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CONTENTS

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GIS-BASED SUITABLE SITE SELECTION FOR INTERNALLY DISPLACED PERSONS' CAMPS IN ABUJA, NIGERIA

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Abstract
Natural and human disasters ranging from insurgency to flooding have increased the incidences of Internally Displaced Persons (IDPs) in Nigeria. This paper thus studies GIS-based suitable site selection for internally displaced person camps in Abuja, Nigeria. The methodological approaches applied in this study are based on supervised image classification and multi-criteria evaluation methods for IDP site selection. The criteria for site selection used are slope, elevation, land cover, proximity to waterbody, town, schools, hospitals, tourism and the main roads. The final weighted model was grouped as an unsuitable, less suitable, and most suitable site. The results of the analysis show that 2.73% of the study area was most appropriate for the IDP campsite, 59.23% suitable, 36.13% less suitable, and 1.91% of the total area was unsuitable. Based on the combined suitability scores, the north-central districts of Abuja Municipal Area Council (AMAC) comprising Mpape, Kado, Jabi, Jahi, Kubwa, and tiny portions of Wuse are most suitable for IDP settlement locations. From the analysis, the study concludes that more than 61% of land in AMAC has the potential for internally displaced camps. This study recommends a list of criteria that government and policymakers on IDP should consider when choosing an appropriate and suitable site for internally displaced persons.

Keywords: Internally Displaced Persons (IDPs), Multicriteria analysis, AHP, Suitable sites, Abuja

Introduction

Population displacement, driven by armed conflict and natural or man-made disasters that may be linked to climate change impacts, is common around the world. This situation is particularly widespread in Africa and the Middle East, where armed conflict drives large-scale population displacement in many countries (Celik, 2017; Ejiofor et al., 2017; Erong, 2017). The emergence of this large population of displaced persons has resulted in an increasing need to establish refugee or internally displaced persons' (IDP) camps in many parts of Africa to provide shelter for the displaced population. When circumstances require a planned transitional settlement, selecting the settlement site could pose a critical challenge, even though it is a crucial endeavour. This is because a poorly selected site can threaten the safety of the displaced persons and the host population, marginalise vulnerable populations, and place an unsustainable strain on socioeconomic and environmental resources (Corsellis and Vitale, 2005). In contrast, a well-cited IDP camp can facilitate social integration, enhance sustainability, and positively contribute to the social and economic development of the host community (UN HABITAT, 2010).

Although humanitarian agencies consider IDPs and refugee camps as the last option when housing displaced persons, these are often the preferred options by governments, this is because governments believe that camps have some significant advantages for the protection of displaced persons and may facilitate humanitarian intervention (Olanrewaju et al., 2019). In addition, the location of camps has serious and long-term implications for the well-being of the displaced population living there (Ikpe, 2017; Olanrewaju et al., 2019). It is therefore important that essential criteria are carefully considered before the siting of internally displaced persons' (IDP) camps is accepted.

Studies on site selection for displaced persons' camps can be divided into two scenarios. The first is to utilise existing community infrastructure, designed such that the selection of sites would assume that IDPs would rely on existing community infrastructure (Davies, 2012). This approach would allow displaced persons to integrate with local communities and minimise the pressure on the government or the UNHCR to develop new camp infrastructure during crisis situations. An alternative approach is to establish a new community infrastructure, designed under the assumption that government or the UNHCR will provide infrastructure for new camps (Ekpa and Dahlan, 2016). Although both models aspire to a level of community integration, this model would be done in the hope that the presence of the UNHCR would benefit communities that have previously suffered from inadequate access to resources (Okobia and Hassan, 2011).

The use of GIS for site selection provides a thorough situational awareness by using meaningful combination and analysis of relevant spatial information. There is a growing use of GIS for emergency humanitarian and disaster response (Ortiz, 2020). In particular, the application of GIS for site optimisation is of interest to the aid community '(Zhang et al., 2011). Despite the increasing use of GIS in humanitarian coordination, it has been mostly used for data visualisation with limited analytical capacity (Verjee, 2007; Thompson, 2011). However, finding a suitable site for an IDP camp requires a multi-criteria approach with accurate, decision-ready operational and strategic maps (Gutjahr and Nolz, 2016). This is because the effectiveness and efficiency of a decision are apparently dependent on the quality of the data used to produce the considered criteria maps, as well as on the method used for decision-making and analysis. Geographic Information System-based Multi-Criteria Decision Analysis (GIS-based MCDA) provides a collection of relevant tools, techniques and procedures for converting spatial and non-spatial data into information that are useful as input into the decision-making process (Feizizadeh et al., 2014).

Although the GIS approach has been widely used for selecting suitable sites for humanitarian operations, there has been an apparent lack of consideration for the social and cultural peculiarity of the refugees. For instance, Mong et al. (2014) combined environmental and social factors in a GIS environment to determine the best locations for refugee resettlement by applying two scenarios to analyse site suitability. Similarly, Cetinkaya et al. (2016) developed a three-step approach using geographic, social, infrastructural, and risk-related criteria in selecting suitable sites for a Syrian refugee camp in Turkey. The host government, landowners, host population, and refugees or internally displaced persons (IDP) must be included in the site selection process. This is because the displaced persons may not be willing to relocate to an area with a population of a different religion or ethnic composition (Mong et al., 2014). This study, therefore, seeks to i) analyse the factors for selecting suitable sites for Internally Displace Persons' camps in the Federal Capital Territory (FCT), Abuja and ii) determine suitable sites for internally displaced persons' camps in the FCT using a GIS-based multi-criteria decision approach (MCDA). The application of the MCDA ensures that the best site is selected while reducing the influence of political actors, which in many instances undermine the selection of optimum locations for social and economic infrastructure. In addition, a suitably selected campsite will enhance the social and economic integration of displaced persons with the local communities and facilitate access to humanitarian interventions by government and non-governmental organisations while enhancing the security and well-being of the IDPs.

Study Area

Abuja, located in the Federal Capital Territory (FCT) (Latitude 8° 25' and 9° 25' N and longitudes 6° 45' and 7° 45' E), is the administrative capital of Nigeria. The 2006 National Census indicates that Federal Capital Territory, Abuja has a total population of 778,567 people estimated to be over three million inhabitants by 2016 (Makama, 2015; Isaac, 2019). Abuja Municipal Area Council (AMAC) is the largest and most developed of the six Area Councils in the Territory, while Kuje Area Council falls within the semi-urban settlement location of the Federal Capital Territory. The FCT has boundaries with Kaduna, Nasarawa, Kogi and Niger States (Figure 1).

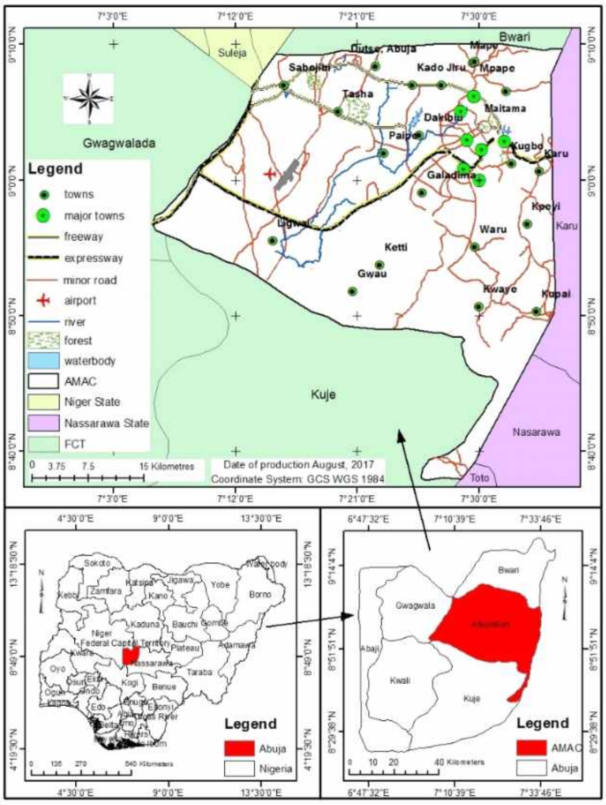

Figure 1: The study area

The area is characterised by guinea savannah vegetation with sparse trees. Rainfall in the study area is not less than six months, with a total annual rainfall usually less than 1600 mm. The area is generally undulating, with peaks of 760 m above sea level in many places (Ujoh et al., 2011; Balogun, 2001).

