid decision making (Rikalovic, Cosic, and Lazarevic, 2014).

One of the most useful applications of GIS for land planning and management is the land use suitability mapping and analysis (Collins *et al.*, 2001). Broadly defined, land use suitability analysis aims at identifying the most appropriate spatial pattern for future land uses according to specified requirements, preferences, or predictors of some activity (Collins *et al.*, 2001). The GIS based land-use suitability analysis has been applied in a whole variety of situations including ecological approaches for defining land suitability and habitat for animal and plant species (Store and Kangas, 2001), geological favourability (Bonham-Carter, 1994) suitability of land for agricultural activities (Kalogirou, 2002), landscape evaluation and planning (Miller *et al.*, 1998), environmental impact assessment (Moreno and Seigel, 1988), selecting the best site for public and private sector facilities (Church, 2002) and regional planning (Jansen and Rietveld, 1990). The diversity of the types of land-use suitability studies can be attributed to the different ways the term land use is defined by various applications and context of its use. In land use suitability analysis, it is important to make distinct decisions between the site selection problem and the site search problem (Cova and Church, 2000). The aim of site selection analysis is to identify the best site for some activity given the set of potential (feasible) sites. In this type of

analysis all the characteristics (such as location, size, and relevant attributes e.t.c.). The problem is to rank or rate the alternative sites based on their characteristics so that the best site can be identified (Malczewski, 2004, Hong and Eastman, 2010).

In tertiary institutions worldwide, the provision of accommodation to the students' population takes different models. This includes; non-residential, where students source for their own accommodation. Residential, where the university houses all its students and dual-residential, where the university houses its student population for a period of time only, probably the first and final year, while the students during the remaining period source for their own accommodations. The experiences of students in Nigerian tertiary institutions in sourcing and securing for their own accommodation around university communities are extremely consequential (Yusuff, 2011). Principally, hostels are in dire need of attention. The "Preliminary Survey of Students' Accommodation" by the Nigerian Universities Commission (NUC, 2006) reveals that the provision of hostel accommodation in Nigerian universities is below 30 percent average of the student population. An explosion of student population in the last 15 years has not been matched by a corresponding expansion or construction of new hostels (Iyizoba, 2007).

The increasing number of students in tertiary institutions in several Nigerian cities has increased the pressure on campus hostels as they can no longer cope with demand. Establishment of private hostels off-campus was initially perceived as a solution but landlords have taken advantage of the high demand by upping rentals and students are reeling under the financial burden (Fatunde, 2012). There has been steady growth in the student population in tertiary institutions, most of which have been expanding their teaching, administrative and research infrastructures. But little effort has been made to provide more accommodation for students and staff. Many tertiary institutions possess large amounts of land on which student hostels could be built. But it is claimed that private sector figures on university governing councils have discouraged government investment in building campus residences (Nwagwu, 2007). This identified challenge has made it a point of necessity to establish a new block of hostel accommodation in Ahmadu Bello University Zaria.

The viability of GIS process and procedures has been applied in many works relating to site selection and the outcome has been excellent. This processes and procedures were fully applied

in selecting a suitable site for developing student hostels in Ahmadu Bello University Zaria.

The Study Area

The establishment of Ahmadu Bello University (ABU) began in 1961 following the recommendation of the Ashby Commission on "Post-School Certificate and Higher Education in Nigeria". The University began in 1961 with the faculties of Agriculture, Engineering, Law and Sciences, fifteen academic departments and 426 students. The Main Campus of Ahmadu Bello University is located in Samaru, a suburb of Zaria in Kaduna State, Nigeria. Samaru is situated within latitude 11^{o} 12" N and longitude 07^{o} 37" E, at an altitude of 550-700 meters. It is about 13km from Zaria-city on the Sokoto road, 8km to Shika and 7km from Bassawa. The University covers a land area of about 7,000 hectares and encompasses two campuses, twelve faculties, a Postgraduate School and 82 academic departments. It also has five Institutes, six Specialized centers, a Division of Agricultural Colleges, a School of Basic and Remedial Studies, a Demonstration Secondary School, a Primary School and a Consultancy Outfit which .provides a variety of services to the University and the wider society.

