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A GIS-AHP Approach for Evaluating Site Suitability for Solar Power Plant: A Case Study of Ewekoro LGA., Nigeria

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Abstract

To address Nigeria's electricity shortages and overreliance on traditional methods, solar power plants are being considered. However, selecting suitable sites for this purpose is critical and often poses a serious challenge considering a range of conflicting factors. In this study, the Analytical Hierarchy Process (AHP) technique and Geographic Information Systems (GIS) were combined to determine suitable sites for a solar electric power plant in Ewekoro Local Government Area (LGA). The approach considered road networks, transmission lines, slope, and land use as the key criteria as well as nineteen subcriteria for the site suitability analysis. The criteria and sub-criteria importance were weighted using AHP and the weights were inputted into the weighted overlay tool in the ArcGIS 10.4 for analysis. The resulting sub-criteria weights of land use are 3.5%, 6.8%, 10.6%, 16%, and 63.1% for built-up areas, waterbody, wetlands, rocky areas, and vegetation respectively. Based on the analysis, a suitability map was generated that categorized the study area as best suitable, suitable, and not suitable. On the map, 15% of the area was best suitable, 17% was suitable, and 68% was not suitable for solar power plants. In conclusion, the site suitability analysis of Ewekoro LGA for solar power plants has been evaluated and this approach can be extended to other areas in Nigeria where solar energy integration is of high priority.

Keywords: Solar Power Plant, Site Suitability, Analytical Hierarchy Process, Geographic Information System, Nigeria.

1.0 INTRODUCTION

Energy accessibility is fundamental to industrialization and an improved standard of living [1]. Through adequate electricity, developed countries have achieved great economic height while developing nations aspire to grow their economy [2]. However, electricity, an important propeller of the modern global economy, has been grossly deficient in Nigeria [3]. According to Okafor [4] and Sambo [5], electricity generated in Nigeria is about 4602.4MW while the demand is well above 7102MW. The impact of the inadequately generated electricity is felt in industries and homes as many of these receive less than 12 hours of energy supply per day [6]. For this reason, there is an urgent need to increase energy generation in Nigeria.

Currently, fossil fuels such as oil and natural gas are the major sources of energy generation in Nigeria and many other countries [7]. However, fossil fuels are considered non-renewable energy sources because they are limited and non-replenishable. Also, the use of fossil fuels for energy generation negatively affects humans and the environment [8]. For example, researchers have attributed them to the increasing air pollution, global warming, climate change, and consequently flooding [9].

There are also indications that the reserves of fossil fuels may decrease which in turn could lead to an increase in their price [10]. On the contrary, many renewable energy sources (RES) are constantly available and do not have significant negative effects on the environment [7].

Currently, the use of RES for energy generation and its systematic replacement of fossil-fuelled energy generation is perceived as part of the concept of sustainable development. The focus of the global energy market is now tilted to renewable energy sources (RES) such as wind, biomass, and solar for electricity generation with more concentration on solar energy [11]. This is because it does not alter the ecological balance of the environment and it is abundantly available in many parts of the world. Solar electricity generation is one of the leading RES in the world due to low operating costs [12].

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However, its applications in Nigeria for large-scale electricity generation appear to be in the early stage compared to countries like China, Germany, India, and Turkey [13]. Even though the country has solar energy in abundance across many of its regions, the development of solar power plants at both medium and large scales remains limited. This could partly be linked to the lack of a framework for determining suitable and attractive sites in built environments and industrial areas.

To develop an efficient and sustainable solar power plant, it is important to consider a suitable location that satisfies all necessary conditions. By suitable site, we refer to a site that satisfies adequate solar penetration and other selected criteria that may be highlighted by the developer. This will aid in selecting an appropriate site for investments in solar power plants. To the best of our knowledge, a document and/or procedure for the determination of suitable sites for solar power plants in Nigeria appears scanty. That is, little efforts have been made in the area of providing a map that indicates an ideal location for solar power plants in both industrialized and residential geographical areas.

One of the potential tools for determining an ideal site location is multicriteria decision-making methods (MCDM). Multicriteria decision-making (MCDM) is a problem-solving tool that is applicable to issues characterized as multiple actors, objectives, and criteria [14]. It aids the decision-making process by assessing the degree to which selected subjects are set to fulfil a set of evaluation criteria. The basic five components of the multi-criteria decision method are; goal, decision maker's preferences, alternatives, criteria, and outcomes respectively [15]. Another tool that has been applied in solving site suitability problems is the geographical information systems (GIS). GIS is a digital database management that is used for spatial analysis. It can store, process, manage and analyse spatially distributed large volumes of collected data. It also provides opportunities for relating previously unrelated information through the use of locations. Given the capability of both GIS and MCDM, researchers have now found their integration to be helpful in the assessment of geographical locations and the visualization of the evaluated geographical area [16].

Recently, studies have shown numerous applications of both MCDM and GIS in the selection of suitable sites. For instance, Hadipour *et al.* [17] and Beskese *et al.* [18] applied fuzzy with AHP and fuzzy with TOPSIS for landfill site selection and aquaculture development in the coastal region of Iran respectively. Also, GIS and MCDM have been applied in transportation, urban planning, siting of health care, and flood risk management in flood-affected environments [19-24]. Another growing application of GIS and MCDM is in the identification of ideal sites for renewable energy generation plants. For example, Janke [25] used a combination of GIS and a multi-criteria technique to select suitable sites for wind and solar farms in Colorado. Also, Uyan [26] and Sánchez-Lozano *et al.* [27] used a combination of GIS and MCDM to evaluate locations for solar farms in a region in Turkey and Southeastern Spain respectively. Yunna and Geng [28] applied a decision-based method in selecting a suitable site for siting hybrid, solar wind power stations. Sharma and Singh [29] selected suitable areas for a solar power plant using a combination of GIS and multi-criteria decision analysis (MCDA). Ayodele *et al.* [30] applied GIS and fuzzy AHP to select suitable areas for wind farm locations in Nigeria. Meanwhile, models that show suitable locations for solar power plant developments in many geographical areas in Nigeria's industrial and residential areas are required to accelerate its development. Therefore, this study focuses on evaluating the suitability of Ewekoro L.G.A. for a solar power plant using a GIS-AHP model. To achieve this, we considered a total of four criteria and nineteen sub-criteria.

