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ABSTRACT

Nigeria's economy is heavily dependent on the oil sector and this has led to neglect of the agricultural sector in the past. To diversify the economy is of paramount necessity in order to drift the economy from total dependence on the oil sector. In order to help in the reversal of this wholly dependence on the oil sector, the government has been advocating to shift attention to other key sectors of the economy and particularly agriculture. The government has initiated cassava production and exportation, this seeks to variegate the use of Nigerian- produced cassava through industrial processing and utilization options. This aims at giving domestic and exporters the opportunity to generate income for the government and individuals. To get the goal achieved, improved varieties of cassava have been made available for higher yields.

In this study, GIS has been used to bring biophysical factors such as rainfall, temperature, sunshine hours, soil, soil slop, elevation and geology together; using Boolean in spatial analyst tools in ArcGIS 10.1 software to ascertain the most suitable area for cassava production in Akoko-Edo L.G.A. of Edo state. The most suitable area is highlighted for large scale cassava production for industries and prospective investors.

Keywords: Geographic Information System, Boolean Calculator, Biophysical Factors, Spatial Analyst, Shuttle radar topographic mission.

1.0 INTRODUCTION

Land evaluation is the process for predicting the potential use of land based on its attributes. It is also the process of assessment of the potential of land for alternative types of use (Beek, 1972). The basic feature of land evaluation is the comparison of the requirement of land use kinds with the characteristics of the available land resources by interpretation of surveys and studies of soils, crops, climates and land forms, (Dent and Young 2002).

Land evaluation presents information and recommendations which can assist planners and decision makers to decide which crops to grow in a particular place, and the limitation of land use. Land evaluation is the selections of suitable land and cropping. The main product of land evaluation investigation is a land classification that indicates the suitability of different types of land for specific land uses, mostly described on maps with accompanying reports from Food and Agricultural Organization, (2002). In order to increase food production and provide food security, there is need to understand the interaction of soil, water, climate, crops, animals and people with a view to having land use planning for improved productivity and commercialization of crops and livestock systems,(Kari,2008). Planning of land use requires collection and analysis of information on soils, climate present and potential land uses, markets, prices and population. The analysis on how this type of information interacts with crops is not sufficiently handled using manual methods. However, the application of modern analytical tools such as geographic information system (GIS) and remote sensing makes it easy to be manipulated and analyzed in ways that are less costly and time consuming. Therefore, for land to be suitable (for a given purpose) and for the use to be sustainable, it must address the values that are related to both aspects: degree of suitability, and potential degradation (from long-term perspective) resulting from land management practices. Although, the need to make value judgment in land evaluation is inevitable, it is important to utilize information / knowledge engineering techniques that minimize human bias to improve the pragmatic value of land evaluation results (De la Rosa et al., 2004). Thus, the choice of Geo -technology techniques in this research work.

2.0 MATERIALS AND METHODS

Study Area

Akoko-Edo local government area is bounded to the North with Ogori /Mangogo, Okehi, Adavi and Okene local government areas all in Kogi state. To the West with Akoko South East, Akoko North East and Ose local government areas in Ondo state. To the South with Owan East and Etsako west and to the East with Etsako East all in Edo state. It lies between longitude 6° 25' E to 6° 55' E and latitude 7° 05' N to 7° 40' N. It is predominantly populated with the Okpamaris, Etunos, Etatunos, Unemes and other tribes in the local government. The major occupations of the people are agriculture, local craft and Blacksmithing, commerce and with few who are civil servants. The map of Akoko-Edo local government area is shown in the next page.

Figure 1: Map Of Akoko-Edo L.G.A.

The suitability evaluation was based mainly on the method as described by FAO (1983). Land units resulted from the overlay process of selected land qualities were established. The selected land qualities are land use land cover, soil type, geology, digital elevation model (DEM), slope, rainfall and temperature. The requirements for each crop were reviewed from FAO (1983). The various factors rating and values assigned as determined by FAO for cassava is summarized in table 3.

3.0 DATA COLLECTION

Table 1: Existing Data

S/N	Data name	Acquisition date	Resolution/Scale	Source
1	NIGERIA SAT 1 IMAGERY	2014	32m x 32m	NASRDA
2	Shape file of Akoko-Edo LGA	Sheet 266,1962	1: 50000	OSGOF
3	SRTM (DEM)	2007	30m	Global Land Facility
4	Climatic data of rainfall, Relative humidity and Temperature	2009- 2012		NASA
5	Geology map of Nigeria	2006		NGSA
6	Soil Map of Nigeria	1997	1: 1,300000	WAGENINGEN THE NETHERLAND

Table 2: Data Analysis

S/N	Data Name	Procedures	Analysis
1	NIGERIA SAT 1 IMAGERY	Geometric and Radiometric correction, clipping and classification	Extraction of shape imagery of study area
2	Shape File of Akoko-Edo LGA	Importation into ArcGIS environment	Creation of shape file
3	STRM	Generation of DEM, Extraction of shape imagery of study area	Reclassification
4	Climatic data of Rainfall, Relative humidity and Temperature	Creation of shape files, interpolation and clipping of study area.	Reclassification
5	Geology map of Akoko-Edo LGA	Importation into ArcGIS environment	Digitization, Reclassification and overlay
6	Soil map of Akoko-Edo LGA	Importation into ArcGIS environment	Digitization, Reclassification and overlay