The total student enrolment in the University's degree and sub-degree programmes is about 35,000, drawn from every State of the Federation, Africa and the rest of the world. Currently, the University has about 1,400 academic and research staff and over 6000 non-teaching, senior and junior administrative staff. The University has also nurtured two University Colleges, - the Abdullahi Bayero College (now Bayero University), Kano and the Abubakar Tafawa Balewa College (now Abubakar Tafawa Balewa University of Technology), Bauchi, while 27 institutions made up of Colleges of Education, Polytechnics and Schools of Basic or Preliminary Studies are currently affiliated to it (www.abu.edu.net, 2012).

Materials and Method

This paper employed the use of GIS analysis of the study area which was achieved using the following materials:

i. Topographic map sheet of Zaria (Zaria sheet 102 NW at 1:50,000). This map was used to extract contour lines covering ABU Zaria and subsequently, the contours were used for generating the Digital Elevation Model of ABU Zaria.
ii. Geology map of Zaria at 1:100,000
iii. Soil map of Zaria at (1:100,000) was obtained from the Soil Science

department faculty of Agriculture and was used to derive the Hydrological soil group map.

iv. Sewer pipeline, Water pipeline and NNPC pipeline were acquired from Estate department

v. ABU Master Plan from Estate Department was used to delineate the areal extent of study.

vi. Spot – 5 satellite image (2.5m resolution) of the study area was obtained from National Centre for Remote Sensing Jos. This image was used to derive the land use and land cover of ABU Zaria.

vii. The land use and land cover data for the study was derived through manual on-screen digitization using ArcGis 10.5 software. Different land use and land cover categories were identified according to the type of cover and usage and were broadly grouped into built up which included residential, academic, hostel and other buildings, agricultural, water bodies, gullies and open spaces.

Six factors were considered as parameters in selecting the most suitable sites for hostel development in ABU Zaria. They are:

- Distance to existing roads should be between 15-200 meters.
- Distance to academic buildings and related facilities will be between 50-200 meters.
- The presence of existing hostel facilities.
- Distance from gullies will be above 300 meters.
- Distance from water bodies will be above 500 meters.
- Size (area) of a potential site will be above 25,000 square meters.

Results and Discussions

This section makes a detail analysis of the results generated from the field in an attempt to bring to limelight the findings in this work. The results of the findings in this work are based on the following selection criteria.