2.0 MATERIALS AND METHODS

2.1 Study Area

The study area is Ewekoro local government area, in Ogun State, South-Western region of Nigeria situated between 6.56˚ latitude and 3.13˚ longitude (see Figure 1) with yearly solar radiation between 1520KWh/m² and 2222 KWh/m² (see Figure 2). Ewekoro's land area is about 594 km² with a total population of more than 55,156 people [31]. Also, it is an industrial area and a potential location for many investors because of its proximity to two major cities. Given these and its abundant solar resources and electric power demand of about 12.5MW, Ewekoro is a potential for solar power plant investments. In addition, the main transmission line (132kV) that runs through Ewekoro provides an opportunity for ease of solar power plant integration into the existing energy network in the region.

2.2 Data Sources

The spatial and non-spatial GIS data were obtained from various sources. For example, the latitude and longitude of the study area were obtained using Global Positioning System (GPS), roads digitization using a scale of 1:25,000 for imagery gotten from the ministry of physical and urban development, slope obtained from the Digital Elevation Model of the study area, LANDSAT 8 data gotten through supervised learning and secondary data, transmission lines dataset gotten from World Bank data, Digital Elevation Model using a 30 m by 30 m SRTM (Shuttle Radar Topography Mission) and 2019 LANDSAT imagery from United States Geological Survey (USGS). All the data conversion and digitization were performed using ArcGIS 10.4 software.

2.3 *Site Suitability Model*

The stages used to achieve the aim of this study are presented in Figure 3. Four main criteria and nineteen sub-criteria were selected for the suitability model (see Table 1) with the criteria being categorized into environmental and economic factors.

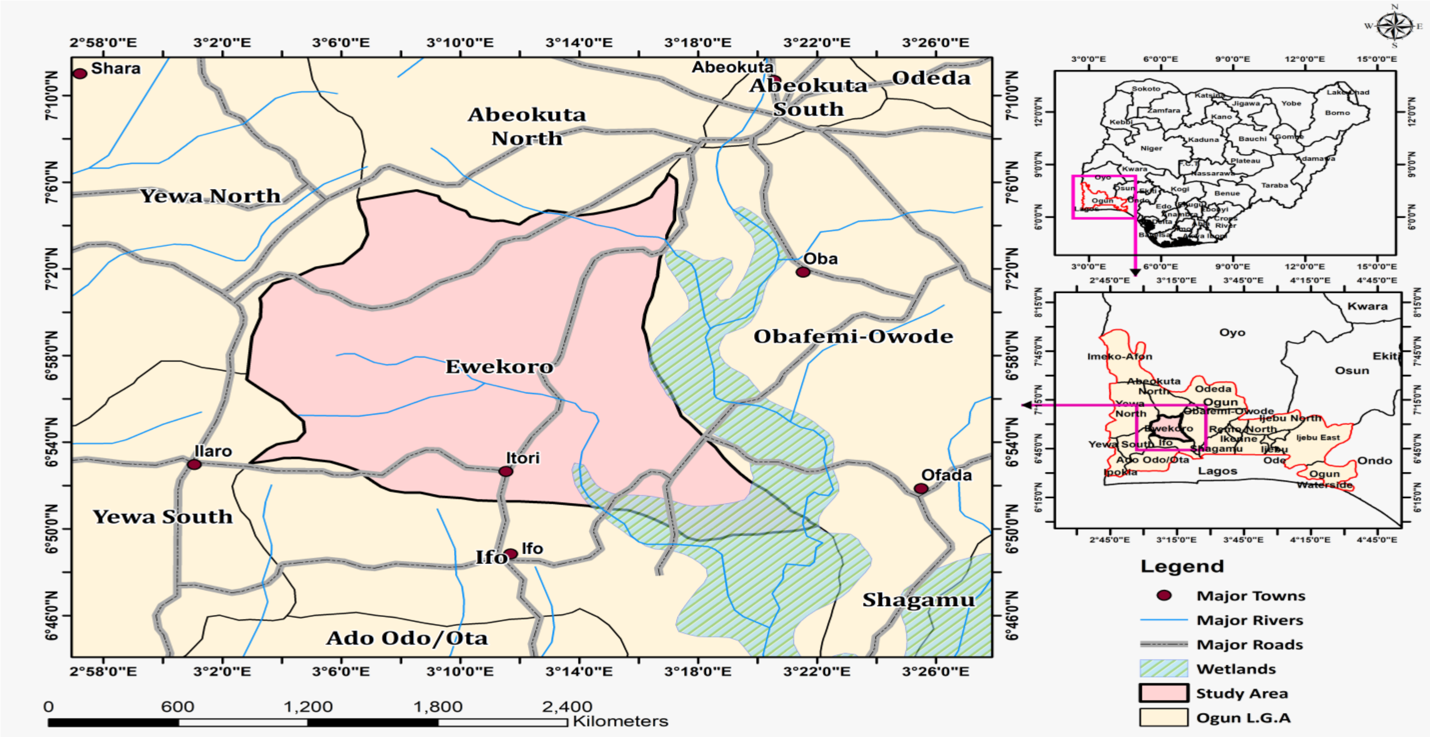


Figure 1: Map Showing the Study Area **(**Source: [32])

