Determination of Spot Heights of the University of Lagos Campus

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ABSTRACT

To obtain the relief of a particular geographical area, the horizontal and vertical coordinates of the area are required. These coordinates can be obtained through various surveying techniques. This project deals with the determination of Spot Heights of the University of Lagos Campus, using Differential Global Positioning System (DGPS). The knowledge of the topography of an area gives planners and engineers the panacea to properly manage and develop old and new man made feature. The need of this project is to produce map of University of Lagos showing the relief pattern of the entire campus and also to show or identify areas of minimum and maximum elevations within the campus vicinity. In order to accomplish the aim of this study, the use of both field observation and remote sensing methods were adopted to acquire data. The measurements of horizontal and vertical coordinates of all stations using Promark 3 Differential Global Positioning System (DGPS) equipment was combined with satellite imagery which was used to create spot heights, contour map, digital terrain model and topographic map of the entire campus. The data obtained are processed using the following software ArcGIS, Surfer 8, Global Mapper, GNSS Solutions and Excel Spreadsheet. The data processed and the results of analysis done can be seen in form of maps, Digital Terrain Model, tables, bar charts and pie charts. The results obtained can be used for both engineering and tourism purposes, cut and fill calculation, development of new structures and identifications of areas that are liable to flooding.

Keywords: Spot Heights, Contour Map, Digital, Terrain, Model, Topographic, Map

INTRODUCTION

A map is a way of representing on a two-dimensional surface, (a paper, a computer monitor, etc.) any real-world location or object. Many maps only deal with the two-dimensional location of an object without taking into account its elevation. Topographic maps on the other hand do deal with the third dimension by using contour lines to show elevation change on the surface of the earth, (or below the surface of the ocean). A topographic map is a type of map characterized by large-scale detail and quantitative representation of relief, usually using contour lines in modern mapping, but historically using a variety of methods. Traditional definitions require a topographic map to show both natural and man-made features. A topographic map is typically published as a map series, made up of two or more map sheets that combine to form the whole map. A contour line is a combination of two line segments that connect but do not intersect; these represent elevation on a topographic map.

Topographic maps usually portray both natural and constructed features. They show and name natural features, including mountains, valleys, plains, lakes, rivers, and vegetation. They also identify the constructed features, such as roads, boundaries, transmission lines, and major buildings. The wide range of information provided by topographic maps makes them extremely useful to professional and recreational map users alike. Topographic maps are used for engineering, energy exploration, natural resource conservation, environmental management, public works design, commercial and residential planning, and outdoor activities like hiking, camping, and fishing. The U.S. Geological Survey (USGS) produces topographic maps at several different scales to meet these various needs.

AIM AND OBJECTIVES OF THE WORK

The aim of this project is to produce a detailed map of the University of Lagos, showing the relief pattern of the entire campus.

The objectives of the work are as follows:

- To identify existing controls within the campus.
- To acquire satellite imagery of the entire campus.
- To carry out reconnaissance with the use of handheld global positioning system.
- To acquire X, Y, Z, coordinate with the use of a differential global positioning system.
- To process all field data and plot them at relevant scale.

SCOPE OF WORK

The project deals with producing a detailed map by acquiring spatial and non-spatial data using Promark 3 differential global positioning system. The work covering an estimated area of 3.25Km^2 while observations were taken along all accessible roads network within the campus vicinity.

STUDY AREA

The area under study is the University of Lagos, Akoka Campus located on the western part of Lagos metropolis in Yaba Local Government Area of Lagos State, map of the study area (University of Lagos) is shown in Figure 1.1.