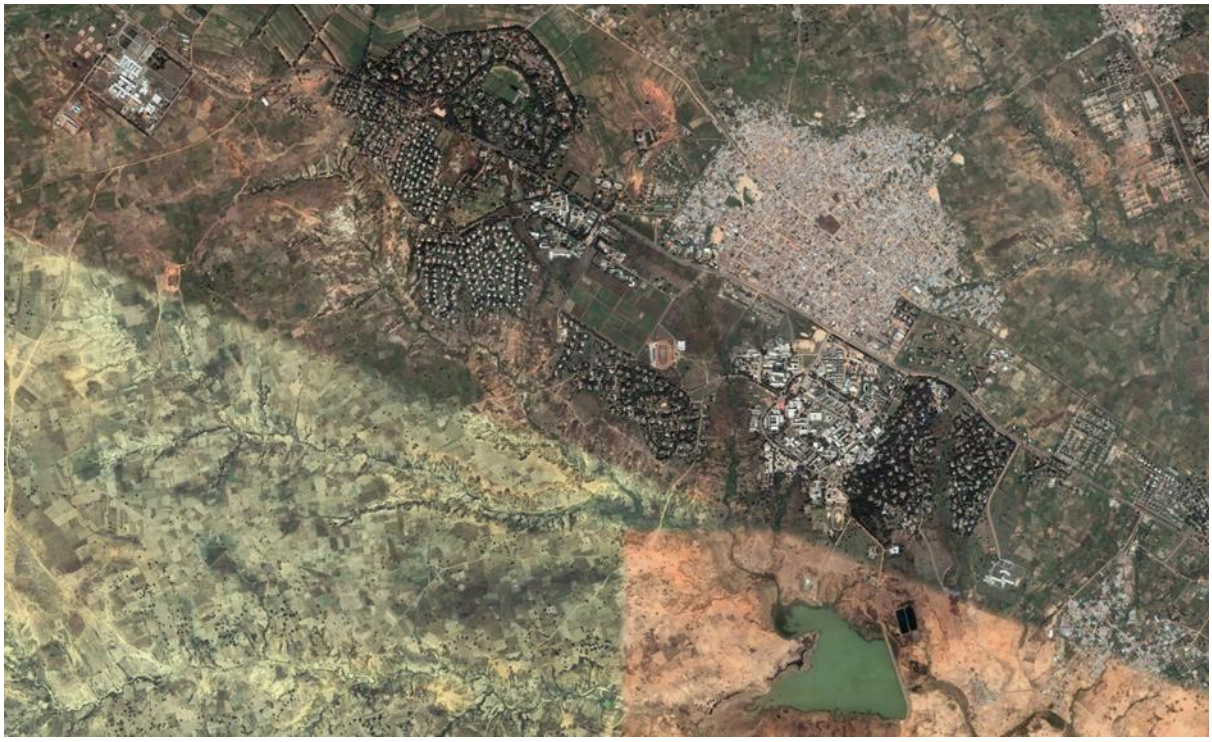

Figure 4.1: A spot-5 image of Zaria

Source: National Centre for Remote Sensing, Jos, Nigeria.

i. Land Use and Land Cover

Land uses basically refer to the uses in which an area in space is put to. ABU Zaria Samaru campus has a relatively sizeable land area with different land uses. The land use in ABU is dominantly build ups, these build ups include student hostels, administrative blocks, staff quarters, lecture halls, teaching hospital among many others. Other land uses in the study area includes sport complex, water body, gullies, farmland and open spaces. Figure (2) shows the various Land uses in the study area as well as their distribution. The land uses in the study area includes build-ups, water body, gullies. It is from this Land uses these open spaces were derived.

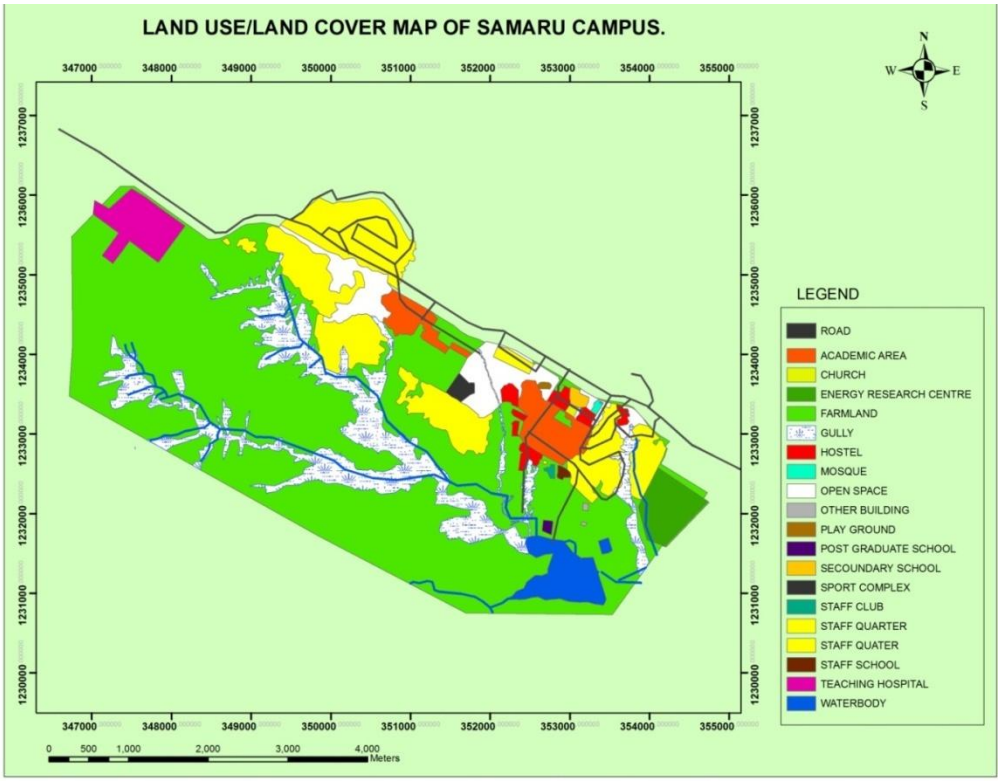

Figure 2: Land use land cover map of ABU Samaru campus

Source: Author' analysis

ii. The Effect of Environmental Constraints on Site Selection

Environmental constraints refer to the phenomena or a feature that exist in a particular environment and now becomes a barrier or impose restrictions to certain activities within that environment. In this context, the environmental constraints refer to the water bodies, gullies and lower elevations that are found within the campus environment. These constraints are also the elements that form part of the criteria considered in site selection. The implication of these constraints is that it has imposed a certain degree of freedom as regarding site selection for hostel development. Water bodies are liable to over flow their banks and flood their surroundings in the events of heavy rainfall. Low lying areas are also susceptible to flooding and erosion which can be disastrous as it can destroy both lives and properties. Gullies have a tendency of expanding by caving in during torrential rainfall and flooding, as such making it almost impossible and suicidal to build hostels very close to such features. Although man has the technology to withstand such an environmental

issue, but the cost implication can be massive and only few agencies or institutions can bear such financial burden (see fig.3)