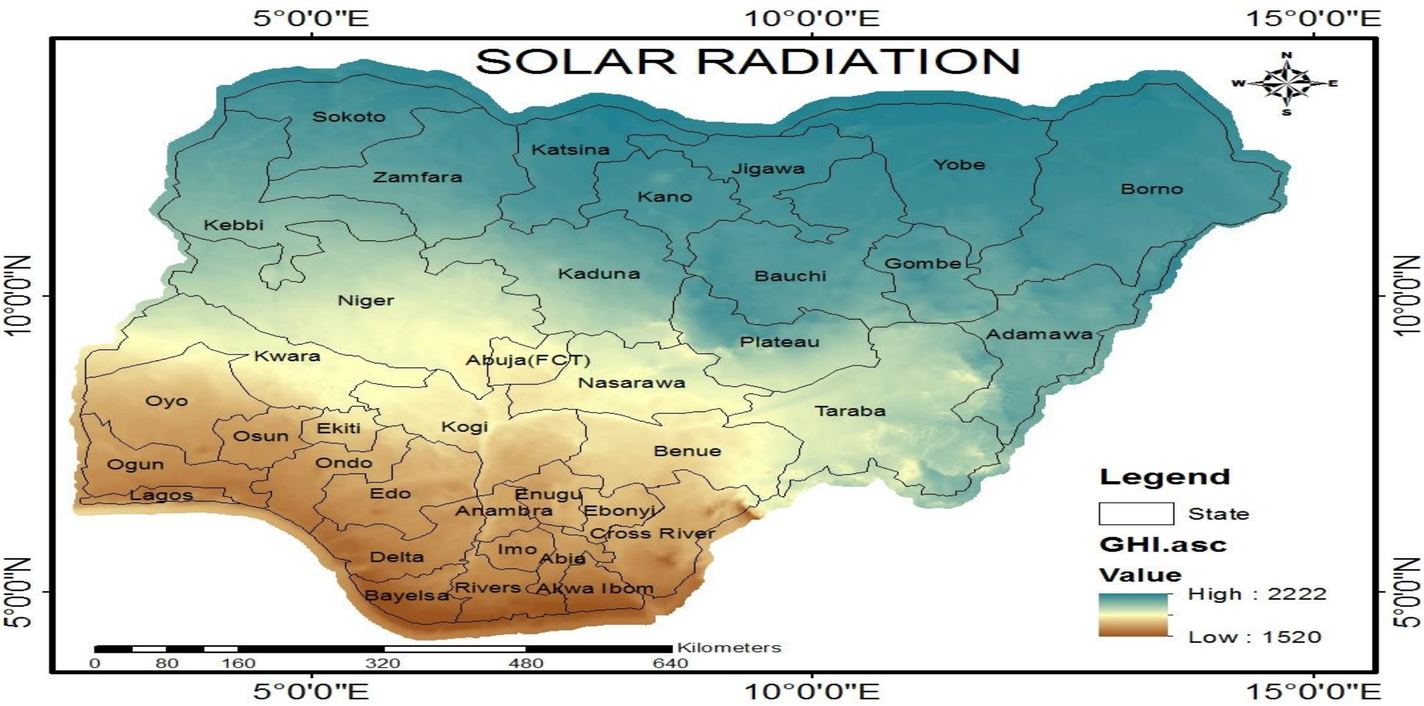


Figure 2: Annual solar radiation of Nigeria with Ewekoro Local Government Area **(**Source: [32])