DATA ACQUISITION METHODS FOR MAPPING IN SURVEYING

Mapping in survey may be conducted by either aerial (photogrammetry) or ground (field) methods (Alamu *et al.,* 2010). The advancement in technology today and the procedure being used as made photogrammetric method to be used widely for large scale mapping survey. Janssen *et al.,* (2001) identified two main categories of spatial data acquisition; these are ground-based methods and remote sensing methods. He narrated ground-based methods to involve making field observations, taking in situ measurements and performing land surveying (Alamu *et al.,* 2010). While Olaleye (2011) defines Remote sensing as a method for collecting information about objects or the environment without coming in contact with such objects. The major medium of

contact is the Electro Magnetic Energy (EME) either reflected and/or emitted by such objects.
Selection of the field method to employ on any topographic survey depends upon the following considerations:

- Purpose of the survey
- Map use (accuracy required)
- Map scale; Contour interval
- Size and type of area involved
- Cost
- Equipment and time available and
- Experience of the personnel.

Data Source

There are differs method to acquire data. The data used in this project are acquired through;

- Existing maps, images and Google map.
- Data collected from the field with the use of Differential GPS.

The Figure 3.1 below illustrates the method adopted.

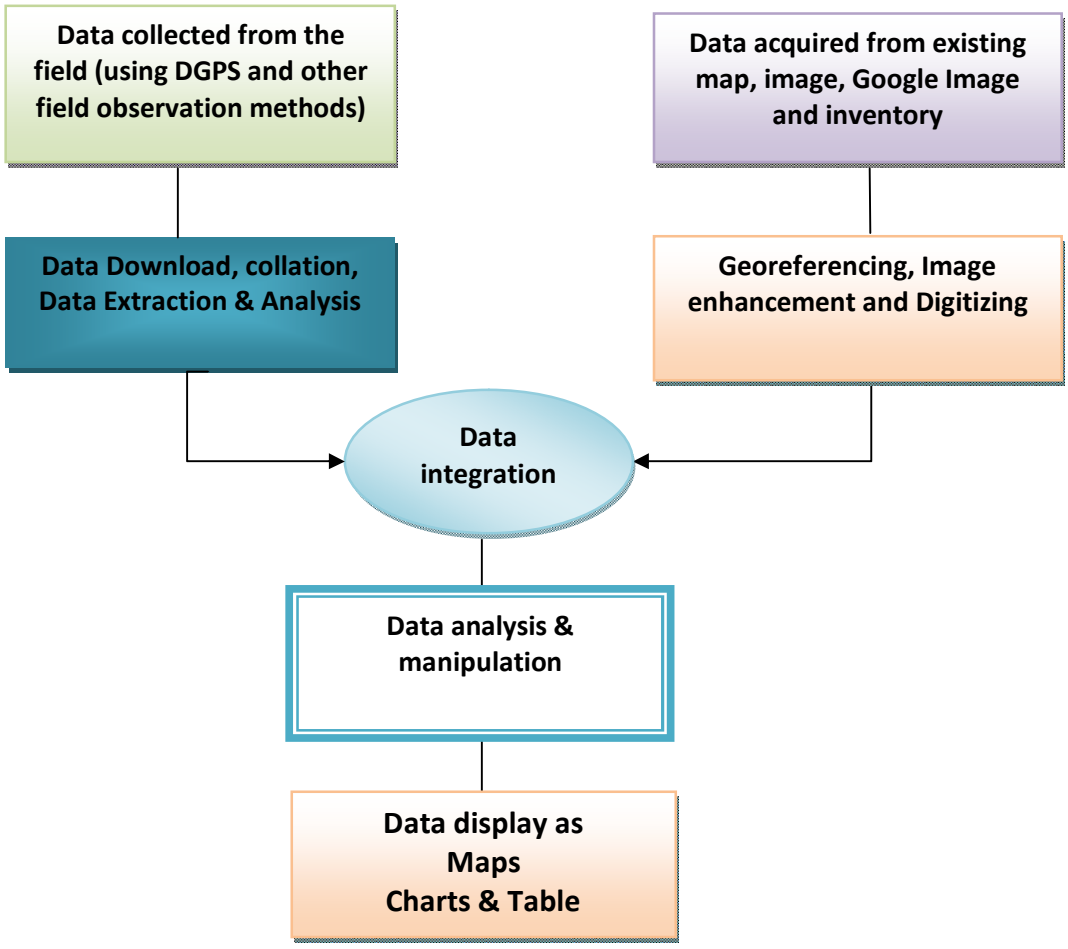

Figure 3.1: Flow Chart of Research Methodology

INSTRUMENTATION

The following instruments were used for the topographic survey of University of Lagos.