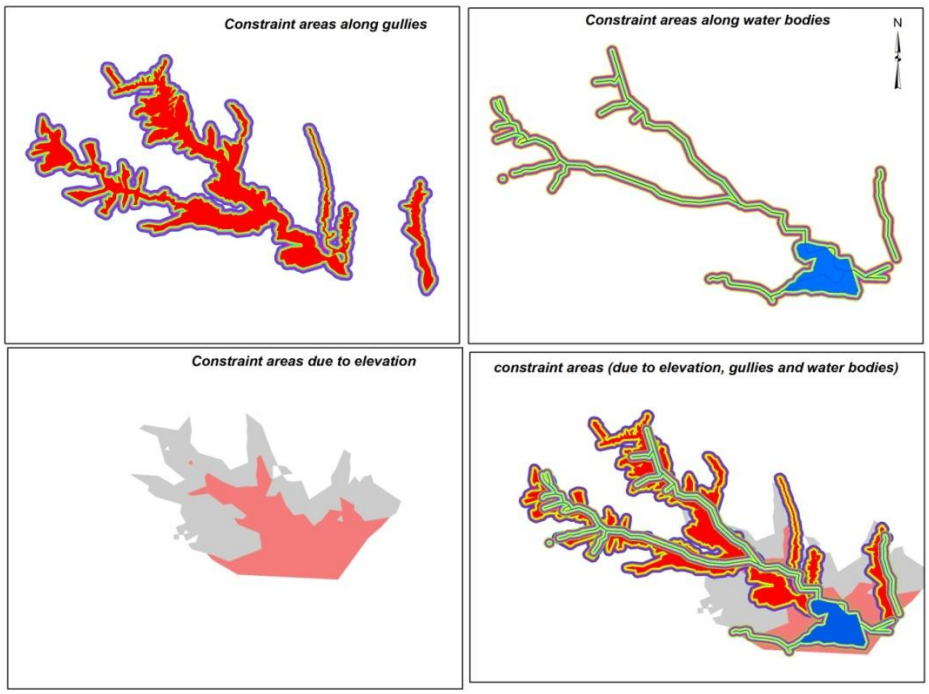

Figure 3: Environmental constraints map

Source: Author's Analysis

iii. Artificial Constraints

Artificial constraints are those barriers that have come to be as a result of man's other activities in the environment. In this context, artificial constraints are basically the existing land used especially the build ups. Some activities cannot coexist for example a market and a library; as such the presence of one could be a constraint in the siting of the other. Similarly, existing buildings were considered as constraints because buildings cannot be constructed on existing buildings. Therefore build-up areas were considered unsuitable and their space unavailable. These include; lecture halls and classrooms, hostels, staff quarters/club, etc. (see fig.4).

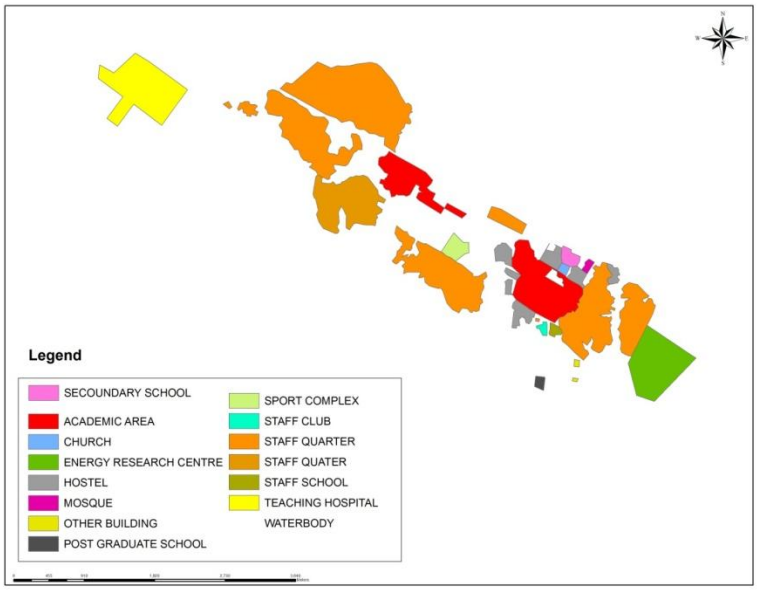

Figure 4: Artificial constraint in site selection

Source: Author's Analysis.