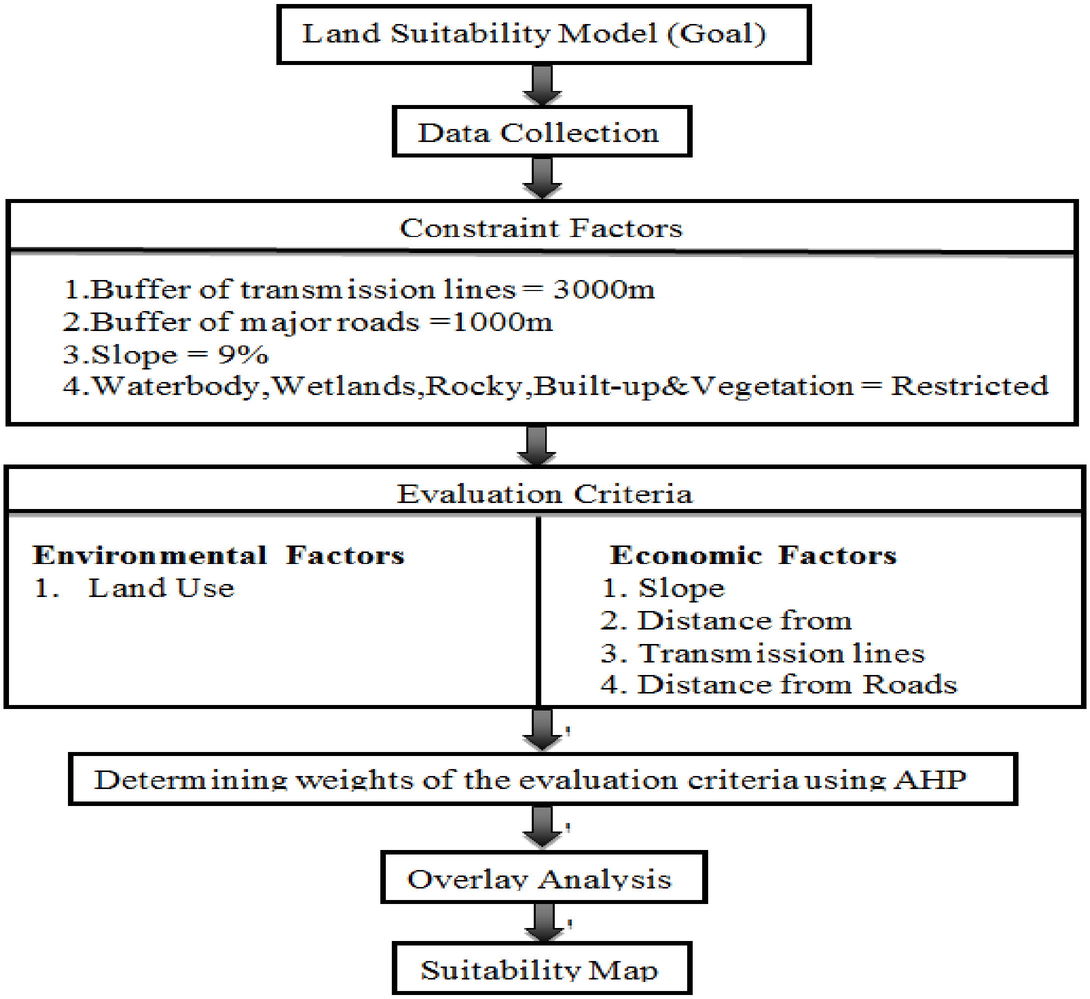


Figure 3: Step by Step Approach for the Suitability Analysis

Table 1: Criteria and Sub-criteria for Site Suitability Model

Objectives	Criteria	Sub-criteria
Environmental factors (k)	Land use (k_1)	Built-up Areas (k_{11})
		Waterbody (k_{12})
		Wetlands (k_{13})
		Rocky Areas (k_{14})
		Vegetation (k_{15})
Economic Factors (l)	Slope (l_1)	<9 (l_{11})
		9 – 19 (l_{12})
		19 – 31 (l_{13})
		31 – 45 (l_{14})
		>45 (l_{15})
	Distance from transmission lines (l_2)	<3000 (l_{21})
		3000 – 6000 (l_{22})
		6000 – 10000 (l_{23})
		>10000 (l_{24})
	Distance from major roads (l_3)	<1000 (l_{31})
		1000 – 3000 (l_{32})
		3000 – 5000 (l_{33})
		5000 – 10000 (l_{34})
		>10000 (l_{35})

2.4 *Description of Site Evaluation Criteria*

To achieve the evaluation of sites, certain constraints were masked for the environmentally unsuitable areas for solar power plants. These constraints are;

- Buffer of transmission lines = 3000 m
- Buffer of major roads = 1000 m
- Slope = 9%
- Waterbody, wetlands, and built-up areas = Restricted

Also, water bodies, wetlands, rocky areas, built-up areas and vegetation (land requirement) were restricted in the weighted overlay tool for this analysis because they were considered unsuitable for the development of a solar power plant.

In the next stage, the four criteria used for scoring the potential sites were defined. The four criteria were selected based on a literature survey, experts' consultation, and observations of solar power plant developments. Solar radiation was not considered as a criterion since the values are the same for the area of study. The four criteria were further explained under environmental and economic classifications while the respective sub-criteria and the scores assigned for the buffered zones were specified. The criteria for the study were;

- Land Use
- Slope
- Distance from Transmission Lines
- Distance from Major Roads

i. Environmental (k)

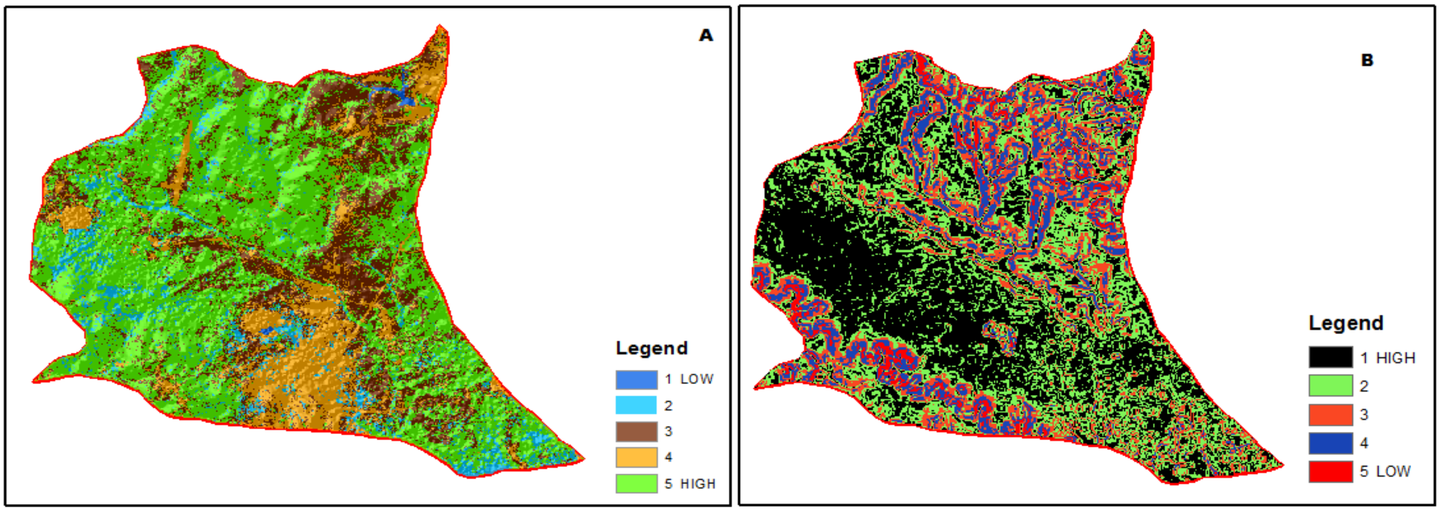
Land Use (*k_1*): land use is a major consideration in site selection for solar power plant studies. The land use was evaluated for five sub-criteria; built-up areas, waterbody, wetlands, rocky areas, and vegetation. The area was scored from 1-5 respectively as described in Figure 4A where a score of 5 represents the most suitable option.

