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THE MAPPING AND ESTIMATION OF SLUM FOOTAGE INVENTORIES OFGARKI-2 ABUJA, NIGERIA.

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Abstract

This research program focuses on mappingand estimating slum footage inventories for Garki-2 slum areas, Federal Capital Territory Abuja, Nigeria. The ultimate goal of the research is to improve slumfootage estimation modelling by creating more accurate footage inventories that require an estimate of number of houses, size of floor areas, soil types and the differential depth of building foundation.The parameters used for mapping and estimation classification from remotely sensed data are accessibility, housing, roof of buildingand the building density. However, change detection in land use and land cover remain obsolete in the study area, it was observed that the study areas had been in a condition of virtual slum before the creation of the Federal Capital Territory Abuja.

The results shows that the most consistent plot size ranges from7.5-81.00m^2 accounting for 53.96% of the total, while, plot size of 120m^2 and above 225m^2 accounts for 46.04%. In addition to more accurately representation of the cohesive and non-cohesive soils type and foundation depth,the dispersion accuracy of vegetable soil are 15.38%, laterites 13.91%, fine sand 58.92%, clayey sand 1.96% and gravely sand 9.82% of which fine sand proved more prominent in the study areas. While the predominant foundation depth types commonly in-use is the light depth (red) that ranges from 20-30cm (Figure 5) accounting for 47.34%, others are the medium depth (blue) accounting for 29.18% and 23.48% for the density depth (green). UsingLandSat-7 ETM+ imagery as well as detailed field work,the results obtained clearly shows that significant slum inventory can be identified in the study areas. The study therefore recommends relevant government agencies should develop policies and strategies that will achieve a balanced and sustainable development forGarki-2 slum areathat can be used by Revenue Assessor (for tax collections), Town Planning Authorities for proper planning and development by Real Estate Developer and Government agencies for upgrading and removal of slums.

Keywords: Mapping, estimation, slum, footage inventories and image classification

1.0 Introduction

Badaru et al. (2014a) explains that slums sprout and continue for a combination of demographic, social, economic, and political reasons. It is anticipated that the causes of slum or squatter areas include rapid rural-to-urban migration, poor planning, economic stagnation and depression, poverty, high unemployment, informal economy, colonialism, segregation and social conflicts (Patton, 1988; Gulyani, et al., 2010).Slum footage inventories is the compilation of the precise illegal, unplanned, squatter settlement square foots of land.According to Badaru et al. (2015), understanding the nature of the slum environment will also be key in developing footage inventory. Without prior knowledge of the study areas, it may be impossible to measure the accurate composition of the footing.In the words of Kimani-Murage and Ngindu, (2007), five and more persons may share a one-room single apartment. Kimani-Murage and Ngindu further explain that the same rooms were used for cooking, sleeping and living. Kundu (2003) buttress the result of Kimani-Murage and Ngindu, that a slum of Kolkata, India, over 10 people sometimes shares a 45 m^2 room.

1.1 Background to the Study Area

Garki-2 slum areas aresituated in the Federal Capital City, Abuja (FCCA) and cover a land area of 4.23sq.km. The geographic coordinates of the study areas can be found onlatitudes $9^o01.314'$ N of the equator and longitudes 7^o $29.211'$ E (Figure 1). The study areas arebordered to the north, east, south and west by Garki Area-3, Garki Area-11, Garki-2 and Apo respectively. The specific study area includes slum or squatter settlement in the neighborhoods and inner suburbsof Garki-2 (Badaru, 2014b).