All natural and artificial constraints were masked from suitable areas to substantiate the most appropriate spaces for the construction of new hostels. This were the application of GIS in site selection analysis is advantageous as it has the ability to bring together all the factors under consideration. In figure 4, all the individual constraints both natural and artificial are brought together and overlaid to form a composite. This is done so as the areas that are free from such constraints will be clearly visible and their potentials for becoming the selected site will increase.

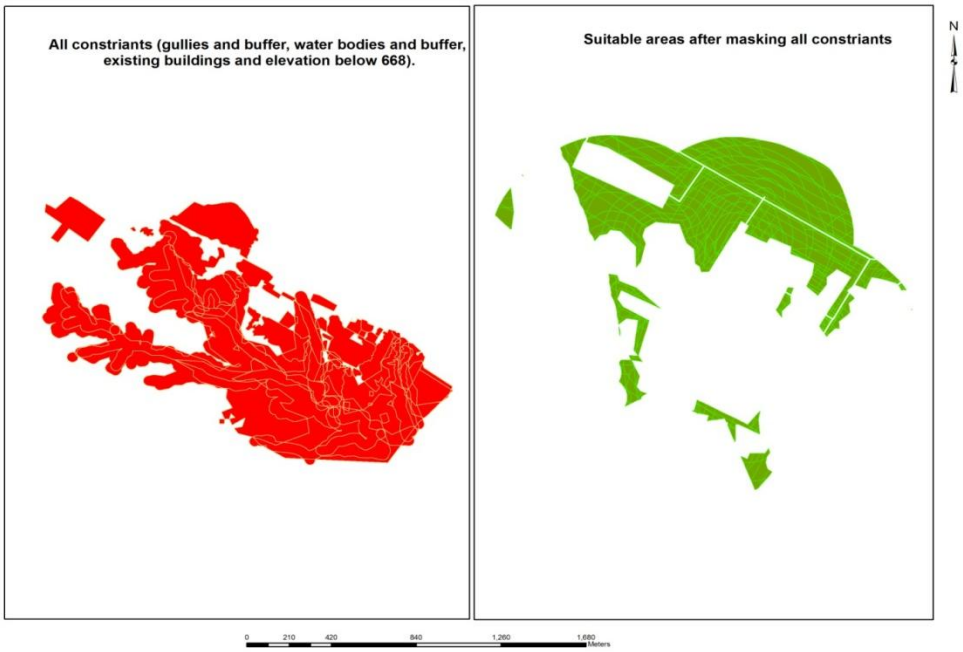

Figure 5: A composite map of environmental factors (natural and artificial) constraints.
Source: Author's Analysis.

However, it is important to note that not all suitable areas are available for construction due to natural and artificial constraints. An intersection of the layers gives the final suitable areas for the construction of new hostels (see fig.6).

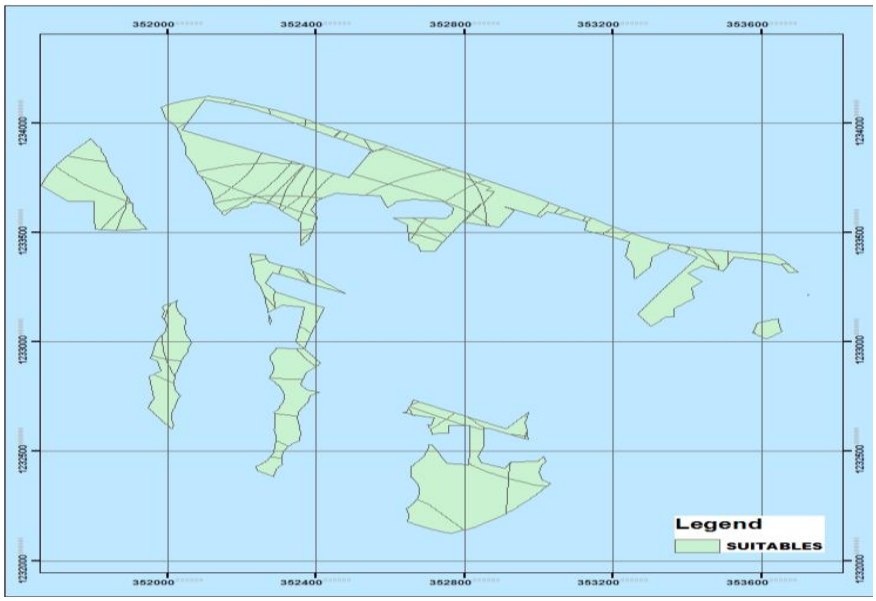

Figure 6: Suitable Areas for Hostel Development.

