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Optimizing Mini Dam Placement for Sustainable Water Management in FUTA: A GIS-MCDA Approach

FUTA'da Sürdürülebilir Su Yönetimi için Mini Baraj Yerleşiminin Optimize Edilmesi: Bir CBS-ÇKKA Yaklaşımı

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Abstract

Addressing the increasing demand for water resources at the Federal University of Technology, Akure (FUTA) due to the growing population requires a data-driven solution. This study determined the suitable locations for the siting of mini-dams as an alternative solution to the problem of water scarcity in FUTA using a Geographical Information Systems (GIS)-based Multi-Criteria Decision Analysis (MCDA) approach by integrating five thematic factors: drainage density, slope, elevation, land cover and soil texture. Preference values were assigned to the criteria based on their importance to a dam. Analytical Hierarchy Process (AHP) was used to assign weights to these criteria, and they were combined using a weighted sum to produce a mini dam suitability map within the study area. The suitable areas were divided into five classes: highly suitable (9%), suitable (18%), marginally suitable (30%), least suitable (26%) and not suitable (17%). The suitability map was validated against the locations of existing dams in the study area. This study contributes to the efforts to manage water resources for a growing population in FUTA and to evaluate the GIS-AHP approach for dam siting for a small study area.

Keywords: *Dam, Multi-criteria decision analysis (MCDA), Analytical hierarchy process (AHP), Geographical information systems (GIS), Site selection*

Özet

Artan nüfus nedeniyle Akure Federal Teknoloji Üniversitesi'nde (FUTA) su kaynaklarına yönelik artan talebin karşılanması, veri odaklı bir çözüm gerektirmektedir. Bu çalışmada, beş tematik faktör (drenaj yoğunluğu, eğim, yükseklik, arazi örtüsü ve toprak dokusu) ve Coğrafi Bilgi Sistemleri (CBS) tabanlı Çok Kriterli Karar Analizi (ÇKKA) yaklaşımı kullanılarak FUTA'daki su kıtlığı sorununa alternatif bir çözüm olarak mini barajlar için uygun yerler belirlemiştir. Kriterlere baraj için önemlerine göre tercih değerleri atanmıştır. Kriterlerin ağırlıklarını belirlemek için Analitik Hiyerarşi Proses (AHP) yöntemi kullanılmış ve çalışma alanında bir mini baraj uygunluk haritası üretmek için ağırlıklı toplam yöntemi uygulanmıştır. Uygun alanlar beş sınıfa ayrılmıştır: çok uygun (%9), uygun (%18), marjinal olarak uygun (%30), en az uygun (%26) ve uygun değil (%17). Uygunluk haritası, çalışma alanındaki mevcut barajların konumlarına göre doğrulanmıştır. Bu çalışma, FUTA'da artan nüfus için su kaynaklarını yönetme çabalarına ve küçük bir çalışma alanı için baraj yerleşimi için CBS-AHP yaklaşımının değerlendirilmesine katkıda bulunmaktadır.

Anahtar kelimeler: *Baraj, Çok kriterli karar analizi (ÇKKA), Analitik hiyerarşi proses (AHP), Coğrafi bilgi sistemleri (GIS), Yer seçimi*

1. Introduction

Water plays a crucial role in the survival of humans and the sustainability of communities around the world. Its immeasurable benefits as renewable resources include providing shelters for people and serving as a means of livelihood. Water serves other purposes such as agricultural, recreational, and industrial uses, but domestic usage of water takes precedence over other uses. Water can be grouped into surface water, which includes oceans, rivers, lakes, reservoirs, and streams; lagoons; and groundwater. Groundwater is considered purer water and is the most common source of water in Nigeria (Egbinola & Amanambu, 2014). Despite the large expanse of area of the Earth's surface covered by water, there is a growing demand for water resources because of the increasing world population, uneven distribution of fresh water, and climate change that is affecting the hydrologic cycle (Cosgrove & Loucks, 2015). Limited water resources and ineffective policies for managing water supply are major barriers responsible for water scarcity in developing countries (Gallego-Ayala & Juízo, 2011; Aldaya et al., 2010).

The need for water supply in an academic institution cannot be over-emphasized. The scarcity of potable water and unstable electricity are major challenges facing students in Nigerian higher education institutions (Amadi et al., 2015). The establishment of new departments and construction of new halls of residence in the Federal University of Technology, Akure (FUTA) campus comes with a rise in population and, as a result, an increase in demand for water resources. FUTA is faced with the problem of water supply shortages and the untapped potential of water supply strategies due to a lack of knowledge of water resources available within the campus. The present sources of water in the university community are boreholes and hand-dug wells, which are not sufficient. The construction of a mini dam is a way to augment the existing sources of water in the university community and solve the problem of water scarcity (Akeju et al., 2021). Roof Top Rainwater Harvest (RTRWH) has been proposed as a means of augmenting the water supply in FUTA (Nzelibe et al., 2022). However, this is very dependent on the number and structure of buildings in the university. This study investigated the suitability of mini dam sites to further provide solutions to water demand in FUTA.