Materials and Methods

Sources and characteristics of data

CNES/Astrium provided a high spatial resolution image (2 m) of the study area. This data was used to identify social infrastructure within and around existing IDP camps. The location and attribute information of settlements and existing infrastructure such as hospitals, schools, tourist centres and IDP camps were captured using a hand-held Global Positioning System receiver. We extracted topographic information from the 2016 SRTM satellite image and a topographic map of the study area. Sentinel 2 images of the study area were also obtained from the archives of the European Space Agency website.

Data processing

Image analysis

The study area was classified into four dominant land use classes: urban, forestland, farmland and grassland, using the supervised image classification technique in ENVI 5.2 software. The urban category consisted of settlements, open spaces and bare ground. Forestland is made up of primary forest and secondary vegetation. Farmland includes all cultivated areas and areas that are left fallow. Grassland consists of all areas under grass and shrubs.

Site selection criteria

Studies have shown that the location of facilities requires the consideration and integration of many factors (Abudeif et al., 2015; Adewale, 2016; Al-Adamat et al., 2010; Quinn et al., 2018). Therefore, based on information obtained from stakeholders, government ministries and agencies involved in managing IDPs and other humanitarian crises in Nigeria, we identified nine key factors necessary for suitable site selection for internally displaced persons' camps in Abuja. Chapin et al. (1979) broadly categorised these factors as social, infrastructure and environmental factors. The factors are existing IDP camps, roads, towns, hospitals, schools, drainage, LULC, tourist sites and topography. These factors must be carefully considered when siting in an internally displaced persons' camp.

Every criterion under review was ranked as per the decision maker's preference. Each factor was weighted according to the estimated significance for determining IDP sites to generate criterion values for each evaluation unit. Standardization of each dataset to a scale of 1 – 4 (1 = unsuitable, 2 = less suitable, 3 = suitable, 4 = most suitable) was done based on reviews.

The pairwise comparison matrix was employed to calculate each factor's weight and ranking. The weight value provided the prioritised factor expressed as a percentage value between 0 and 100%. The ranking of each reclassified factor relied solely on the literature review and personal judgment. The range of ranking was 1 to 4; the highest influence factor ranked 4, and the lowest influence factor was 1. After collection and conversion of the data, the AHP decision method was prepared with the determination of the criteria priorities/weights utilised in GIS analysis. A questionnaire was administered to critical stakeholders to elucidate relevant information for creating the pairwise comparison matrix. The normalisation process for the reciprocal matrix was obtained by dividing each of the records in the pairwise comparison table by its corresponding column total. The result was normalised relative weighting. One of the crucial points in this analysis context is assigning weights to the criteria involved, and the most powerful tool to solve this problem is the AHP method (Akıncı et al., 2013). The first step is to determine the priorities of criteria or relative weights, i.e. the reciprocal matrix, to discern the importance of the criteria (Hossain et al., 2007). The second step is determining the weights by normalising the pairwise comparison matrix (Erden and Kun, 2010). Finally, a consistency ratio (CR) is calculated for the pairwise comparison matrix to certify the degree of integrity of the relative weights. The final step of the AHP involved the calculation of the Consistency Ratio (CR) of the factors, which should be less than or equal to 10% (Saaty, 1987). The λ_{max} value is an essential indicator in AHP and is used as a reference index in calculating the estimated vector's consistency ratio (CR). At each level of the hierarchy, if CR < 0.10, pairwise comparisons are acceptable; if, however, CR ≥ 0.10, the ratio values indicate inconsistent judgements in the evaluation process. In such cases, one should reexamine and revise the original pairwise comparison matrix (Anane et al., 2012: Sener and Davraz, 2013).

$$CR = \frac{CI}{RI} = \frac{\text{Consistency Index (CI)}}{\text{Random Consistency Index (RI)}} \quad \text{......... (1)}$$

$$CI = \frac{\lambda max - n}{n - 1} \quad \text{......... (2)}$$

Where λ_{max} is the Principal Eigenvalue, n = 9,\ RI =1.45. The Principal Eigenvalue (λ_{max}) is obtained by multiplying the summation of products between each element of the Eigenvector above by the sum of columns of the reciprocal matrix. $\{Ws\} \cdot \left\{\frac{1}{w}\right\}$

Thus, Principal Eigen Value, λmax = …(3)

The weighted overlay operation was done to get the final suitability map of the study area. The various suitability maps based on each criterion were combined in ArcGIS using the 'Weighted Overlay' tool to produce the final suitability map. The weighted overlay process of combination is easily achieved in ArcMap because the criteria values have been rasterised and classified into a common ranking scale. The final suitability map in raster format was converted to a polygon feature in ArcGIS Desktop using the 'raster to polygon tool. The conversion is to allow us to get an accurate measurement. The polygon was then disaggregated into suitability classes using the 'dissolve' tool by 'grid codes'. The suitability map attribute table shows the total area cover of AMAC in lesser individual units or sites.

Results

Proximity to Towns

The proximity of a displaced persons' camp to nearby towns is a crucial social criterion in the IDP campsite selection. Towns have built-up areas like settlements, commercial areas, health centres, religious institutions, educational institutions and other social service areas. Hence, IDP sites should not be placed too far away from town. Table 1 shows the suitability level when considering the distance from the towns.

Based on the distance from nearby towns, suitable land accounted for 925.24 km^2 (52.92%), while the most suitable covers about 246.13 km^2, 14.08% of the total area (Figure 2).

Proximity to Roads

The proximity map to the roads was obtained by classifying the roads into seven Euclidean distance classes and assigning the relative suitability of zones according to the degree of closeness to the roads. As a general concept, a displaced persons' settlement should be located within 500m of any major highways, town streets or other transportation routes. Table 2 shows the suitability level when considering the distance from the main road.

The suitable land accounted for 626.73 $km^{2,}$ while w the most suitable extends over 36.42% of the total area in AMAC (Figure 3).

Proximity to Water Source

Table 3 gives the water class and suitability level. The part of AMAC suitable for IDP camp based on the water source covered 749.51 km^2 (42.87%) of the study area. The most suitable land covered 9.81% (171 km^2) of the total area. Therefore, as the distance between the camps and water decreases, accessibility to water supply becomes high.