ii. Economic (*l*):

Slope (*l_1*): the slope is a major economic consideration that is very effective in the selection of a site for solar power plants because it influences the design and mounting of solar arrays. The slope was divided into five parts; <9, 9-19, 19-31, 31-45, and >45%, and they were scored as 1, 2, 3, 4, and 5 respectively as shown in Figure 4B. A low slope is important for cost consideration. Thus, the most preferred score for this sub-criteria is 1 while the least preferred is 5.

Distance from Transmission Lines (*l_2*): given the high cost involved in constructing power transmission lines, the distance from it becomes an important factor to consider in siting a solar power plant. Thus, the sub-criteria under distance from transmission lines are given in metres as; <3000, 3000-6000, 6000-10000, >10000 distance of sites from the main transmission line. The sub-criteria are scored 1, 2, 3, and 4 respectively with the most preferred score being 1 (Figure 4C). That is, proximity to the transmission line is prioritized to reduce the cost of installation.

Distance from Major Roads (*l_3*): proximity to the major roads is another important economic factor considered for the cost of construction. The considered sub-criteria under the distance from the road in meters are; <1000, 1000-3000, 3000-5000, 5000-10000, >10000 and were scored 1, 2, 3, 4, and 5 respectively (Figure 4D). The most preferred score is 1 and the least preferred is 5.



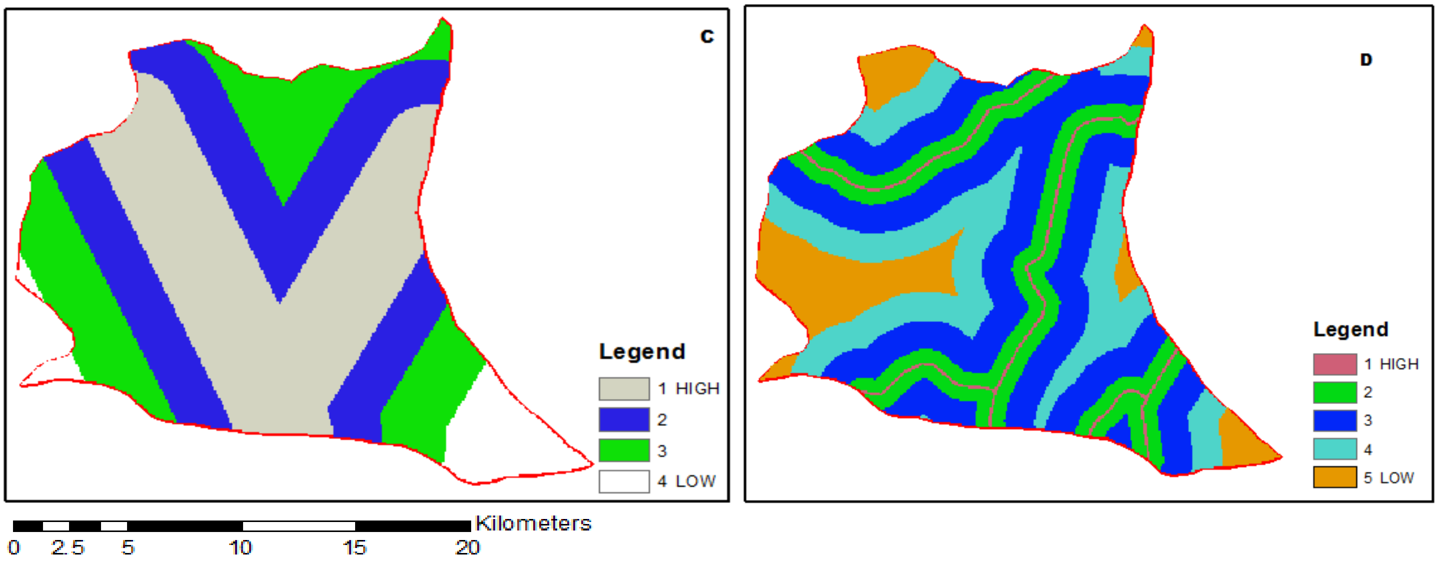


Figure 4: Suitability index: (A) Land Use, (B) Slope, (C) Distance from transmission lines, (D) Distance from major roads

This is to avoid the additional cost of opening a new road to the solar power plant site.

2.5 Estimating Weights of the Evaluation Criteria

To determine the importance of the identified criteria and sub-criteria in Table 1, the analytic hierarchy process (AHP) was applied to determine each weight. AHP is a powerful mathematical tool that is applied in addressing decision-making problems. It applies prioritization techniques using pairwise comparison in evaluating weights of a predefined set of criteria. This method was proposed by Saaty (1980) as a solution to multi-criteria decision problems and since that period, it has been frequently used by experts in various decision-making processes [33].