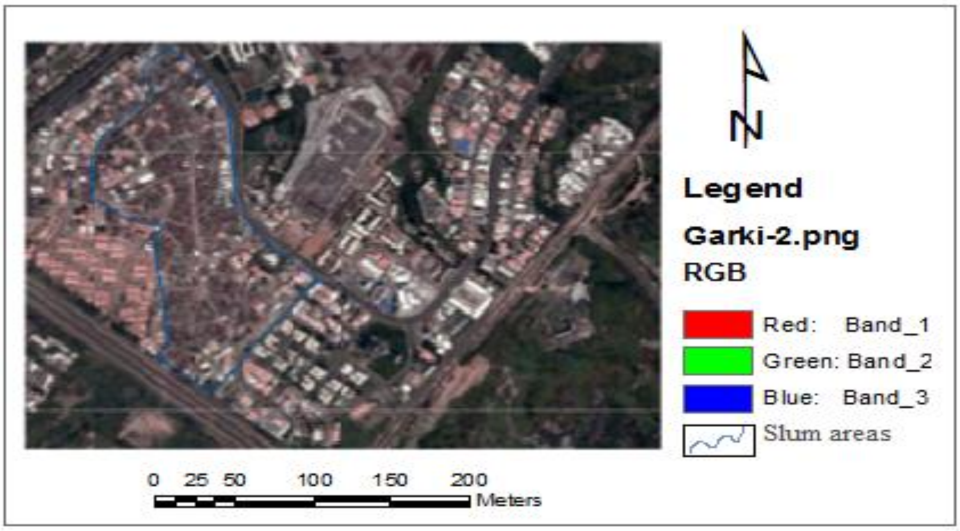

Figure 1: The study Area

1.2 Statement of Research Problem

The current methods of using manual estimation of assessing slum footing or substructure inventory could produce negative results, which is capable of misleading tax official, government agencies, Federal Capital Development Authority (FCDA), Builders, Planners, Surveyors and health related departments. The study attempts to use geospatial and temporal techniques which are necessary to provide a standard inventory database of the footing to the slum environment.

1.3 Aim and Objectives

The study aimed at mapping and estimating slum footage inventories of Garki-2, Abuja-Nigeria. To achieve the above aim of the study, the specific objectives were as follows:

a. To identify and classify the slum footage distribution
b. Using the combination of spatial and temporal technologies to discrminate or diffrentiatesoil type, building foundation depth, number of existing house-plot and individual floor areas or plot size.

c. To identify the economic parameter associated with large-scale slum footage development.

2.0 Review of Related Slums

Slums form and grow in many different parts of the world for many different reasons (Giok and Kai, 2007). In many developing countries, it is easier to distinguish the slum-areas and non-slum areas (Chandrasekhar, 2005), particularly in the city of Abuja, slum dwellers are usually in city neighborhoods, inner suburbs and more common on the urban outskirts. In some cities, especially in countries in Southern Asia and sub-Saharan, slums are not just marginalized neighborhoods holding a small population; slums are widespread, and are home to a large part of urban population (Nyametso, 2012).Badaru et al. (2014a) discovered that the Federal Capital Development Administration (FCDA) often refuse to recognize slums, because of the fear that quick official recognition will encourage more slum formation. Recognizing and notifying slums often triggers a creation of properrty rights, and requires that the government provide public services and infrastructure to the slum residents.

3.0 Methods

3.1 Image classification

Satellites-based systems that offer ETM+ sensor capabilities are adopted. Having created the signature file, hence the data is ready for supervised classification. Maximum Likelihood (MLC) was carried out on the acquired 2012 and 2013Landsat imagery of the Federal Capital City, Abuja, Nigeria using the Image Classificationmodule of ARCMAP-10.1 GIS.Landsat satellite data set was selected corresponding to the ground truth measurements of the slum levels (Badaru, 2014b).

3.2 Field work sampling and Ground truthing

The sampling of the slum footage variable that includes foundation depth, soil types, plot sizes and number of existing plot were examined by remote sensing scientist, registered builder, surveyor and environmental scientist concurrently at the study area between the hours of 10.00am to 3.40pm for the period of ten days. The appropriate samples collected in the month of January 2015 (cool/dry season) is taken on site and they were professionally sorted out and examined, compared with the professional code of practice of the CORBON, SRCN, TOPREC, NES, COREN etc. currently adopted in Nigeria.

4.0 Results

4.1 Spatial Distribution of Land-use

Figure 2 shows an aerial view outlining slum per-plot footprints fordifferential house type. The Figure 2 is essentially a non-shaped plot with building located on the fridge-edged of the land, therefore showningdistortion in the town planners regulation.Thedata ornamenting from Figure 2 provide informationon the distributions of major accessibility and the unapproved layout plan of the existing slums in the study areas.