- Promark 3 DGPS (One reference station and one mobile receiver);
- Tripod Stand; Tribach;
- Tracking rod; Computer Hardware and Software;
- Handheld GPS;

DATA ACQUISITION

The data acquisition consists of the following stages:

- **Reconnaissance:** consists of the office and field phase which serve as a guide in the actual implementation of the project.

- **Field Observation:** consists of two segments which are instrument setting and observation. Using the PROMARK 3 DGPS for observation, bar method of initialization was employed for the communication of the rover with the base with time duration of 5 minutes. After this, observations were taken along accessible roads within the campus vicinity.

- **Data Processing:** This involves the extraction of the data acquired on site from the PROMARK 3 DGPS memory card and GNSS Solutions was used to process the data into their respective x, y and z coordinates with the z-coordinates in orthometric height.

DATA INTEGRATION

This involves combining maps of a geographical area made at different dates, scales, coordinates or projection which may equally involves integrating digital map data with remote sensing data (satellite imagery) and aerial photographic data and all these geographical data sets can also be integrated or linked with non-geographic (statistical) attribute data sets.

DATA MANIPULATION AND ANALYSIS

The overlay of point data over image and vectorised data gave an insight to how the map would look like.

DATA PRESENTATION AND ANALYSIS

The data presentations highlighted below is based on the usage of the following GIS software ArcGIS 9.2, Global Mapper 10, Surfer 8, GNSS Solutions and Excel Spreadsheet.

DIGITAL TERRAIN MODEL

The Digital Terrain Model represents the bare ground surface without any objects like plants and buildings. This representation allows us to view or geo-visualize the project area in proper 3D perspective rather than 2.5D perspective the contour map is seen. Geo-visualization is a 3D scene that gives opportunity for maneuver on any generated

surface with ease. This tends to fully represent the real world scenario perfectly. There are times when the vertical exaggeration is increased to view the high and low area which is a good attribute of Surfer Software by Golden software. The 3D Digital Terrain Model of University of Lagos is shown in Figure 4.1.

DATA ANALYSIS

From the contour map obtained through the processing of data, the spot heights interval at a particular location and places within the campus vicinity are shown below in form of tables with their respective bar charts and pie charts plotted using height intervals to depict their spot heights variations.

Buffer Analysis

Using shape file of the spot heights created in ArcGIS, the data for the spot heights was queried using selection by attribute method. The queries of the spot heights are between 1m to 2m, 4m to 5m, 7m to 8m and 9m to 10m. For each of the result of the queries, shape file were created for them and using the analysis tools in ArcGIS, buffer of 1m distance unit were done for each of the queried shape file.
The buffer analysis helps us to know where we have the minimum and maximum height within the campus environment. Also it enables us to know areas within the campus that are vulnerable and liable to flooding and also provides information as to the best location to established mast stations within the campus environment.
The results obtained from the analysis are as shown (Figure).

The remaining results obtained from the buffer analysis can be seen in the Appendix B of this summary report. Their names and locations are as well stated below:

- See Table 4.8 in Appendix B for Locations of Spot heights 1 to2 metres within the campus vicinity and the map showing the spot heights 1 to 2 metres within the campus vicinity can be seen in Figure 4.20 in Appendix A.

- See Table 4.9 in Appendix B for Locations of Spot heights 4 to5 metres within the campus vicinity and the map showing the spot heights 4 to 5 metres within the campus vicinity can be seen in Figure 4.21 in Appendix A.

- See Table 4.10 in Appendix B for Locations of Spot heights 4 to5 metres within the campus vicinity and the map showing the Spot heights 9 to 10 metres within the campus vicinity can be seen in Figure 4.22 in Appendix A.