Figure 2. Flow Chart

Table 3: Climatic, soil, and land requirements for cassava production

Land use requirement			Factor rating			
Suitability requirements			Highly suitable	Moderately suitable	Marginally suitable	Least suitable
Land quality	Diagnostic factors	Unit	1.0	0.8	0.5	0.2
Water availability	Annual rainfall	mm	1100-1500	900 - 1100 1500 - 2500	500 - 900 2500 - 4000	<500 >4000
Oxygen availability	Soil drainage	-	Well	Moderate	Poor	poor
Water retention capacity	Soil texture	-	L, Si, Sil, Sc, Cl	Sicl, Ls, Sil	Sic, S	C, G, Sc, Ac
Root condition D	Soil dept.	cm	>150	100 - 150	50 - 100	<50
Temperature Te	Annual mean temperature	°c	>25.6	24.7 – 25.6	23.7 – 24.7	<23.7
Solar energy S	Mean sun shine hours/day	hours	>7.1	6 – 7.1	4.9 – 5.9	<4.9
Topography T	slope	%	<5%	5 – 12%	12- 20%	>20%
Nutrient availability index NAI	N	%ppm	>0.2	0.1 -0.2	<0.1	-
	P		>25	6 -25	<6	-
	K		>60	30- 60	<30	-
	PH		6.1 – 7.3	7.4 -7.8	7.9 -8.4	>8.4
				5.1 – 6.0	4.0 -5.0	<4.0

C=clay, Cl= clay Loam, L =Loam, Si= Silt, Sil=Silty Loam, SIC=Silty clay, Sl=Sandy loam, Ls=loamy sand, SCL=Sandy clay loam, SiCL=Silty clay laom, S=Sand, G=gravel soil, AC= Alluvial complex, SC= slope complex.

Adapted from FAO (1983)

4.0 RESULTS AND DISCUSSION

Rainfall is the most important weather factor that influences crop yields and production (Alabi and Ibiyemi, (2000)). Akoko-Edo L. G. A. is located in the Northern part of Edo state and shares in the moderate rain fall of the middle belt of Nigeria. The average annual rainfall of the area is 2200mm-2500mm, this suggested that the area under study is marginally suitable for cassava production. It also has moderate solar energy due to 5 – 6 hours mean daily sunshine.

Landsat 8, 2014 imagery of the region was acquired from Nigeria sat 1, layer stacked using band 5, 4 and 3. The shape file of Akoko-Edo L.G.A. was overlaid, copied selection to AOI and sub setted. Thereafter, supervised classification of the above image was done in ERDAS IMAGINE software where the image was classified. The classified image was exported to ArcGIS environment for composition. The land use data includes settlement, forest, woodland, rock- outcrop, cultivation, riparian, water body and woodland, it is as shown below.

[illegible]

Figure 4: Soil map of Akoko-Edo L.G.A. reclassified

Figure 5: Geology of Akoko-Edo L.G.A

The shape file of Akoko-Edo L.G.A. was overlaid on the existing geology map of Edo state and clipped.

Figure 6: Digital Elevation Model (DEM) of Akoko-Edo L.G.A.

The map was generated by overlaying the Shape file of Akoko-Edo L.G.A. on the Shuttle Radar Topographic Mission (SRTM) Map of Nigeria and clipped. 3D analyst tool was used to generate the DEM on ArcGIS environment.

Figure 7: Slope of Akoko-Edo L.G.A.

The map was generated by overlaying the Shape file of Akoko-Edo L.G.A. on the Shuttle Radar Topographic Mission (SRTM) Map of Nigeria and clipped. 3D analyst tool was used to generate the slope in ArcGIS environment. It was observed that southern part of the study area has flat, even and low terrain. The study area is observed to have rugged and high terrains especially the central and the northern part of the study area.

Figure 8: Reclassified slope of Akoko-Edo L.G.A.

Having considered the FAO standard of slope for cassava cultivation, the area was reclassified into two major classes. The light pink colour shows gentle slope while the deep pink shows steep slope.

Figure 9: Map showing overlaid layers of all participating maps

This map was generated by adding all the layers of participating maps and features. The features were rasterized and coded. The spatial analyst tool was used for Boolean operation. The Boolean's calculator was used for raster calculation to find the intersection of all participating features, Considering the FAO standard requirements for cassava production. The interset is the area showing RED COLOURATION which is the most suitable area for cassava production. The total area of land most suitable for cassava production is about 15 km² in the local government under study

5.0 CONCLUSION

From the results of this work, it is clear that GIS can be an effective tool for combining biophysical factors of cassava production to highlight most suitable areas for large commercial production in Nigeria. It is also possible to use the results of this work to guide investors in prioritizing and targeting of their resources in cassava industrial development. (Malachy and Tunrayo (2005)). The conclusion of Malachy in his work is very true as this work also follows suit to further prove the efficiency of GIS. Akoko-Edo L.G.A. is one of the areas in Nigeria that commercial cultivation of cassava can be done.

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