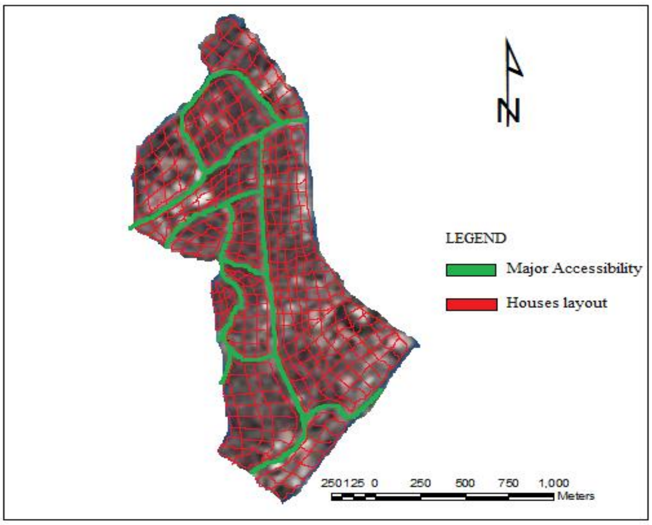

Figure 2: The spatial distribution of Land-use map layout.

4.2 Typical Floor or Plot Areas

Figure 3 shows that eightfloor areas or plot size can be observed from the study area. There are other informative review of various aspects ofthe distribution of floor sizes and their location as indicated; 1,6 & 8-blue, 1,2,5,6 & 8-green and 1,3,4,7 & 8-red, while the most predominant is the red (Figure 3).

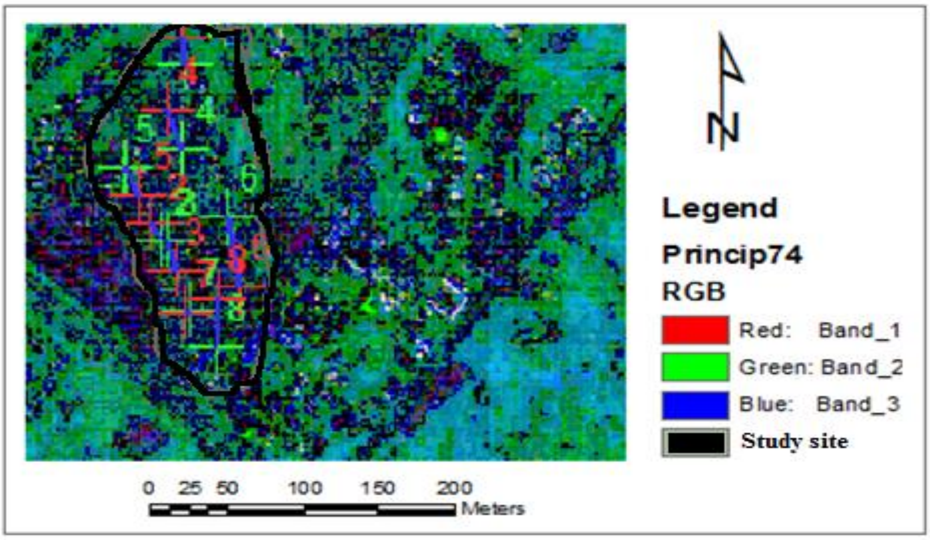

Figure 2: The spatial distribution of Floor Areas

4.3 The Qualitative Plot Size

Table 1 show that there are thirteen applications, describing plot/floor sizes, estimating the affected number of plot size and monitoring long-term trends thatare actively used by the community. The Table 1 also indicates potential application to guide those that use the slum regulatory, particularly the other Nigerian class. The Table 1 also shows the significant distribution of floor sizes, including the number of affected floor size, plot availability to indigene, other Nigerian and other nationals.