PRESENTATION OF MAPS AND OTHER RESULTS OBTAINED

Maps and digital terrain model of a particular geographical area are vital information in the implementation of engineering projects. Engineers are in need of this information which serves as a guide and to enable them to know the specific profile or relief of a particular geographic area which facilitate the technical knowhow in the actual implementation of the propose project.

The topographic map of University of Lagos, contour map, detail map, Triangulated Irregular Network (TIN) with contour and buildings overlaid on it, digital terrain model and spot heights of the University of Lagos using ArcGIS 9.2 can be seen in Figure 4.15-4.19 and Figure 4.23- 4.24 in Appendix A.

CONCLUSION AND RECOMMENDATION

Results Achieved

At the completion of this study the following results were achieved.

- Spot Heights of University of Lagos.
- Contour Map of University of Lagos.
- Topographic Map of University of Lagos.
- Triangular Irregular Network of University of Lagos.
- Identification of minimum and maximum elevations within the campus vicinity.
- Identification of areas liable and vulnerable to flooding.
- Statistical analysis showing spot heights variations within the campus vicinity.
- Establishment of UBA 1 and UBA 2 control points as shown below.

The above results are shown in the following Tables and Figures in the appendices

- Table 3.0: Control Establishment (UBA 1 and UBA 2)
- Table 3.1: Height Variation in the Faculties
- Table 3.2: Height Variation on the roads network
- Table 3.3: Height variation of selected basement of buildings
- Table 3.4: Height variation within Faculty of Engineering
- Table 3.5: Height variation on road along Lagoon Front
- Table 3.6: Locations of Spot heights 7 to8 metres within the campus vicinity
- Figure 1.1: Map of University of Lagos
- Figure 3.2: Spot Heights of University of Lagos
- Figure 3.3: Contour map of University of Lagos using Surfer 8
- Figure 3.4: Topographic Map of University of Lagos
- Figure 3.5: Map showing Spot Heights 1 to2 metres within University of Lagos

Conclusion

- The map produced can serve for both engineering and tourism purposes which makes the map a multipurpose map.
- The results of the survey obtained can be used for further engineering design of University of Lagos like sand filling of the swampy area (Land Reclamation), construction of bridges and good drainage system etc.
- The elevations data obtained can be used for cut and fill calculation and development of new structure.
- The results of buffer analysis can be used to identify areas within the campus vicinity liable to flooding and appropriate measure can be put in place to curb the occurrence or the effects of the natural disasters.
- The statistical and buffer analysis help to identify the region of minimum and maximum height variation on campus.

- Promark 3 DGPS is an efficient equipment for gathering large amount of data in large area within a limited time frame.
- The Rover receiver is vulnerable to signals loss within the vicinity of high rise structure due to the interference of satellites signal by the buildings (Multipath Effect).

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APPENDICES

Table 3.0: Control Establishment (UBA 1 and UBA 2)

Control	Locations	Eastings	Northings	Heights
UBA1	UBA PARK	542712.317	720440.185	2.3
UBA2	UBA PARK	542724.767	720438.319	1.847

Table 3.1: Height Variation in the Faculties

Height Variation in the Faculties		
S/N	Faculties	Height Intervals (m)
1	Faculty of Engineering	2 to 8
2	Faculty of Education	4 to 7
3	Faculty of Environment Science	2 to 9
4	Faculty of Social Science	3 to 9
5	Faculty of Science	3 to 9
6	Faculty of Art	4 to 9
7	Faculty of Law	6 to 9

Table 3.2: Height Variation on the Roads Network

Height Variation On Some Roads Network		
S/N	Roads	Height Intervals (m)
1	Commercial Road	2 to 7
2	Oduduwa Drive	2 to 5
3	International School Road	4 to 6
4	Ozolua Road	3 to 5
5	Dan Fodio Road	4 to 8