The suitable areas were further clustered according to size (Fig 8.), this is very important in the ranking system for site selection and suitability, because an open site could be deemed suitable after meeting up all other positive criteria, but its size could be too small for hostel development. The clusters are different in both shapes and sizes, but the sizes are the most important factors, as such their sizes are generated in meters.

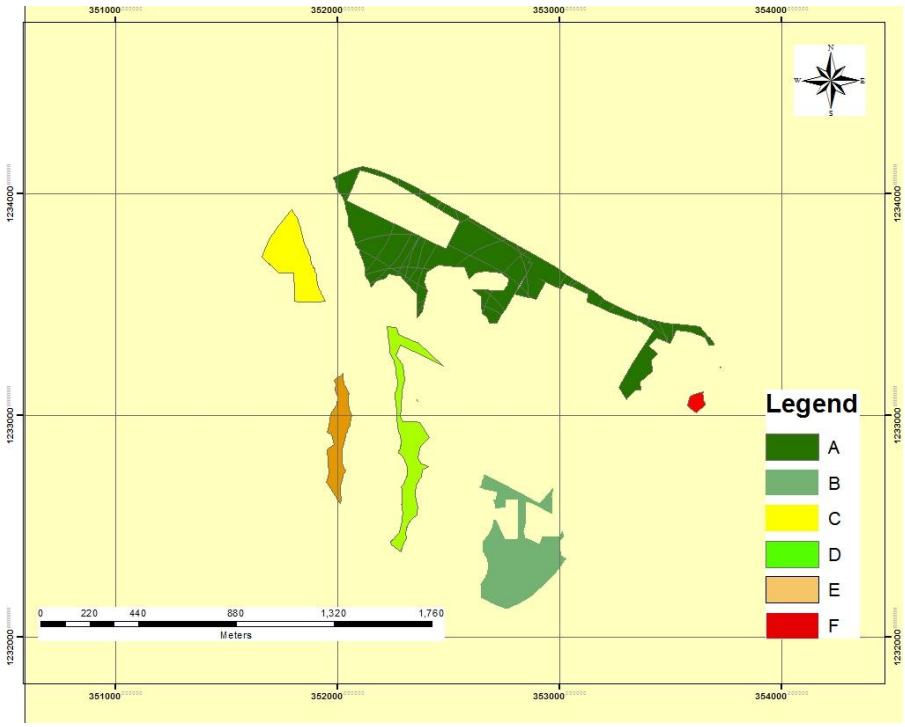

Figure 8: Categorised clusters of available spaces.
Source: Author's Analysis.

The categorized clusters are further identified by their sizes in terms of the area they cover.

Clusters	**Area (m^2)**	**%**
A	447944.8	45.9
B	367077.6	37.6
C	66740.82	6.8
D	54739.71	5.6
E	34260.43	3.5
F	4753.014	0.6
Grand Total:	**97556.4**	**100**

The idea behind the area calculation was to bring out the extent area in meters, the larger the area the more suitable the site for the construction of hostels. However, with the recent breakthrough in building designs, this might not be entirely true. In this study we stick to the fact that area or size of the available open space is a strong factor for consideration. Therefore, the larger the area, the more suitable it is for hostel development. Figure 8 shows the different level of suitability (suitability ranking) of the available spaces and potential sites for hostel development.