Table 1: The distribution of floor/plot sizes

FLOOR SIZE	No. of Affected Floor Size	Available to Indigene	Available to Other Nigerian	Available to other National
$7.5m^2$	5	-	5	-
$9.0m^2$	11	4	7	-
$12.0m^2$	6	3	3	-
$15.0m^2$	9	4	5	-
$25.0m^2$	10	4	6	-
$36.0m^2$	8	3	5	-
$49.0m^2$	5	-	5	-
$64.0m^2$	9	3	6	-
$81.0m^2$	12	6	6	-
$120.00m^2$	15	7	8	-
$150.0m^2$	10	6	4	-
$225.0m^2$	21	10	11	-
Above $225.0m^2$	18	5	13	-
Total	**139**	**55**	**84**	0
Average	10.39	5	6.46	0

Note: Total floor area $7,230m^2$

4.4 The Spatial analysis of the Soil Types

Table 2 shows five geologic layers that include the vegetable soil, laterite, fine sand, clayey soil and gravely sand of which the vegetable soil and fine sand are relatively permeable /loose in most places. Other geologic layers also shows differential variation of soil intensity from one area to the other bearing in-mind the occurrences of soil types. The Table 2 further shows that the lithological vegetative and fine sanddepth is observed to be characterized as a porous and permeable layer. Table 2 also shows the soil bearing capacity which is the presumed pressures that would normally result in an adequate factor of safety against shear failure for particular soil types, but without consideration of settlement.

Table 2: The Cohesive and non-Cohesive soilstype

Soil Types	Hectare (ha)	Percent (%)	Lithologic depth	Bearing capacity
Vegetative soil	0.94	15.38	0-25.50cm	75 kN/m²
Laterites	0.85	13.91	25.5-50.5cm	100 kN/m²
Fine sand	3.60	58.92	30-55.40cm	120 kN/m²
Clayey sand	0.12	1.96	55-73.30cm	150 kN/m²
Gravely sand	0.60	9.82	0-55.80cm	200 kN/m²
Total	6.11	100		

4.5The Contour map layer

Figure 3 shows the trend in contour spatial information system that deals with facilitating the physical position of every locational point of the study areas. The Figure 3 represents the relation between one elevation and the others, particularly contour layers ranging from 50, 100, 150, 200 and 300 of which the apex layer of 300 can only be found at the western part of the image.

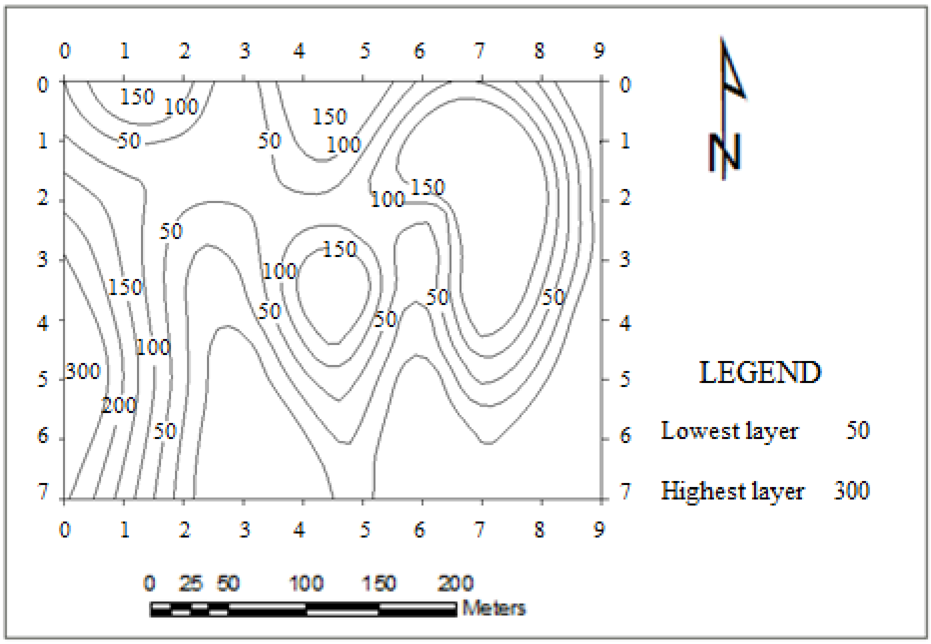

Figure 3: Contour map of the slum

4.6 The Contour and Vector data

Figure 4 shows the distribution of vector and contour data. The Figure 4 shows that there is a directional runoffs otherwise called sloping movement from the highest contour layer of 300 to the lower layer of 50, therefore, the study indicate undulating land-cover surfaces.