Table 3.3: Height Variation of Selected Basement of Buildings

Height Variation of Selected Buildings		
S/N	Buildings	Height Intervals (m)
1	Sports Centre	4 to 6
2	Health Centre	5 to 6
3	Chapel	2 to 9
4	New Hall	4 to 7
5	Multipurpose Hall	4 to 7
6	UNILAG Consult	4 to 7
7	Jaja Hall	5 to 7
8	Dept. of Physical Planning	3 to 9
9	UNILAG Staff School	5 to 7
10	Jaja Hall Canteen	5 to 7
11	Mosque	5 to 8
12	Senate Building	5 to 8
13	Council Chamber	6 to 8
14	Main Auditorium	7 to 9

Table 3.4: Height Variation within Faculty of Engineering

Height Variation Within Faculty of Engineering		
S/N	Department/Hall	Height Intervals (m)
1	Julius Berger Hall	3 to 6
2	System Engineering	5 to 6
3	Department of Creative Art Lab	5 to 6
4	Department of Architecture	5 to 6
5	Metallurgical and Material Engineering	5 to 7
6	Electrical Engineering	6 to 7
7	Surveying and Geoinformatics	6 to 8
8	Mechanical Engineering	7 to 8
9	Civil Engineering	7 to 8
10	ELT	7 to 8

Table 3.5: Height Variation on Road along Lagoon Front

Height Variation on Road along Lagoon Front		
S/N	Points	Heights (m)
1	P1	1.2
2	P2	1.8
3	P3	1.4
4	P4	1.5
5	P5	1.47
6	P6	1.35
7	P7	1.39
8	P8	1.56
9	P9	1.4
10	P10	1.54

Table 3.6: Locations of Spot Heights 7 to 8 Metres within the Campus Vicinity

Locations of Spot Heights 7 to 8 Metres within the Campus Vicinity	
S/N	Locations
1	Faculty of Engineering
2	Tafa Balewa Way
3	Mariere Hall
4	Senate Building and Environs
5	Jaja Hall
6	CITS
7	Kosoko Drive
8	Department of Mass Communication
9	Main Auditorium
10	Akintunde Ojo Library
11	UNILAG Staff School
12	Afe Babalola Auditorium
13	UBA Bank
14	UNILAG BookShop
15	Human Resource Centre