Table 1: Town class interval and suitability area coverage

S/N	Proximity to Town (km)	Factor rating	Suitability	Area (km^2)
1.	0 – 1	4	Most Suitable	246.13
2.	1 – 3.5	3	Suitable	925.24
3.	3.5 – 10	2	Less suitable	528.29
4.	10 >	1	Unsuitable	48.73

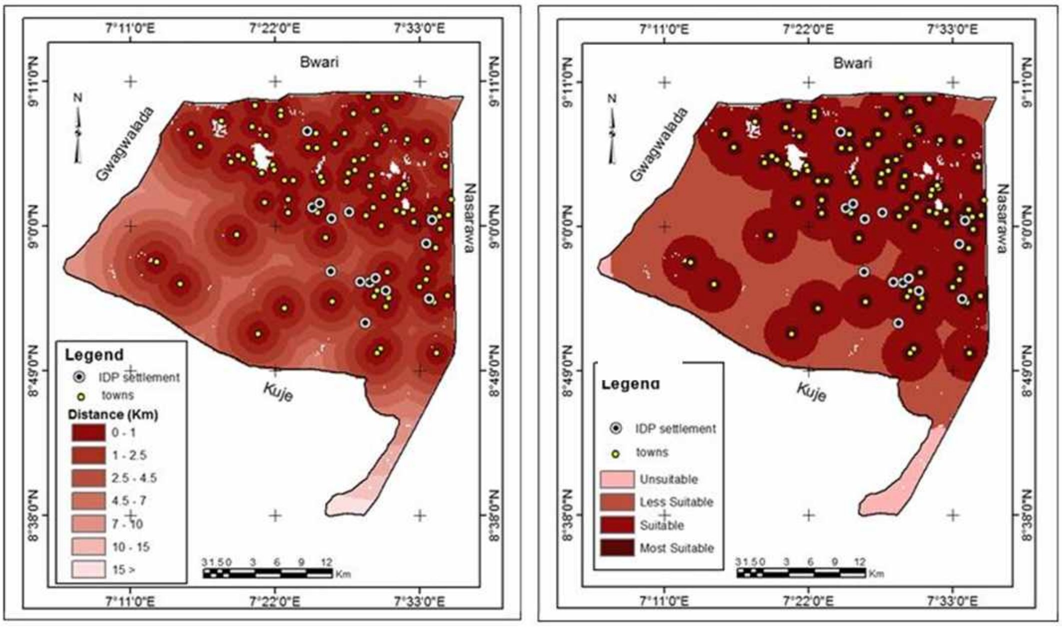

Figure 2: Distance from towns

Table 2: Road class interval and suitability area coverage

S/N	Proximity to Road (km)	Factor rating	Suitability	Area (km^2)
1.	0 – 0.5	4	Most Suitable	636.71
2.	0.5 – 1.5	3	Suitable	626.73
3.	1.5 – 3.5	2	Less suitable	408.91
4.	3.5 – 7	1	Unsuitable	76.04

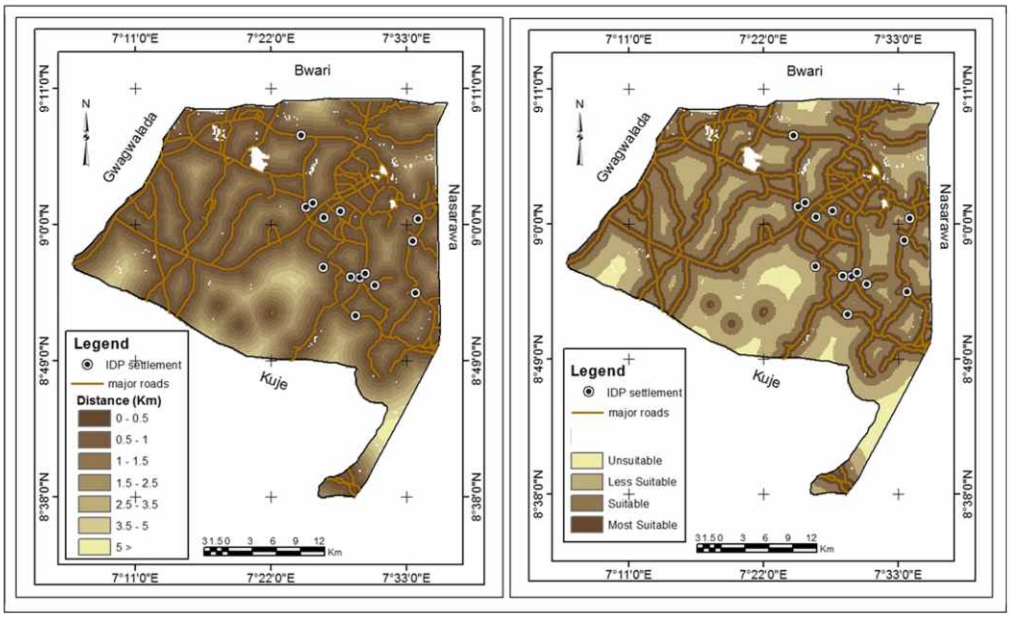

Figure 3: Distance to Roads

Table 3: Water class interval and suitability area coverage

S/N	Proximity to Water (km)	Factor rating	Suitability	Area (km^2)
1.	0 – 0.5	4	Most Suitable	171.56
2.	0.5 – 5	3	Suitable	749.51
3.	5 – 15	1	Less suitable	488.99
4.	15 >	0	Unsuitable	338.34

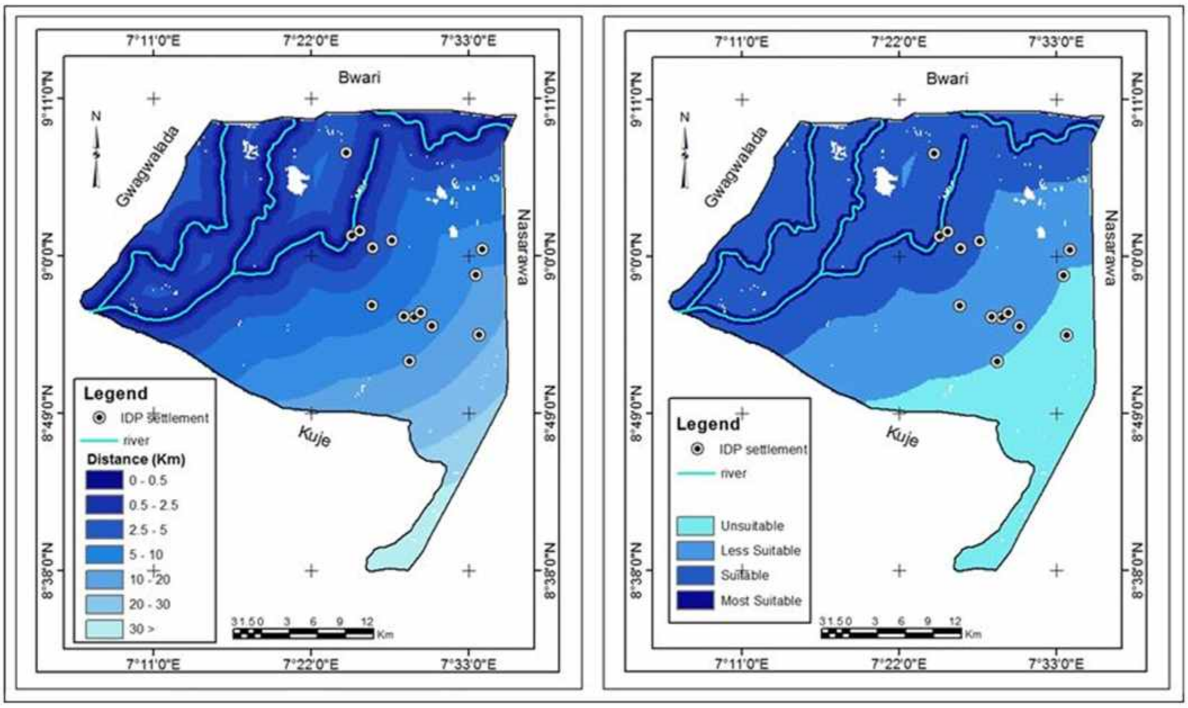

Figure 4: Distance to water sources

Table 4: Hospital class interval and suitability area coverage

S/N	Proximity to Hospital (km)	Factor rating	Suitability	Area (km^2)
1.	0 – 0.5	4	Most Suitable	112.67
2.	0.5 – 3.5	3	Suitable	732.78
3.	3.5 – 10	1	Less suitable	717.55
4.	10 >	0	Unsuitable	185.39

In general, closeness to lakes and permanent rivers implies that the settlement's population has access to potable fresh water for home and agricultural use. Accordingly, distances far from streams are less suitable, while distances around 500m near streams for this study are more suitable for IDP campsites (Figure 4).