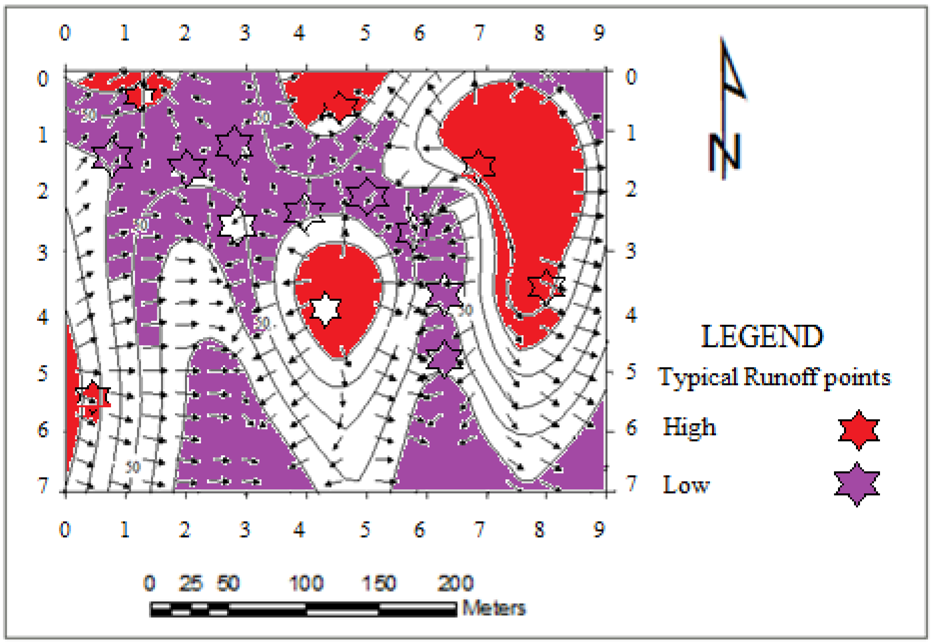

Figure 4: The Vector and contour map of the slum

4.7Analysis of Building foundation depth

Figure 5 represents the spatial distribution of building foundation depth and their precise location. The Figure 5 further indicates that there are three categories of depths concentration utilized, which correspond to light (20-30cm red), medium (30-35cm blue), and dense (35-40cm green) depth respectively.

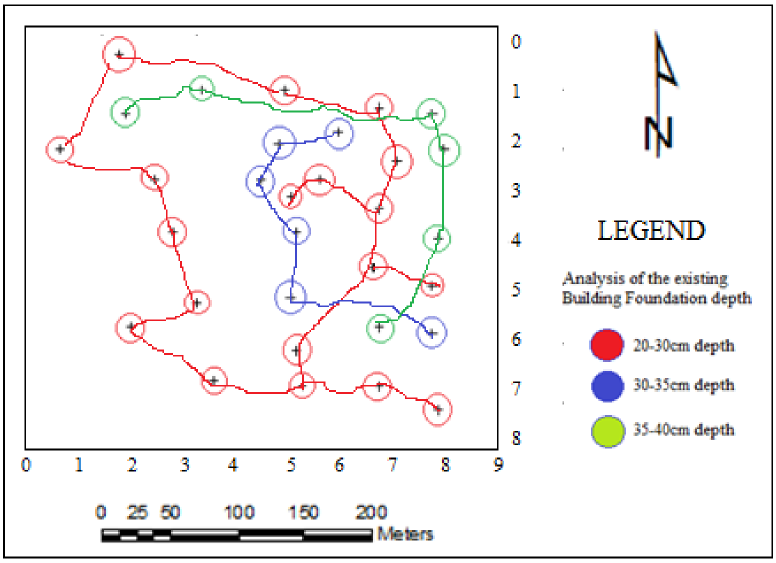

Figure 5: The spatial distribution of building foundation depth

4.8 The overlaying structure

Figure 6 focuses on discriminating and differentiating the various positions of soil types corresponding to the position of foundation depth. Furthermore, the Figure 6 shown have been normalized to the actual existing foundation depth, categories of soil types overlaying on the geometric of land cover (LC).Figure 6 indicates that vegetable top soilprecisely spotted on the contour layer of 50-100 demonstrateaccurate building foundation depth of 35-40cm. Whereas, the contour layer of 100-200 shows that the predominantsoil consist of laterites, fine sand and clayey sand, bearing in mind that the corresponding building foundation depth will be 20-30cm, while, the gravely sand can be sited on 200-300 contour layer indicating the precise building foundation depth of 20-35cm.