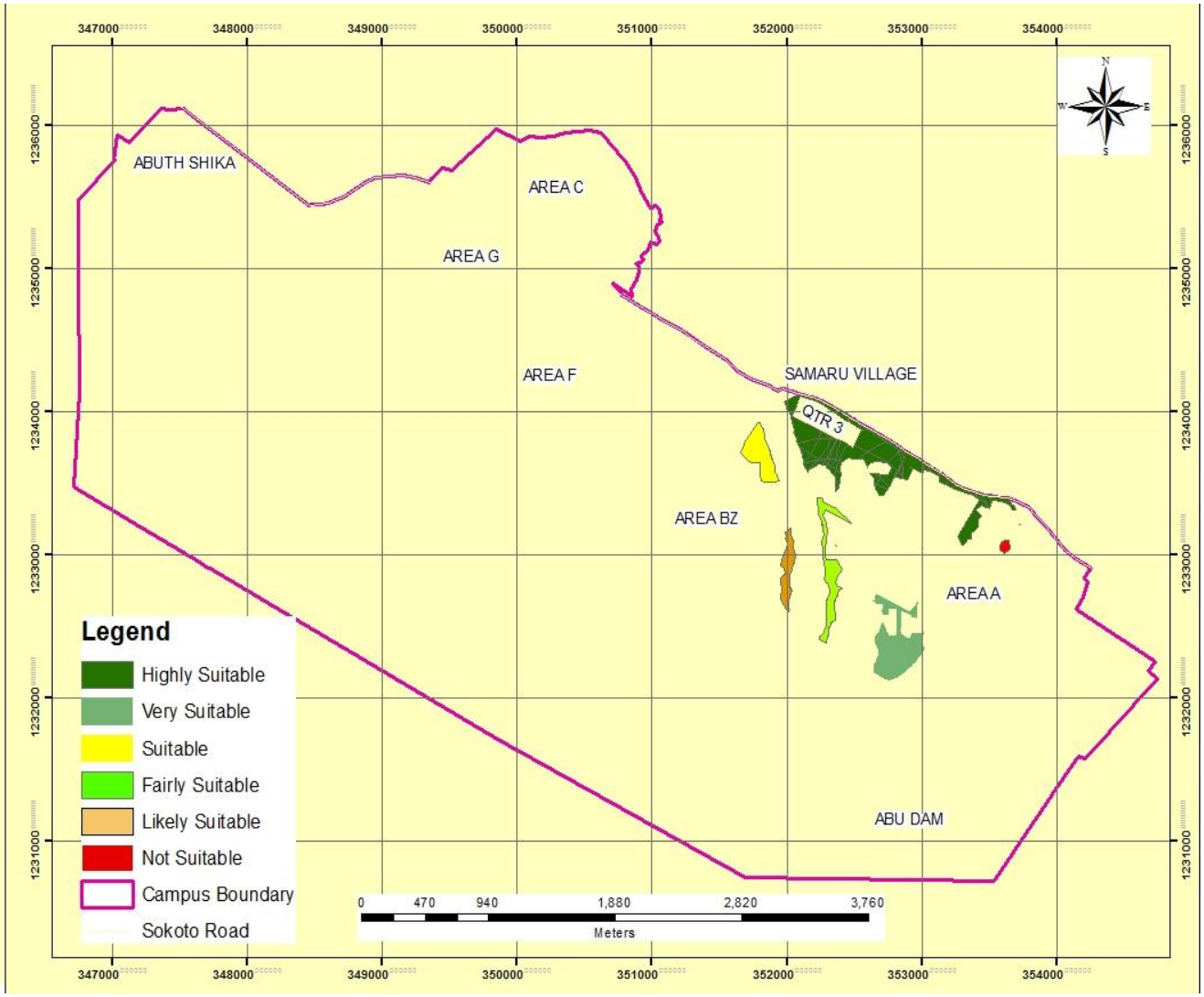

Figure 9: Suitability ranking of sites on the A BU map

Source: Author's Analysis

Each ranking category is achieved by an intersection of the weight parameters. A site is said to be highly suitable because it has the best ranking in terms of proximity to other related facilities, it has the highest degree of accessibility ranking from the buffer generated, it has met the necessary criteria in geology and soil ranking and evaluation, it has a farther distance to water bodies and gullies which are negative factors and has the largest area in terms of size in square meters. The same criteria goes for a site that is said to be very suitable, this means that in ranking of all the above mentioned criteria, it is closer to the site that was considered highly suitable. The site that is considered Suitable is the one that came third in the ranking.

The site that was ranked as highly suitable is a strip of open space that starts just behind Suleiman Hall near the North Gate and includes the small football field without the tracts and extends to just back of quarter three. The site that was ranked as Very suitable is the football field and extended open space in-between the staff school and the Drama village. The third site which is ranked as Suitable is located between the school gym and the NUGA gate just before the School of Agriculture farms. The site that is ranked as fairly suitable is a strip located behind Sassakawa hostel and extends downward just before the gully near Area Bz. The site that was ranked as likely suitable is the space between Area Bz and the gully when coming from Area F. The site ranked as not suitable is a small space in the heart of area A before the gully that goes down to the Dam. All these areas can easily be located on the ground in the study area.