Proximity to Hospitals

Using the health centre feature class based on the Euclidean distance function, a distance buffer was created. The reclassify function was then used to reclassify the raster into four Boolean values from 1 for unsuitable to 4 for most suitable (Table 4).

The suitable areas covered 41.91%, while the most suitable occupied about 6.44% of the total area. As the distance between the IDP settlements and hospitals decreases, the accessibility to health facilities becomes high. There is an oral agreement that the distance is 500 meters (Jamali et al., 2014). Hence, for this study, hospitals within 500 m distance from the IDP settlements were most suitable (Figure 5).

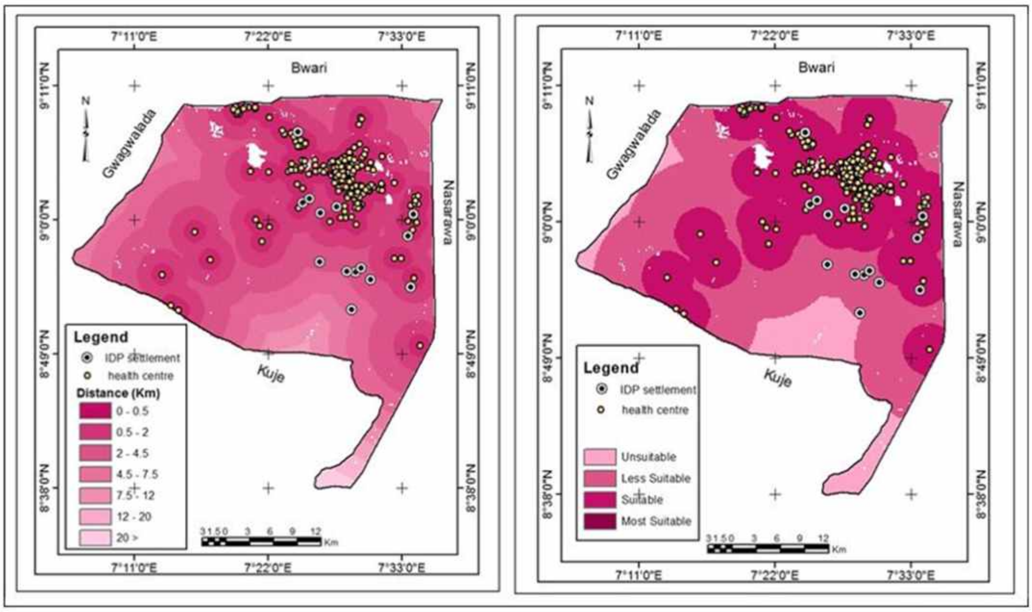

Figure 5: Distance to hospitals

Table 5: School class interval and suitability area coverage

S/N	Proximity to school (km)	Factor rating	Suitability	Area (km^2)
1.	0 – 1	4	Most Suitable	247.96
2.	1– 5	3	Suitable	839.50
3.	5 – 12.5	1	Less suitable	564.18
4.	12.5 >	0	Unsuitable	96.75

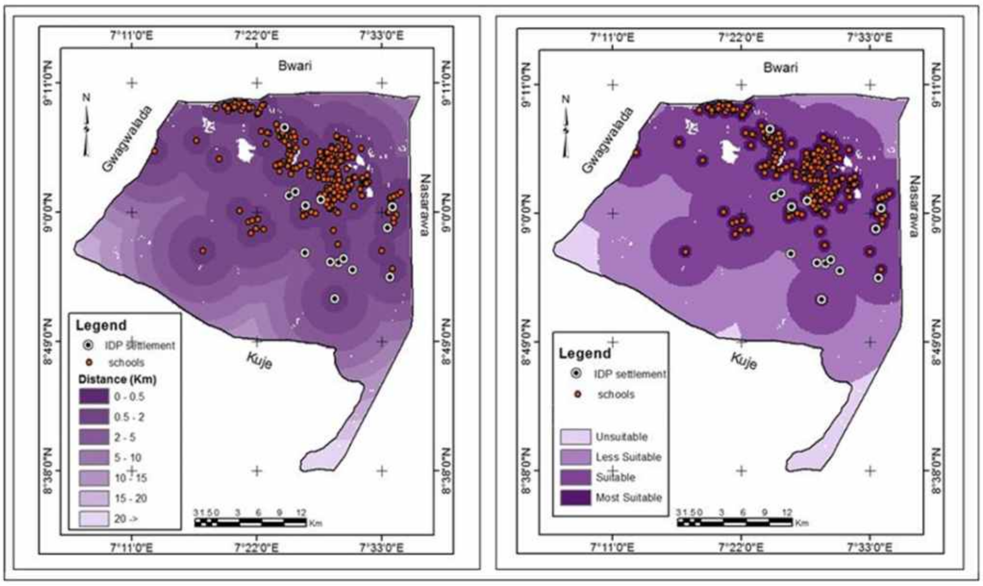

Figure 6: Suitability areas according to proximity to schools

Proximity to Schools

Talam and Ngigi (2015) suggested that buffer values of 0 – 1000m, with distances less than 1000m to displaced person settlements from schools, are the most suitable. Table 5 gives an overview of the distances to schools and suitability level. The value is based on how far a pupil should walk to school.

The results from the school class and suitability area given in Table 5 show that 48.02% (839.5km^2) of the landscape in the study area is suitable, while 14.18% of the total area was shown to be most suitable for IDP camps (Figure 6)

Table 6: Tourism class interval and suitability area coverage

S/N	Proximity to Tourism (km)	Factor rating	Suitability	Area (km^2)
1.	0 – 2.5	0	Unsuitable	155.73
2.	2.5 – 7.5	2	Less Suitable	549.14
3.	7.5 – 20	3	Suitable	863.36
4.	20 >	4	Most Suitable	180.17