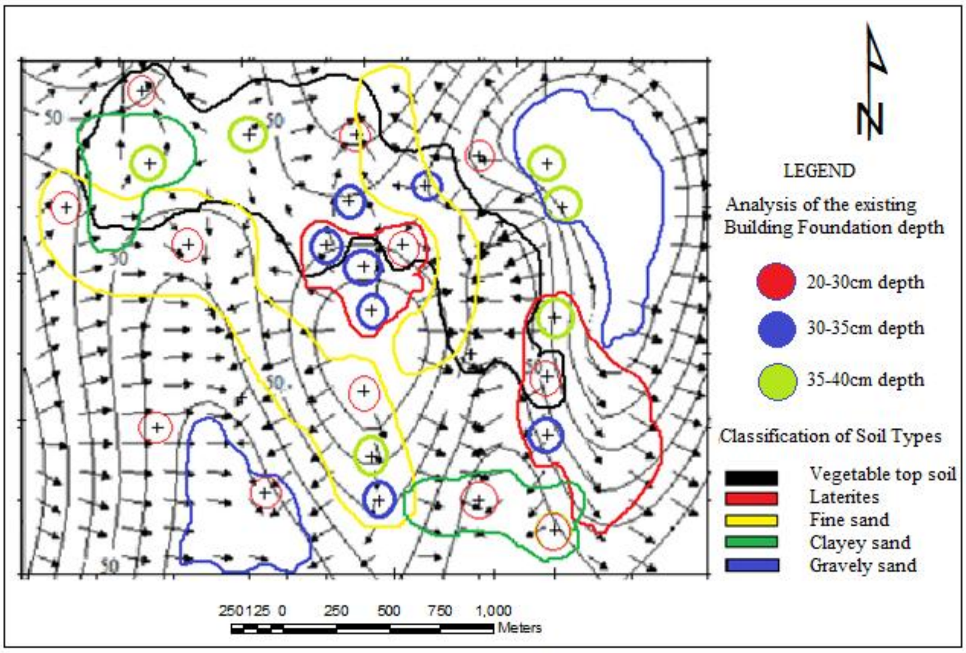

Figure 6: Classification of spectral data

4.9 Discussion

There are four important considerations in mapping and estimating slum footage inventory information that includes the number of buildings, plot sizes, soil types and foundation depths. Figures 2-7 shows the geometric analysis of the study areas, visible in the image is the physical properties of Garki-2 slum with its land-cover distribution pattern. The study shows that the most predominant floor sizes or plot sizes are between 7.5-81.00m^2 accounting for 53.96% of the total. For plot size of 120m^{2}and above 225m^2 accounts for 46.04%. In addition to more accurately representation of the soil types and foundation depth,the dispersion accuracy of vegetable soil is 15.38%, laterites 13.91%, fine sand 58.92%, clayey sand 1.96% and gravely sand 9.82% of which fine sand is prominent in the study areas. While the predominant foundation depth types commonly in-use are the light depths (red) that ranges from 20-30cm (Figure 5) accounting for 47.34%, others are the medium depth (blue) accounting for 29.18% and 23.48% for the density depth (green). However, the soil types layers utilizedare not likely to sustain the stability of the building bearing in mind their state of porosity. It is likely that the extraction of the position of under-pinning to ascertain existing foundation depth can be very useful considering differential contour level along the same course and soil properties. Therefore, to outline slum footage inventory, the most effective approach is adopting geospatial and temporal techniques.

Conclusion

The use of satellite remote sensing techniqueand accurate field work should be construed as a call for replacement to other traditional methods for mapping and estimation of slum footage inventory.This information generated can be used by government agencies for planning and developmental purposes for the upgrading the slums, infrastructural developmental and economic planning. We expect that the successes and limitations revealed in this study will lay the basis for applying more advanced space borne methods to capture the dynamic variability in the number of building, plot size, soil types and foundation depth in the near future.

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