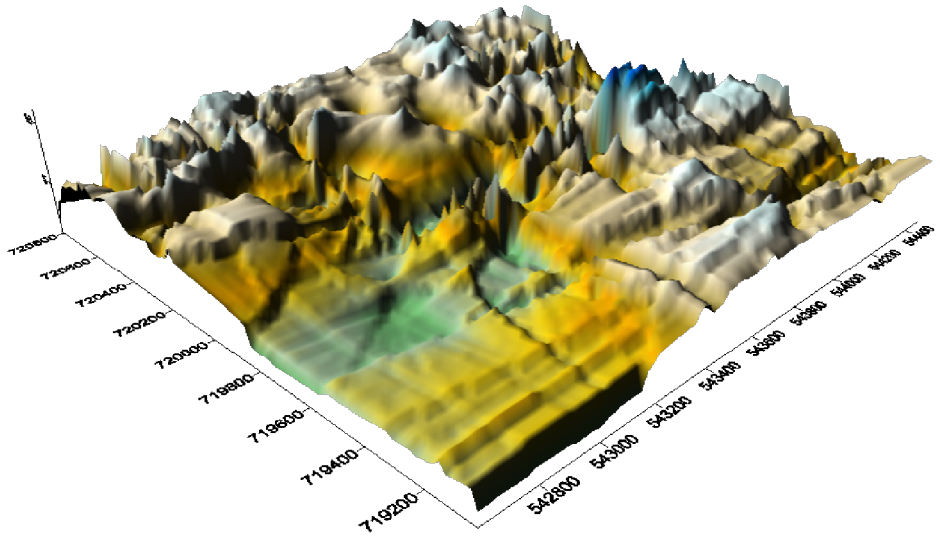

Figure 3.1: Digital Terrain Model of University of Lagos Using Surfer 8

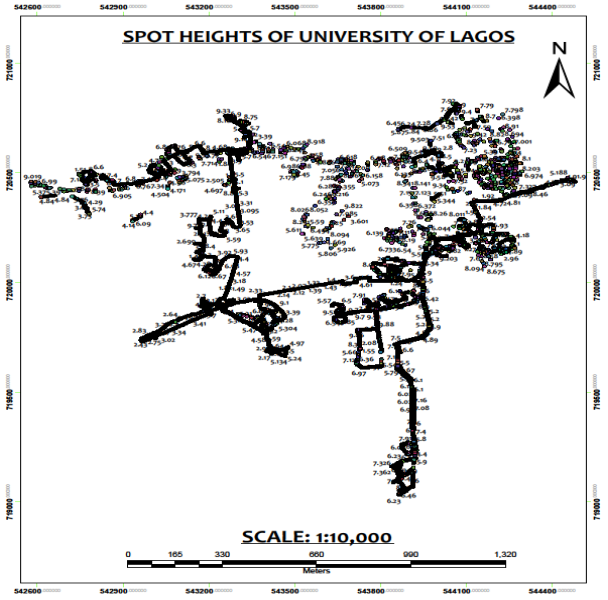

Figure 3.2: Spot Heights of University of Lagos

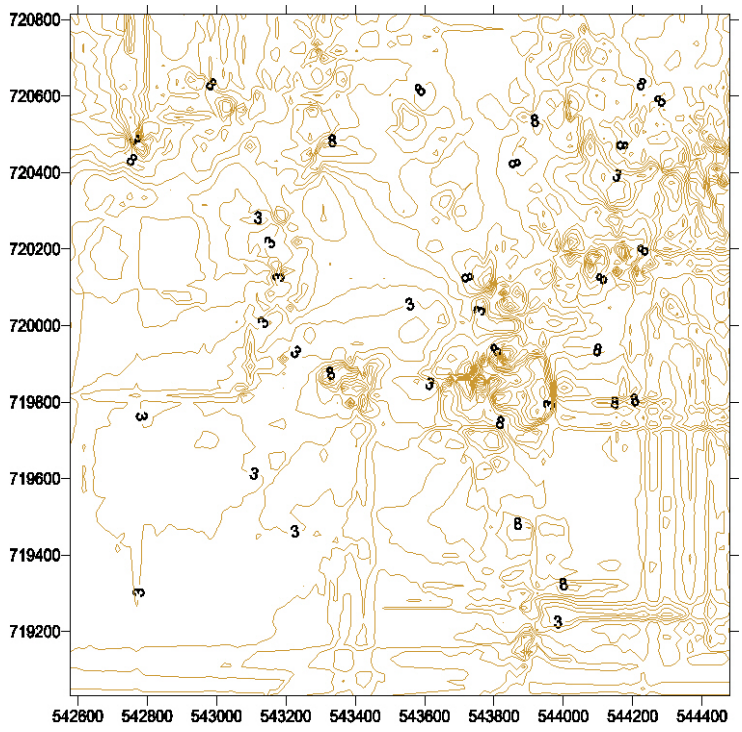