Thus, the AHP technique and GIS were combined to evaluate the site under consideration. After the weight for the site suitability criteria and sub-criteria were estimated, they were integrated into the weighted overlay tool in ArcGIS 10.4 for assessment.

Stages I-Iv Describes the Weighting Procedure:

i. Construct a pairwise matrix for $criteria$ as described in equation 1.

$$A = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ a_{n1} & a_{n2} & \dots & a_{nn} \end{bmatrix} \quad (1)$$

In equation 1, a_{ij} represents the comparison of the importance of the ith criteria relative to the jth criteria. This is true for all values of i and j, where $a_{ii} = 1$ and $a_{ij} = 1/a_{ji}$. The values of the relative importance of the criteria for comparison are presented in Table 2.

ii. Divide all entry in column j of the matrix A by the sum of the entries in column j to produce a new matrix A_w. The sum of each column in the new matrix A_w should be 1.

Table 2: AHP Evaluation Scale

Values of a_{ij}	Interpretation
1	Criterion i and j are of equal importance
3	Criterion i has slightly higher importance than j
5	Criterion i has strong importance than j
7	Criterion i has very strong importance than j
9	Criterion i has extreme importance than j

Source: [34]

$$A_w = \begin{bmatrix} {a_{11}}/{\sum a_{i1}} & {a_{12}}/{\sum a_{i2}} & \cdots & {a_{in}}/{\sum a_{in}} \\ \cdots & \cdots & \cdots & \cdots \\ {a_{n1}}/{\sum a_{i1}} & {a_{n2}}/{\sum a_{i2}} & \cdots & {a_{nn}}/{\sum a_{in}} \end{bmatrix} \quad (2)$$

iii. Compute C the column vectors of the criteria weight by finding the average of entries in row i of the matrix A_w. The values of c_i represent the relative degree of importance of the ith criteria. The values are the percentage of the weight that sums up to 1.

$$\mathrm{C} = \begin{bmatrix} c_1 \\ \vdots \\ c_n \end{bmatrix} = \begin{bmatrix} \frac{{a_{11}}/{\sum a_{i1}}}{n} & \frac{{a_{12}}/{\sum a_{i2}}}{n} & \cdots & \frac{{a_{in}}/{\sum a_{in}}}{n} \\ \cdots & \cdots & \cdots & \cdots \\ \frac{{a_{n1}}/{\sum a_{i1}}}{n} & \frac{{a_{n2}}/{\sum a_{i2}}}{n} & \cdots & \frac{{a_{nn}}/{\sum a_{in}}}{n} \end{bmatrix} \quad (3)$$

iv. Consistency check of the determined weight is important. The process for consistency check suggested by AHP is described in expressions 4-6. The first stage of the consistency check is to calculate the consistency vector as described in 4.

$$\mathrm{A\,X\,C} = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix} X \begin{bmatrix} c_1 \\ \vdots \\ c_n \end{bmatrix} = \begin{bmatrix} x_1 \\ \vdots \\ x_n \end{bmatrix} \quad (4)$$

Thereafter, λ_{max} is calculated using equation 5;

$$\lambda_{max} = \frac{1}{n}\sum_{i=1}^{n}\frac{x_i}{c_i} \quad (5)$$

Then, the consistency ratio (CR) is calculated using equation 6;

$$\mathrm{CR} = \frac{CI}{RI} \quad (6)$$

Where, the consistency index (CI) is as expressed in equation 7 and random consistency index (RI) for different numbers of n is presented in Table 3. The decision is, if $\mathrm{CR} \le 0.10$, the degree of consistency is satisfactory and, if $\mathrm{CR} > 0.10$, then serious inconsistencies are present and the AHP may not give a meaningful result.

$$\mathrm{CI} = \frac{\lambda max - n}{n-1} \quad (7)$$

2.6 *Weighted Overlay Analysis*

The weighted criteria and sub-criteria were then integrated with the overlay analysis tool in ArcGIS to estimate the percentages of suitable areas for solar power plant in Ewekoro LGA. The suitability of area for solar power plant in Ewekoro was then analysed as not suitable, suitable sites and best suitable sites. The spatial superposition was computed using equation 8 [36]

$$S = \sum_i WA_i \text{ x } \sum_j WB_j\, S_j \quad (8)$$

Where; S represents final score of a criterion,
WA_i is the weight of factor i,
WB_j is the weight of criterion j
S_j is the assigned score for criterion j

3.0 RESULTS AND DISCUSSION

Four main criteria relating to environmental and economic factors were considered in this study for site suitability model. The two factors (i.e. environmental and economic) used for the criteria classificiation were weighted 60% and 40% respectively [37]. The implication of these weights is that environmental factors are more important and must be given more consideration in the development of solar power plant. Table 4 presents the criteria weights for slope, distance from transmission lines and distance from roads and their respective sub-criteria.

Also, the weight for the criteria under economic factors are 10.6%, 63.3% and 26.1% for slope, distance from transmission lines and distance from roads respectively. This implies that priority should be given to location that are closer to transmission lines for easy integration into the main power transmission line in that area. By so doing, required costs to transmit electricity generated form the solar power plant can be reduced The sub-criteria weights under land use were determined using the procedure in section 2.5 and the results are as presented in Tables 5-7. Tables 5 and 6 present the pairwise comparison matrix and the normalized pairwise matrix for land use respectively. The weight determined for the sub-criteria under the land use are; 3.5%, 6.8%, 10.6%, 16.0% and 63.1% for built-up areas, water body, wetlands, rocky areas and vegetation respectively. The implication is that locations with vegetation are found more suitable and have less environmental effect on the development of a solar power plant.