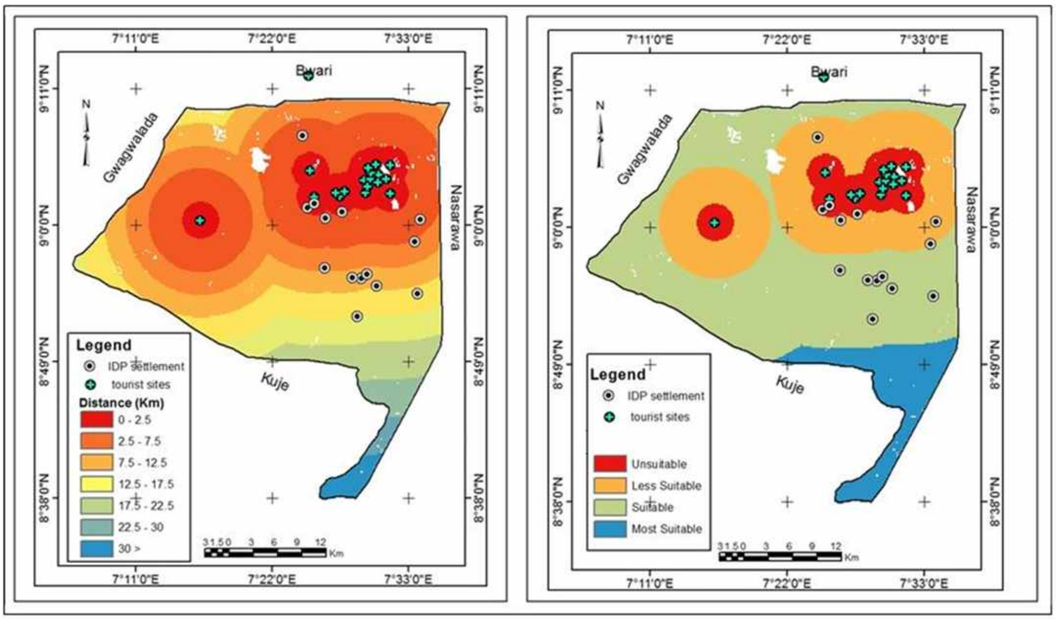

Figure 7: Suitability areas according to proximity to tourist sites

Table 7: Elevation class interval and suitability area coverage

S/N	Elevation (m)	Factor rating	Suitability	Area (km^2)
1.	177 – 365	4	Most Suitable	521.49
2.	365 – 470	3	Suitable	642.46
3.	470 – 597	2	Less suitable	372.30
4.	597 – 934	1	Unsuitable	211.57

Proximity to Tourist sites

To maintain tourism attractiveness, Cetinkaya et al. (2016) suggested buffer values of between 0 – 2500m, with distances less than 2500m to IDP camps as being unsuitable. This distance is preferred to protect the attraction. The value seemed appropriate for this study and adapted to generate buffer distances, as presented in Table 6. The most suitable IDP campsites were those farther from the tourist locations and received higher ratings.

Table 6 shows the suitability level when considering the distance from the tourist attractions. Results show that the suitable land based on the distance from nearby tourism locations accounted for 863.36km^2 (49.38%) of the study area, while just 10.30% is most suitable for locating a camp (Figure 7).

Elevation

The Euclidean distance tool classified the elevation types into seven raster categories. They were then further reclassified into four suitability classes with factor ratings of 1 to 4 (Table 7). Areas with high altitudes were less suitable and assigned a low score, while areas low in altitude were more suitable for settling IDPs.

Based on elevation, results show that the suitable land accounted for 642.46 km^2 (36.76%) of the total area, while 29.83% (521.49 km^2) is deemed most suitable for Internally Displaced Persons' camp (Figure 8). Elevation higher than 900m is considered weak because of fewer water outlets. High elevation has few water points, whereas low elevation has many.

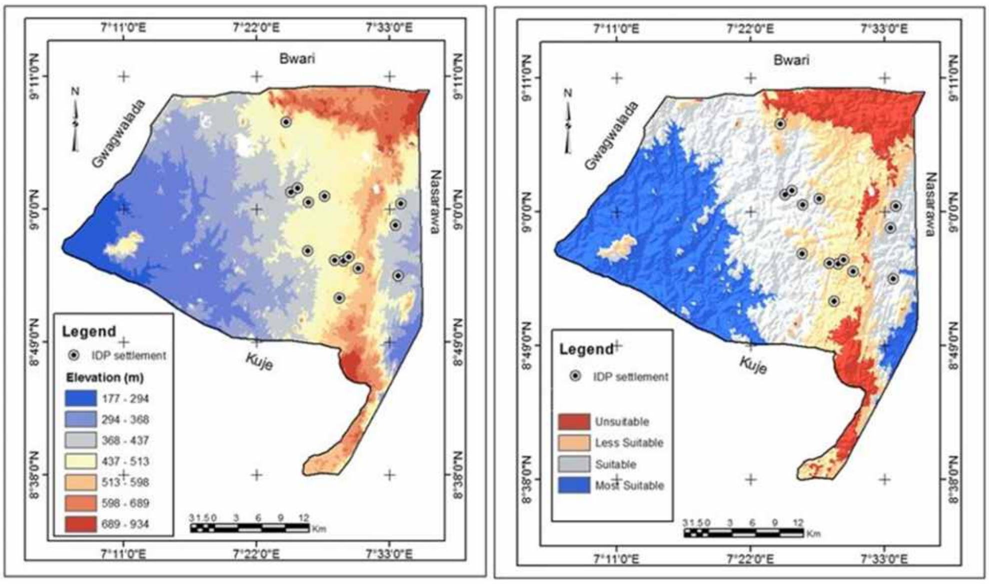

Figure 8: Suitable elevation

Table 8: Slope class interval and suitability area coverage

S/N	Slope interval (%)	Factor rating	Suitability	Area (km^2)
1.	0 – 2	2	Less Suitable	143.58
2.	2 – 7	4	Most Suitable	752.25
3.	7 – 15	3	Suitable	726.83
4.	15 – 100	0	Unsuitable	152.17

Slope

Table 8 shows the slope configuration of the area and classes of suitability. Steep slopes of 10% and above are challenging and expensive to develop and should be averted. Based on this, most of the land is suitable for IDP site selection.

It is observed from Table 8 that the majority of the study area falls under the slope class of 2 – 7 and covers 42.38% of the total area. This coverage makes the class most suitable for IDP settlement, while 40.95% is suitable (Figure 9). The slope is not so much a significant criterion for displacement settlement camp in Abuja Municipal Area Council as it is flat overall in its topography.

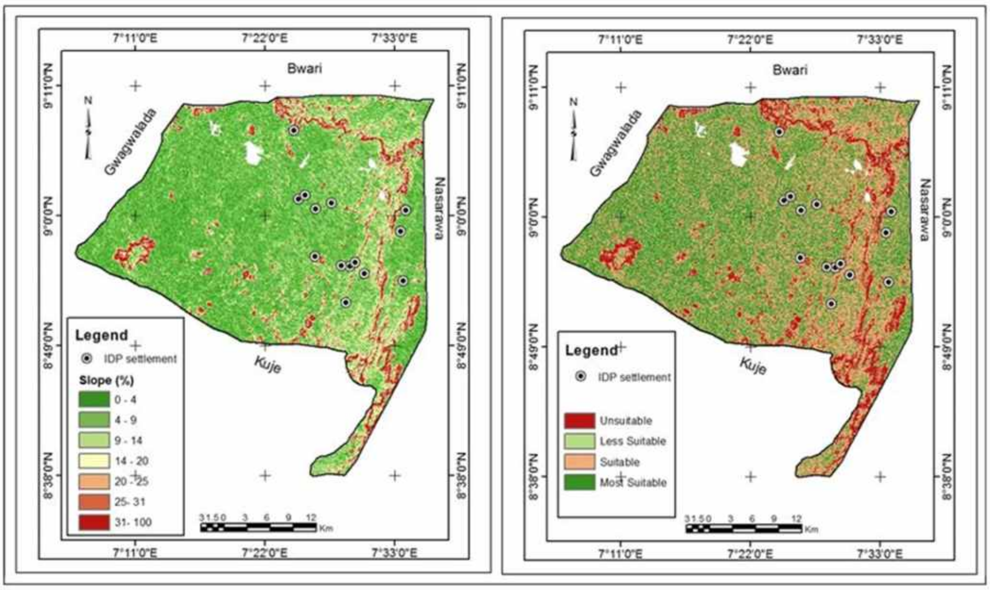

Figure 9: Suitable Slope

Table 9: LULC class interval and suitability area coverage

S/N	LULC Types	Factor rating	Suitability	Area (km^2)
1.	Urban	0	Unsuitable	445.38
2.	Forestland	1	Less Suitable	269.15
3.	Farmland	2	Suitable	431.87
4.	Grassland	4	Most Suitable	623.01