Figure 3.3: Contour Map of University of Lagos Using Surfer 8

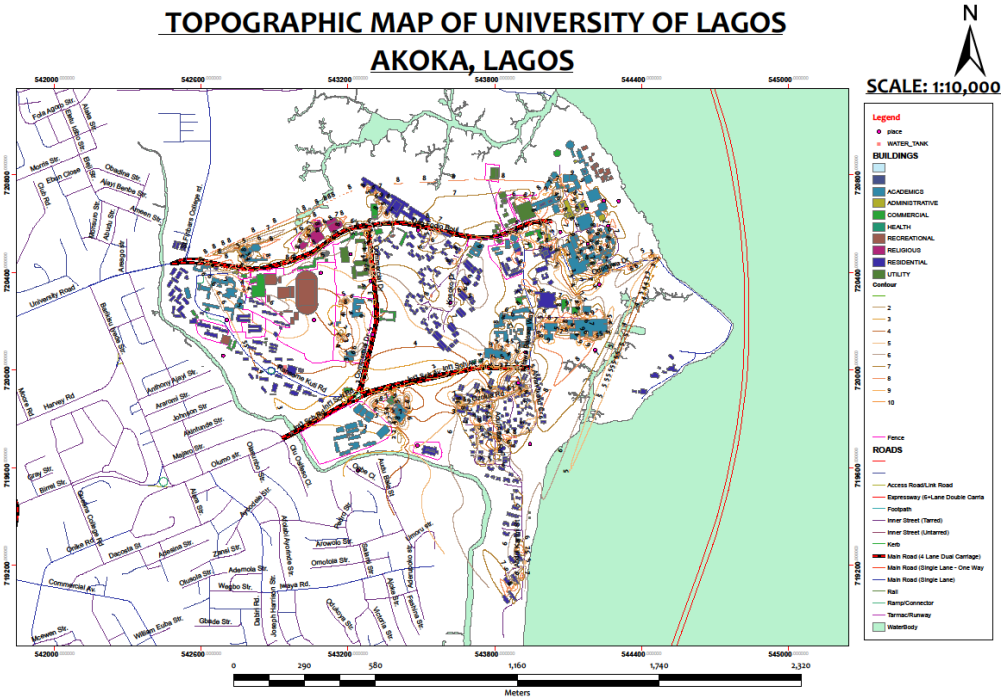

Figure 3.4: Topographic Map of University of Lagos

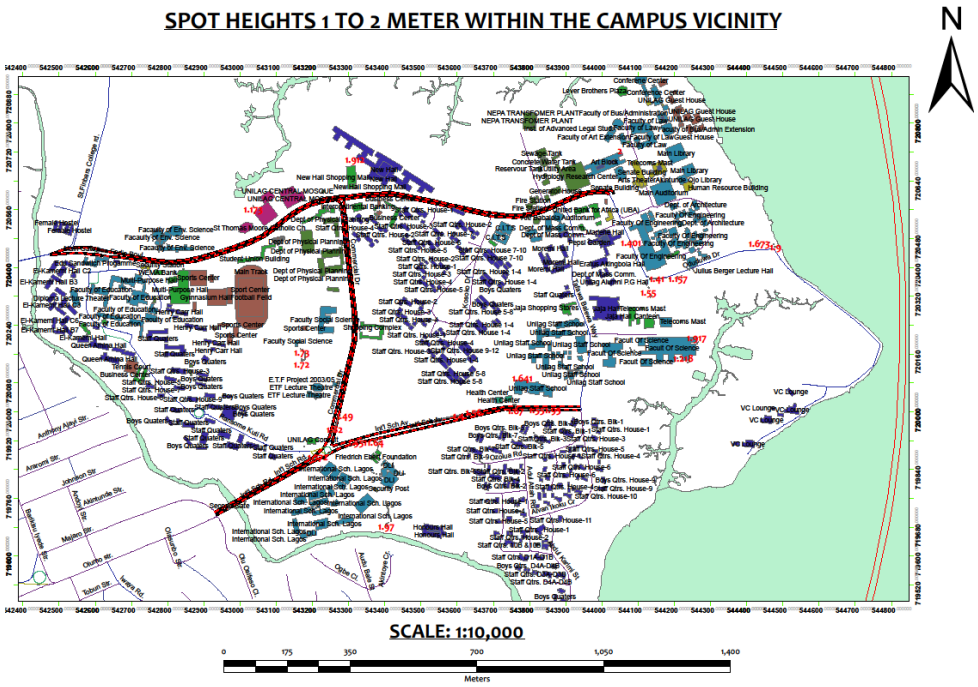

Figure 3.5: Map showing Spot Heights 1 to 2 Metres within University of Lagos