Also, after the weight of the sub-criteria were determined, the consistency of the variables were checked to ascertain the quality of the response. Table 7 shows the weighted sum of the sub-criteria under land use and the values of $\lambda_{\max}$, CI and CR were calculated as 5.297, 0.074 and 0.07 respectively. Thus, the degree of consistency of the pairwise comparison for the sub-criteria under land use was satisfactory based on Saaty [38] rule that says CR is satisfactory when is less than 0.10 ($0.07 \leq 0.10$). For that reason, we proceeded to use the weight gotten from this comparison for the land use sub-criteria.

Table 3: Random Consistency Index

N	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

Source: [35]

Table 4: Criteria Weight of Economic Factors

Criteria	**Weight**	**CR**	**Sub-Criteria**	**Weight**	**CR**
Slope	0.106	0.033	<9 (l_{21})	0.386	0.059
			9 – 19 (l_{22})	0.353	
			19 – 31 (l_{23})	0.182	
			31 – 45 (l_{24})	0.045	
			>45 (l_{25})	0.034	
Distance from Transmission Lines	0.633		<3000 (l_{21})	0.445	0.046
			3000 – 6000 (l_{22})	0.407	
			6000 – 10000 (l_{23})	0.097	
			>10000 (l_{24})	0.051	
Distance from Roads	0.261		<1000 (l_{31})	0.352	0.066
			1000 – 3000 (l_{32})	0.352	
			3000 – 5000 (l_{33})	0.171	
			5000 – 10000 (l_{34})	0.090	
			>10000 (l_{35})	0.035	

Adapted from [35]

Table 5: Pairwise Comparison Matrix for Sub-Criteria of Land Use

Sub-Criteria	**Built-up Areas**	**Water Body**	**Wetlands**	**Rocky Areas**	**Vegetation**
Built-up Areas	1	0.333	0.2	0.2	0.111
Water Body	3	1	0.5	0.333	0.111
Wetlands	5	2	1	0.333	0.111
Rocky Areas	5	3	3	1	0.111
Vegetation	9	9	9	9	1
Sum	23.00	15.33	13.70	10.86	1.44

Table 6: Normalized Pairwise Comparison for Sub-Criteria of Land Use

Sub-Criteria	**(K_{11})**	**(K_{12})**	**(K_{13})**	**(K_{14})**	**(K_{15})**	**Sub-Criteria Weights**
Built-up Areas (K_{11})	0.043	0.022	0.015	0.018	0.077	0.035
Water Body (K_{12})	0.130	0.065	0.036	0.031	0.077	0.068
Wetlands (K_{13})	0.217	0.130	0.073	0.031	0.077	0.106
Rocky Areas (K_{14})	0.217	0.196	0.219	0.092	0.077	0.160
Vegetation (K_{15})	0.391	0.587	0.657	0.828	0.692	0.631

Table 7: Table of Weighted Sum for Sub-Criteria of Land Use

Sub-Criteria	(K_{11})	(K_{12})	(K_{13})	(K_{14})	(K_{15})	Weighted Sum
Built-up Areas (K_{11})	0.023	0.021	0.032	0.035	0.070	0.181
Water Body (K_{12})	0.068	0.053	0.053	0.105	0.070	0.349
Wetlands (K_{13})	0.034	0.106	0.053	0.175	0.070	0.438
Rocky Areas (K_{14})	0.204	0.317	0.160	0.175	0.070	0.926
Vegetation (K_{15})	0.612	0.951	1.442	0.315	0.631	3.951

Table 8: Weights of Criteria for Study

Objectives	Weight	Criteria	Weight	Sub-Criteria	Weight	$\sum Weight$
Environmental factors (k)	0.60	(k_1)	1.00	(k_{11})	0.035	0.021
				(k_{12})	0.068	0.041
				(k_{13})	0.106	0.064
				(k_{14})	0.160	0.096
				(k_{15})	0.631	0.379
Economic Factors (l)	0.40	(l_1)	0.106	(l_{11})	0.386	0.016
				(l_{12})	0.353	0.015
				(l_{13})	0.182	0.008
				(l_{14})	0.045	0.002
				(l_{15})	0.034	0.001
		(l_2)	0.633	(l_{21})	0.445	0.113
				(l_{22})	0.407	0.103
				(l_{23})	0.097	0.025
				(l_{24})	0.051	0.013
		(l_3)	0.261	(l_{31})	0.352	0.037
				(l_{32})	0.352	0.037
				(l_{33})	0.171	0.018
				(l_{34})	0.090	0.009
				(l_{35})	0.035	0.004

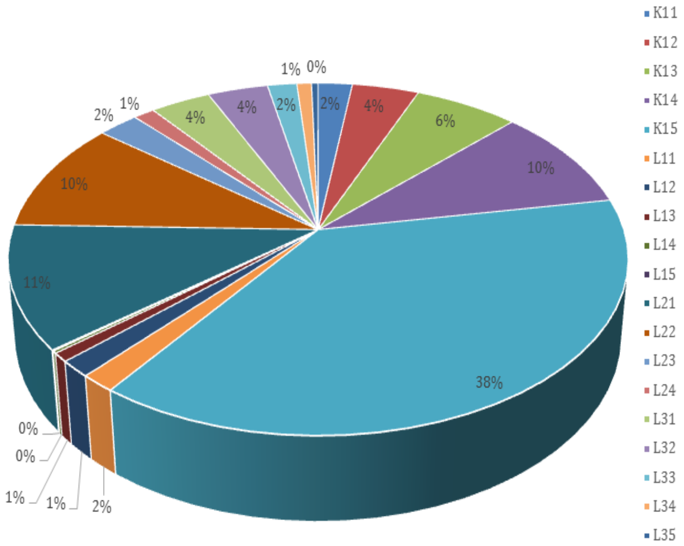


Figure 5: Percentage Distribution of Sub-Criteria within the Suitability Model

$$A \times C = [0.181\ 0.349\ 0.438\ 0.926\ 3.951\ ]$$

$$\lambda\text{max} = \frac{1}{5}\left[\frac{0.181}{0.035}+\frac{0.349}{0.068}+\frac{0.438}{0.106}+\frac{0.926}{0.160}+\frac{3.951}{0.631}\right] = 5.297$$