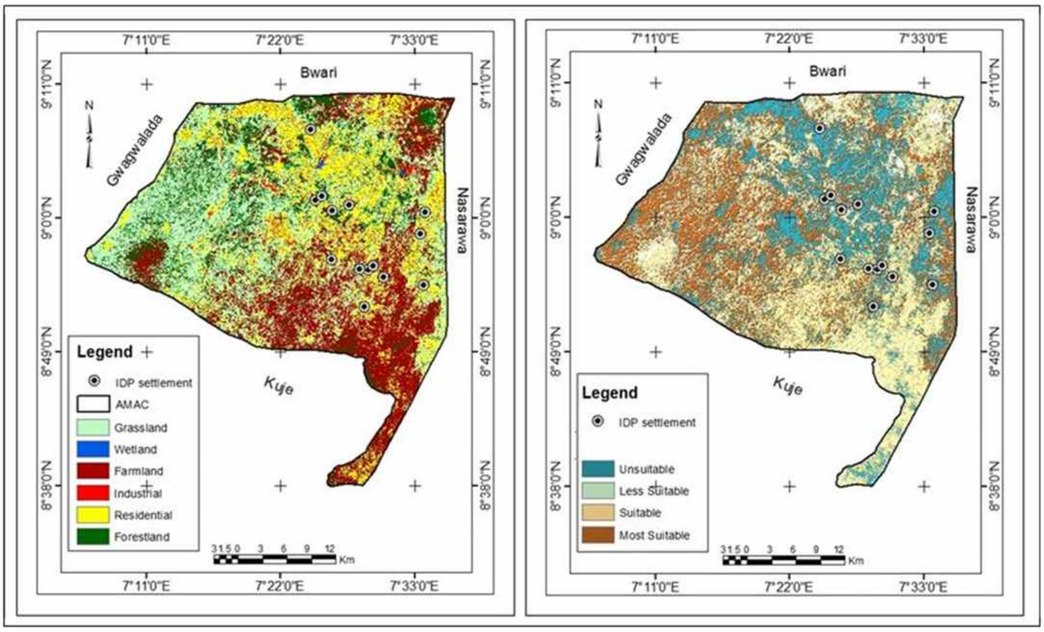

Figure 10: Suitable land use

Table 10: Pairwise comparison matrix for nine criteria suitability model

	Slope	River	Road	Hospital	School	LULC	Town	Tourist	Elevation
Slope	**1**	2	3	3	3	3	5	5	3
River	1/2	**1**	3	1	3	5	3	5	5
Road	1/3	1/3	**1**	1	3	1	1/5	5	5
Hospital	1/3	1	1	**1**	2	1	1/3	5	3
School	1/3	1/9	1/3	1/2	**1**	1/3	1/3	3	3
LULC	1/4	1/5	1	1	3	**1**	1/5	1	3
Town	1/7	1/7	1/3	3	2	3	**1**	3	5
Tourist	1/8	1/9	1/5	1/5	1/5	1/3	1/3	**1**	3
Elevation	1/7	1/7	1/5	1/7	1/5	1/3	1/5	1/3	**1**
TOTAL	**3.16**	**5.04**	**10.07**	**10.84**	**17.40**	**15.00**	**10.60**	**28.33**	**31.00**

Land Use Land Cover (LULC)

LULC classification divided the study area across all land types (Figure 10). Table 9 shows the suitability level according to land cover types. Grassland was chosen as the most suitable land to build a camp on because the area is open and accessible to clear structures. Forest areas in AMAC were given a lower rate because it takes time and effort to deforest an area before constructing a camp. Farmland was also ranked low because arable lands may not be easily released for IDP camp building (Mong, 2014).

A large percentage of the study area falls under the class grassland and covers 623.01 km^2 (35.21%). This coverage makes the class most suitable for IDP settlement whereas about 24.41% (431.87 km^2) was suitable (Figure 10).

Determination of weights

The calculation of the pairwise comparison matrix, reciprocal matrix, consistency ratio (CR), random consistency index, and consistency index related to AMAC criteria is seen in Tables 10 and 11. Each factor criterion was paired one against the other in the table to show priority.

Table 11: Pairwise comparison normalised reciprocal matrix

	Slope	River	Road	Hospital	School	LULC	Town	Tourist	Elevation	Eigen Vector	(%)
Slope	0.316	0.397	0.298	0.277	0.172	0.200	0.472	0.176	0.097	0.267	26.7
River	0.158	0.198	0.298	0.092	0.172	0.333	0.283	0.176	0.161	0.208	20.8
Road	0.105	0.066	0.099	0.092	0.172	0.067	0.019	0.176	0.161	0.106	10.6
Hospital	0.105	0.198	0.099	0.092	0.115	0.067	0.031	0.176	0.097	0.109	10.9
School	0.105	0.022	0.033	0.046	0.057	0.033	0.031	0.106	0.097	0.058	5.8
LULC	0.079	0.040	0.099	0.092	0.172	0.067	0.019	0.035	0.097	0.078	7.8
Town	0.045	0.028	0.033	0.277	0.115	0.200	0.094	0.106	0.161	0.118	11.8
Tourist	0.040	0.022	0.020	0.018	0.011	0.022	0.031	0.035	0.097	0.033	3.3
Elevation	0.045	0.028	0.020	0.013	0.011	0.022	0.019	0.012	0.032	0.023	2.3
TOTAL	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**100**
	λ_{max} = 9.21				**CI = 0.03**					**CR = 0.02 < 0.1**	

Table 12: Summary of criteria and final weights of the matrix

Criteria Type	Criterion	Categories	Ranking	Suitability Class	Weight
Economical	Proximity to Town (km)	0 – 1 1 – 3.5 3.5 – 10 10 >	4 3 2 1	Most Suitable Suitable Less Suitable Unsuitable	0.12
	Proximity to Hospital (km)	0 – 0.5 0.5 – 3.5 3.5 – 10 10 >	4 3 1 0	Most Suitable Suitable Less Suitable Unsuitable	0.11
	Proximity to School (km)	0 – 1 1– 5 5 – 12.5 12.5 >	4 3 1 0	Most Suitable Suitable Less Suitable Unsuitable	0.06
	Proximity to Tourism (km)	0 – 2.5 2.5 – 7.5 7.5 – 20 20 >	0 2 3 4	Unsuitable Less Suitable Suitable Most Suitable	0.04
Environmental	Proximity to Water (km)	0 – 0.5 0.5 – 5 5 – 15 15 >	4 3 1 0	Most Suitable Suitable Less Suitable Unsuitable	0.21
	Land use Land cover	Grassland Farmland Forestland Urban	4 2 1 0	Most Suitable Suitable Less Suitable Unsuitable	0.08
Infrastructural	Elevation (m)	177 – 365 365 – 470 470 – 597 597 – 934	4 3 2 1	Most Suitable Suitable Less Suitable Unsuitable	0.02
	Slope interval (%)	0 – 2 2 – 7 7 – 15 15 >	2 4 3 0	Less Suitable Most Suitable Suitable Unsuitable	0.27
	Proximity to Road (km)	0 – 0.5 0.5 – 1.5 1.5 – 3.5 3.5 – 7	4 3 2 1	Most Suitable Suitable Less Suitable Unsuitable	0.11

Table 13: Final weighted suitability area

S/N	Colour Code	Range of Score	Suitability	Area (km^2)
1.	Red	Class 1	Unsuitable	33.36
2.	Brown	Class 2	Less Suitable	631.53
3.	Lemon	Class 3	Suitable	1035.36
4.	Green	Class 4	Most Suitable	47.74

According to the normalised Eigenvector, the slope was the most important factor. With an overall priority weight of 26.7%, this factor is considered the most important of the criteria (Table 11). Other considerable factors are ranked as follows: water (20.8%), town (11.8%), hospital (10.9%), road (10.6%), land use (7.8%), school (5.8%), tourism (3.3%) and elevation (2.3%).