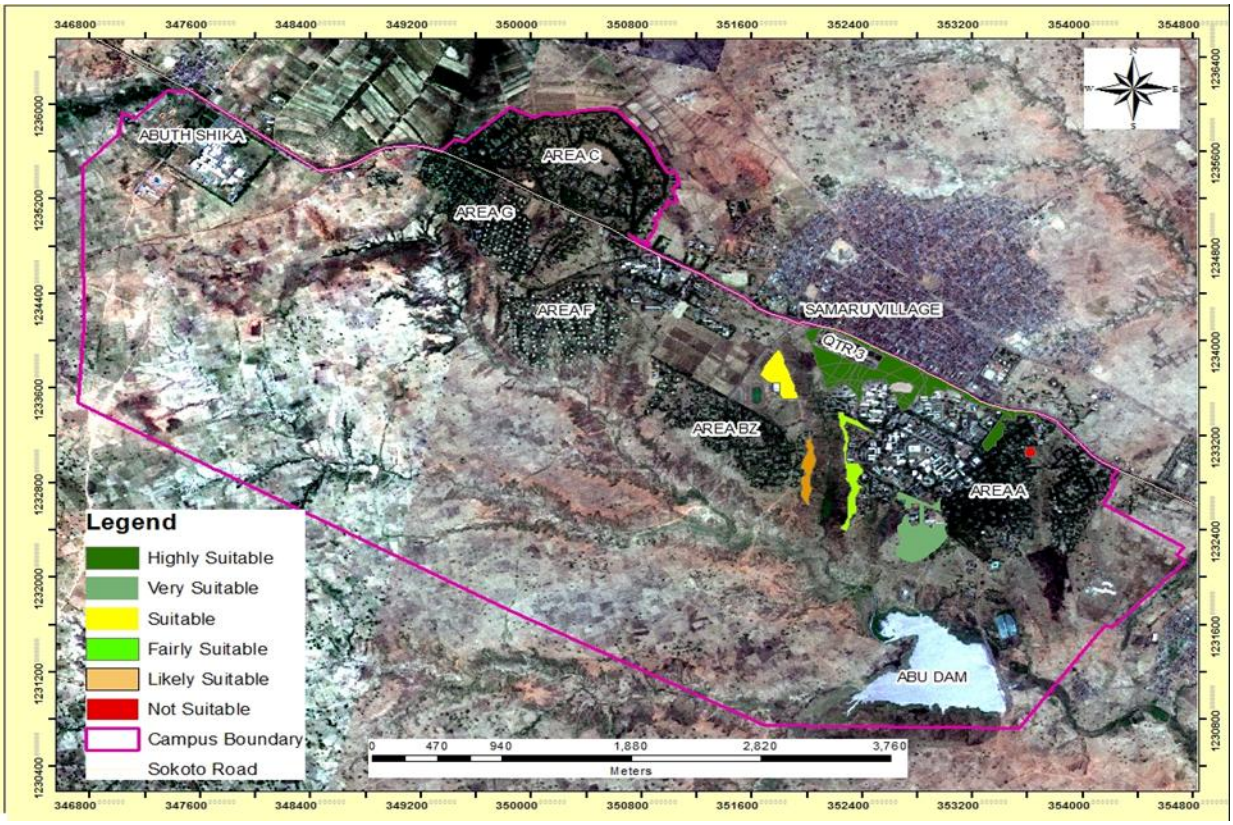

Figure 10: Suitability Sites on the ABU Satellite Image.

Source: GIS Analysis

Conclusion

Land use suitability analysis and site selection for hostel development is necessary to overcome the problem with limited land availability against drastic growth of population and urbanization. It gives room for proper planning and prompt decision making. It is a known fact that there is a growing pressure on our institutions to admit and accommodate an increasing large number of students because of the increase in population and school enrolments.

Although there are 6 unused spaces in ABU Zaria Samaru campus, only two are the most suitable for developing reasonable standard hostels that can help in addressing the current accommodation problems in this great institution. This research has come to conclude that the original master plan has been altered as

many structures have come to be where they ought not to be. In the light of this, this research has come to conclude that the unused spaces labelled A and B in figure 8 are the most suitable for the development of new hostels in ABU Zaria Samaru campus because they have met all criteria and have the largest area in square meters.

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