$$CI = \frac{5.297-5}{4} = 0.074$$

$$CR = \frac{CI}{RI} = \frac{0.074}{1.12} = 0.066 \cong 0.07$$

After the weights of the two factors, criteria and sub-criteria were determined, the distribution of each criterion and sub-criterion in the study were calculated as presented in Table 8. Also, the percentage distribution of the sub-criteria within the suitability model is shown in Figure 5 where K_{15} (vegetation) has the highest distribution with 37.9% and l_{14} (slope 31–45) and l_{15} (slope >45) the lowest. This implies that, sub-criteria “vegetation” has more importance and as such area with vegetation cover represents suitable areas and, is considered over others for solar power plant location. In contrary, the sub-criteria “slope 31–45” and “slope >45” appears to be totally insignificant based on their percentage. The percentage score of these two sub-criteria indicated that areas with such traits are not suitable for solar power plant.

Finally, the model builder function in ArcGIS 10.4 was used to develop a site suitability model that identifies and selects suitable sites for a solar power plant. The input criteria maps (see Figure 4A-4D) were inputted using the weighted overlay process that utilize both raster and vector databases. The output results from the analysis is presented as a suitability map in Figure 6. The suitability map of Ewekoro for solar power plant was generated using a combination of AHP and GIS. The suitability map was categorized as; not suitable, suitable, and best suitable areas. The maps used an equal interval classification method and as a result, 68% (403.92 km²) of the total area was marked not suitable for solar power plant, 17% (100.98 km²) of the total area was suitable and 15% (89.1 km²) of the total area of Ewekoro L.G.A. (594 km²) was estimated as best suitable areas for solar power plants. The distribution of the suitability map of Ewekoro LGA was further analysed in Figure 7.

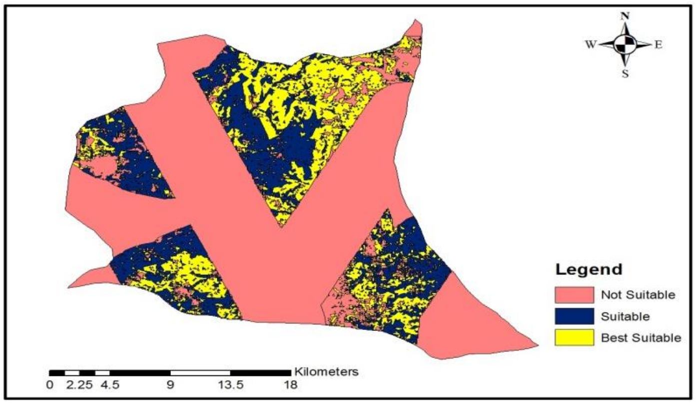


Figure 6: Ewekoro Suitability Map for Solar Power Plant

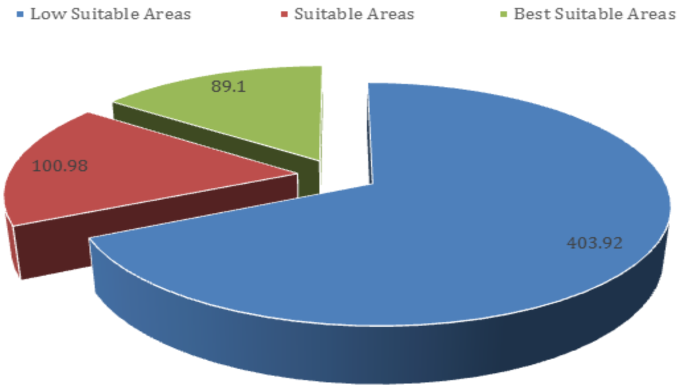


Figure 7: Suitability Distribution of Ewekoro LGA for Solar Power Plant

4.0 CONCLUSION

The objective of this study was to assess the suitability of Ewekoro LGA for solar power plant and AHP and GIS methods were applied to achieve this objective. Four main criteria belonging two factors and nineteen sub-criteria were selected. The slection were based on literature review and experts opinions. Analytical Hierearchy Process (AHP) was used to determine the weight of the sub-criteria and the consistency was checked before the weights were used for analysis. The suitability map of Ewekoro was generated and analysed using ArcGIS 10.4 Thus, the conclusion are; sites with vegetation is the most preferred for consideration under the land use criteria, followed by rocky areas. Also, the distribution of the sub-criteria within the suitability showed that sub-criteria under land use is the most important, followed by the distance from the main transmission line which should be the minimum as possible.

In terms of the suitability of Ewekoro for solar power plant, the total land area was divided into not suitable areas, suitable areas and best suitable areas. 68% of the total area considered not suitable for solar power plant, 17% is suitable and 15% of the area have the best suitablility. Given the evaluation, these classification were mapped and presented. It is recommended that this study should be replicated in many geographical areas across the country and government should make the results available for energy stakeholders in order to fast track investment decision and growth in solar power plant.

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