The Consistency Ratio's final value was 0.02 (Table 11). This value is less than 0.10, which indicates that the pairwise comparison between the various factors is consistent.

Table 12 summarises the AHP process, including the criteria evaluation, selection of intervals from the reviews, and ranking from 1 to 4, which corresponds to unsuitable to suitable. It also presents the final weights determined from pairwise comparison generated by experts, the normalised or reciprocal matrix and the consistency ratio.

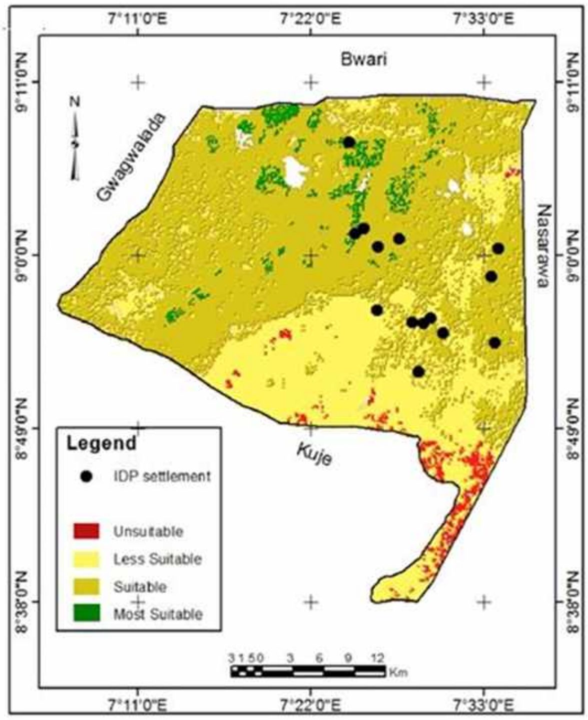

Figure 11: Final IDP camp suitability map

IDP camp suitability analysis

Out of the 1747.99 km^2 total land area of AMAC, 47.74 km^2 (2.73%) falls under the most suitable category (class 4) for siting an IDP camp. The suitable areas (class 3) cover 1035.36 km^2 (59.23%). The less suitable category (class 2) covers 631.53 km^2 (36.13%), and the remaining 1.91 % at (33.36 km^2) is classified as unsuitable (Table 13).

Using the stated criteria, the most suitable areas for IDP campsites were found mainly in parts of the north-central and north-western parts, then some pockets in the southwestern part of Abuja Municipal Area Council (Figure 11).

The whole area of the weighted overlay suitability of IDP site is a result of the final suitability analysis obtained from all criteria used. Based on the combined suitability score, the north-central districts of AMAC (Mpape, Kado, Jabi, Jahi, Kubwa) are most suitable for IDP settlement locations (Figure 11). Tiny portions of Wuse districts also include the most suitable class.

Discussion

The present study has identified suitable sites after considering a set of factors cross-analysed for decision-making. The combination of GIS techniques and MCA is well justified, as Jankowsky (1995) provided because there have been discussions regarding whether GIS decision support capabilities are sufficient, especially in land suitability analysis use.

This study has explored the potential of Geographic Information Systems coupled with Multicriteria analysis in land suitability for IDP camp selection. Based on suitability classification, the combination of all raster suitability models representing the full criteria in a weighted scheme according to the designed weights produced the final suitability map. This approach is in line with Cetinkaya et al. (2016), who used the suitability analysis approach to suggest suitable campsites for Syrian refugees in Turkey.

They came out with a model that offers 15 new refugee camps and suggested that alternative camp locations are more suitable than currently existing camps. In the same vein, the approach is similar to Jamal (2016), that studied schools' suitability analysis in Khorog and Porshnev towns, Kazakhstan, and concluded that the selection of criteria might apply to the suitability of other facilities such as a hospital or a place of worship and therefore generic.

Many other researchers have used the combination of GIS with MCA, but in different application areas, and few authors focused on IDP camps siting. For example, Dawod (2016) focused on utilising Multi-Criteria Analysis (MCA) within a GIS environment to locate optimum locations for solar energy projects in Egypt towards an ambitious plan to increase renewable energy share from currently 2% to 20% of total demand by 2020. The study showed that almost the entire Egyptian territory is suitable for solar energy. Soltani et al. (2015) generated a list of appropriate criteria to be used in deciding to select sites for temporary shelter in Iran after an emergency. His approach was explicitly from an earthquake perspective, considering a situation with long-term reconstruction.

Mong et al. (2014) developed a methodology to determine the best locations for refugee camps in Uganda using GIS by examining how both environmental and social factors could be used to locate the best places on a country basis for displaced peoples' settlements or camps. They declared the method satisfactory and hoped it could be applied to other countries to serve as a beneficial tool for policymakers and humanitarian groups. Despite the differences in the application area, it is worth noting that the common line for these studies is the identification and selection of criteria, their ranking and weight. While we based our analysis on three categories of factors such as environmental, social and infrastructural cum nine sub-criteria, Cetinkaya et al. (2016) used four criteria (geographical, risk related, infrastructural and social) and their 19 corresponding sub-criteria for a similar study in Turkey. This shows that the peculiarity of each study area dictates the types and the number of factors to work with, even though Saaty (1980) has recommended that such factors should be small in number. The model we presented, like others that have used MCA (Cetinkaya et al., 2016; Mong et al., 2014; Erden et al., 2010), multiplies the weighted value by each raster layer value sum of each corresponding cell. Restriction zones were excluded at the start of the research, and in our case, these included criteria and restrictions for IDP camps, i.e., protected areas (reserves), and surface waters (lakes).

Conclusion

The study results indicate the most suitable area for IDP camp siting in Abuja and Environs, covering about 61.96% or 1083.10km^2 of the total land in the study area. This result indicates that the study area can fulfil the future demand for displacement persons' camps. The most remarkable identification of this analysis is that a good number of the most suitable lands belong to the open/vacant land category. It indicates the validity of the methodology. Most suitable lands are located in Kubwa and Airport Districts, which are located in the permissible zone for agriculture development. The study concludes that over 61% of lands available in AMAC have the potential for internally displacement camps.

This study developed a list of criteria to select adequate sites for internally displaced persons settling after a disaster. City planners could use these criteria in detailed models or systems to select suitable sites for emergencies. Developing and applying such models should be achieved in the preparedness phase. This approach would benefit the Nigerian Emergency Management Agency (NEMA) operation regarding cost reduction and incur the approval of displaced people. Moreover, the study results, which act in one place as a preliminary index for authorities and decision-makers to assist them in making informed decisions, may apply elsewhere in the assessment and re-development of the rural sector.

Further research should be undertaken to perform and determine the land use suitability index for this purpose.

References

Abudeif, A. M., Abdel Moneim, A. A., & Farrag, A. F. (2015). Multicriteria decision analysis based on analytic hierarchy process in GIS environment for siting nuclear power plant in Egypt. *Annals of Nuclear Energy,* 75, 682–692.

Adewale, S. (2016). Internally displaced persons and the challenges of survival in Abuja. *African Security Review,* 25(2), 176–192.

Al-Adamat, R., Diabat, A., & Shatnawi, G. (2010). Combining GIS with multi-criteria decision making for siting water harvesting ponds in Northern Jordan. *Journal of Arid Environments,* 74(11), 1471–1477.

Akinci, N., Cornelis, J., Akinci, G., & Teschner, M. (2013). Coupling elastic solids with smoothed particle hydrodynamics fluids. *Computer Animation and Virtual Worlds,* 24(3- 4), 195-203.

Anane, M., Bouziri, L., Limam, A., & Jellali, S. (2012). Ranking suitable sites for irrigation with reclaimed water in the Nabeul-Hammamet region (Tunisia) using GIS and AHP- multi-criteria decision analysis. Resources, Conservation and Recycling, 65, 36-46.

Balogun O (2001). *The Federal Capital Territory of Nigeria: A Geography of its Development*. University Press, Ibadan.

Celik, E. (2017). A cause and effect relationship model for location of temporary shelters in disaster operations management. International Journal of Disaster Risk Reduction, 22, 257-268.

Cetinkaya, C., Özceylan, E., Erbaş, M., & Kabak, M. (2016). GIS-based fuzzy MCDA approach for siting refugee camp: A case study for southeastern Turkey. *International Journal of Disaster Risk Reduction,* 18, 218-231.

Chapin, F. Stuart, Jr., & Edward J. Kaiser. (1979). *Urban Land Use Planning*. 3rd Edition. Urbana, IL: The University of Illinois Press.

Corsellis T. and Antonella Vitale A. (2005). *Transitional Settlement: Displaced Populations. Shelter Project*, Oxfam GB, University of Cambridge, 240p

Davies, A. (2012). *IDPs in Host Families and Host Communities: Assistance for Hosting Arrangements*. Geneva: UNHCR.

Dawod, G. M., & Mandoer, M. S. (2016). *Optimum Sites for Solar Energy Harvesting in Egypt Based on Multi-Criteria GIS*. Paper presented at the First Future University International Conference on New Energy and Environmental Engineering Cairo, Egypt. April 11-14, 2016.

Ejiofor, O. C., Oni, S., & Sejoro, J. V. (2017). An Assessment of the Impact Of Internal Displacement On Human Security In Northern Nigeria (2009-2016). *Acta Universitatis Danubius. Relationes Internationales*, 10(1).

Ekpa, S., & Dahlan, N. H. (2016). Legal Issues and Prospects in the Protection and Assistance of Internally Displaced Persons (IDPs) in Nigeria. *JL Pol'y & Globalization*, 49, 108.

Erden, T., & Coskun, M. Z. (2010). Multi-criteria site selection for fire services: the interaction with analytic hierarchy process and geographic information systems. *Natural Hazards and Earth System Sciences*, 10(10), 2127.

Erong, C. (2017). Community Hosting of Internally Displaced Persons in Maiduguri, Borno State- Nigeria, Master of Arts in Development Studies Research Paper, International Institute of Social Studies, The Hague, The Netherlands, 57 p

Feizizadeh, B., Roodposhti, M. S., Jankowski, P., & Blaschke, T. (2014). A GIS-based extended fuzzy multi-criteria evaluation for landslide susceptibility mapping. Computers & Geosciences, 73, 208-221.

Gutjahr, W. J., & Nolz, P. C. (2016). Multicriteria optimisation in humanitarian aid. *European Journal of Operational Research*, 252(2), 351-366.

Hossain, M. S., Chowdhury, S. R., Das, N. G., & Rahaman, M. M. (2007). Multi-criteria evaluation approach to GIS-based land-suitability classification for tilapia farming in Bangladesh. *Aquaculture International,* 15(6), 425-443.

Ikpe, E. (2017). Counting the development costs of the conflict in North-Eastern Nigeria: the economic impact of the Boko Haram-led insurgency. *Conflict, Security & Development,* 17(5), 381-409.

Isaac I., Danlami G., Habila J., Salami H., Salami R. O., & Abutu P. 2019. Service Deprivation in Internally Displaced Persons' Camps in Nigeria: Case Study of Abuja*, International Journal of Management & Development*, 6(12), 186-196.

Jamal, I. (2016). Multi-criteria GIS analysis for school site selection in Gorno-Badakhshan Autonomous Oblast, Tajikistan. Master Thesis in Geographical Information Science. Department of Physical Geography and Ecosystem Science, Centre for Geographical Information Systems, Lund University, 83 p.

Jamali, I. A., Mörtberg, U., Olofsson, B., & Shafique, M. (2014). A spatial multi-criteria analysis approach for locating suitable sites for construction of subsurface dams in Northern Pakistan. *Water Resources Management*, *28*(14), 5157-5174.

Jankowski, P. (1995). Integrating geographical information systems and multiple criteria decision-making methods. *International Journal of Geographical Information Systems,* 9(3), 251-273

Makama A. A. 2015. Appraisal of Sanitary Facilities in Public Areas of Garki District, Abuja. Master's Thesis, ABU, Zaria

Mong, C., Nelson, C., & Oni, M. (2014). GIS for Good Optimal Site Selection for Refugee Camps in Uganda. Retrieved from http://gisforgood5.weebly.com/uploads/3/0/6/3/3063 6149/gisfinal report1.pdf 21/06/2017

Okobia, E. L., & Hassan, S. M. (2011 Assessment of ambient atmospheric concentration of volatile organic compounds in Abuja-Nigeria. *Journal of Chemical, Biological and Physical Sciences*, *2*(3), 1637-1647.

Olanrewaju, F. O., Olanrewaju, A., Omotoso, F., Alabi, J. O., Amoo, E., Loromeke, E., & Ajayi, L. A. (2019). Insurgency and the Invisible Displaced Population in Nigeria: A Situational Analysis. *SAGE Open*, 9(2), 215824401984620.

Ortiz, D. (2020). Geographic Information Systems (GIS) in Humanitarian Assistance: A Meta- Analysis. Pathways: *A Journal of Humanistic and Social Inquiry*, 1(2), 1–13.

Quinn, J. A., Nyhan, M. M., Navarro, C., Coluccia, D., Bromley, L., & Luengo-Oroz, M. (2018). Humanitarian applications of machine learning with remote-sensing data: Review and case study in refugee settlement mapping. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences,* 376(2128), 20170363.

Saaty, T. L. (1980). The Analytic Hierarchy Process: Planning. Priority Setting. Resource Allocation, MacGraw-Hill, New York International Book Company, 287.

Saaty, R. W. (1987). The analytic hierarchy process—what it is and how it is used. Mathematical modelling, 9(3-5), 161-176.

Sener, E., & Davraz, A. (2013). Assessment of groundwater vulnerability based on a modified DRASTIC model, GIS and an analytic hierarchy process (AHP) method: the case of Egirdir Lake basin (Isparta, Turkey). *Hydrogeology Journal,* 21(3), 701-714.

Talam, P. K., & Ngigi, M. M. (2015, May). Integration of GIS and Multicriteria Evaluation for School Site Selection: A Case Study of Belgut Constituency. *In Proceedings of Sustainable Research and Innovation Conference* (pp. 138-149).

Thompson, J. (2011). Humanitarian performance and the Asian Tsunami. *TDR/The Drama Review,* 55(1), 70-83.

UN-HABITAT. (2010). State of the World's Cities 2011: Bridging the Urban Divide. Earthscan

Ujoh F., kwabe I. D., and Ifatimehin O. O. 2011 Urban expansion and vegetal cover loss in and around Nigeria's Federal Capital City, *Journal of Ecology and the Natural Environment*, 3(1), 1-10.

Verjee, F. (2007). An assessment of the utility of GIS-based analysis to support the coordination of humanitarian assistance. The George Washington University.

Zhang, F., Johnson, D. M., & Sutherland, J. W. (2011). A GIS-based method for identifying the optimal location for a facility to convert forest biomass to biofuel. *Biomass and Bioenergy,* S09619534 11003 308.