Dam construction and groundwater potential delineation are the most economical ways to explore groundwater resources for optimum benefit (Etikala et al., 2019; Abushandi & Alatawi, 2015). Dams can either be artificial constructions or naturally formed obstacles positioned across rivers, exerting control over water flow to increase water levels. The selection of suitable sites for dam construction requires the consideration of both environmental and socio-economic factors. While there are pivotal criteria to be considered in selecting a dam site, the number of criteria for dam site selection cannot be universally uniform. The selection of criteria will depend on factors like literature review, the capacity and intended purpose of the dam, data availability, and the peculiar environmental and social conditions of the study area (Wang et al., 2021). Topographical condition, geological and geomorphological structure, foundation condition, physiographic unit, availability of construction materials, spillway size and location, climatic hazards, earthquake hazards, length and height of the dam, life of the dam, and runoff capacity of streams are the most utilized factors in dam site selection (Luís & Cabral, 2021; Al-Ruzouq et al., 2019a; Noori et al., 2019; Abushandi & Alatawi, 2015).

The challenges in locating suitable sites and integrating different environmental factors are major problems in constructing reservoirs for water storage (Winter et al., 1998). Conventional approaches have been used to select suitable locations for dam sites (Jozaghi et al., 2018). There are now improved tools to create dam site suitability maps because of the recent advancements in geospatial technologies and machine learning (Wang et al., 2021; Al-Ruzouq et al., 2019a). Geospatial data in the form of remote sensing and GIS largely contributes to decision-making processes like the selection of suitable sites for the construction of dams. The improved spatial and temporal resolutions of remote sensing data with advanced geospatial tools and techniques have enhanced the process of water resource management. Several approaches have been used for dam site selection, which include statistical rational method and GIS multi-criteria analysis (Abushandi & Alatawi, 2015), AHP (Yasser et al., 2013), GIS-AHP and weighted overlay analysis (Luís & Cabral, 2021; Shao et al., 2020), AHP and fuzzy logic (Noori et al., 2019), AHP and machine learning (Al-Ruzouq et al., 2019a). Other approaches to dam site selection are summarized in Al-Ruzouq et al. (2019b) and Wang et al. (2021). Integrating GIS and Analytical Hierarchical Process (AHP), which provides a consistent ranking of potential mini-dam locations based on a variety of criteria provides suitable sites for mini dam placement.

MCDA combined with GIS has been employed to solve geospatial problems. The development of user-oriented GIS technology is responsible for the increased and wide integration of GIS and MCDA for addressing spatial decision problems (Malczewski, 2006). The benefit of AHP is that it allows a hierarchical structure of the criteria that enables users to have a better focus on specific criteria and sub-criteria when assigning the weights (Ouma & Tateishi, 2014; Saaty, 2008). AHP is applied in the site selection process to aid the decision-making process by allowing decision-makers to organize the criteria and alternative solutions for a problem in a hierarchical decision model. Determining the importance of parameters is the principal task in AHP. Of all the MCDA techniques, the Analytical Hierarchy Process (AHP) has gained wide application in site suitability research in recent years. Several GIS software such as the ESRI's ArcGIS products have toolboxes and extensions like weighting overlay and map algebra, which can be used for a GIS-based MCDA (Boroushaki & Malczewski, 2008).

GIS-based AHP has been used in several studies on the selection of suitable sites for dam construction, such as Luís & Cabral (2021), Shao et al. (2020), Njiru & Siriba (2018), Al-shabeeb (2016), and Dai (2016). These studies were carried out on relatively larger study regions with different numbers of physical, climatic, and hydrological criteria. The efficacy of this approach for dam site selection has not been tested in a relatively small study area with little variation in topography and environmental conditions like FUTA. Furthermore, the selection of suitable locations for a mini-dam construction in FUTA will provide valuable information to help in spatial planning to mitigate the perennial problem of water scarcity faced by students and members of staff on campus and serve as a source of irrigation and boost the institution's agricultural production. Apart from the increasing demand for water resources, the potential adverse environmental effects such as dam breakage that may arise from dam construction cause the need to select a suitable site for siting dams FUTA.

2. Materials and Method

2.1 Study Area

The study area is the Federal University of Technology, Akure (FUTA) campus, as shown in Figure 1. It is between latitudes 7° 18' 53.38"N & 7° 17' 33.47"N and longitudes 5° 6' 35.31"E & 5° 9' 17.02"E in Akure South Local Government Area, Ondo State. It lies along the Akure-Ilesha expressway, with Awule and Ibule as its neighbouring villages. About 5.401 km^2 (540.108 hectares) of landmass was covered in this study. The average annual rainfall is 1500 mm, and the average elevation is about 374 m. The rainy season is often between April to October, while the dry season is between November to March (Nzelibe et al., 2022; Olujumoke et al., 2016). The mean annual temperature ranges from 24 °C to 27 °C. Lowlands and a few rugged hills characterized the topography of FUTA, and it is within the sub-equatorial climatic belt with tropical rainforest vegetation (Akeju et al., 2021). The population of staff and students in FUTA rose from 21,462 in 2017 to 28,419 in 2019, while the current population of students and staff now stands at 25, 867 (https://www.futa.edu.ng/). The average daily water demand of FUTA was estimated to be 1,475.83 m^3/day in 2021, which is projected to increase to 2,995.74 m^3/day by the year 2049. The present sources of water in the university community are boreholes and hand-dug wells. The amount of water supply from these boles is estimated at 1,198.07 m^3/day, which is not sufficient for the FUTA population (Akeju et al., 2021).

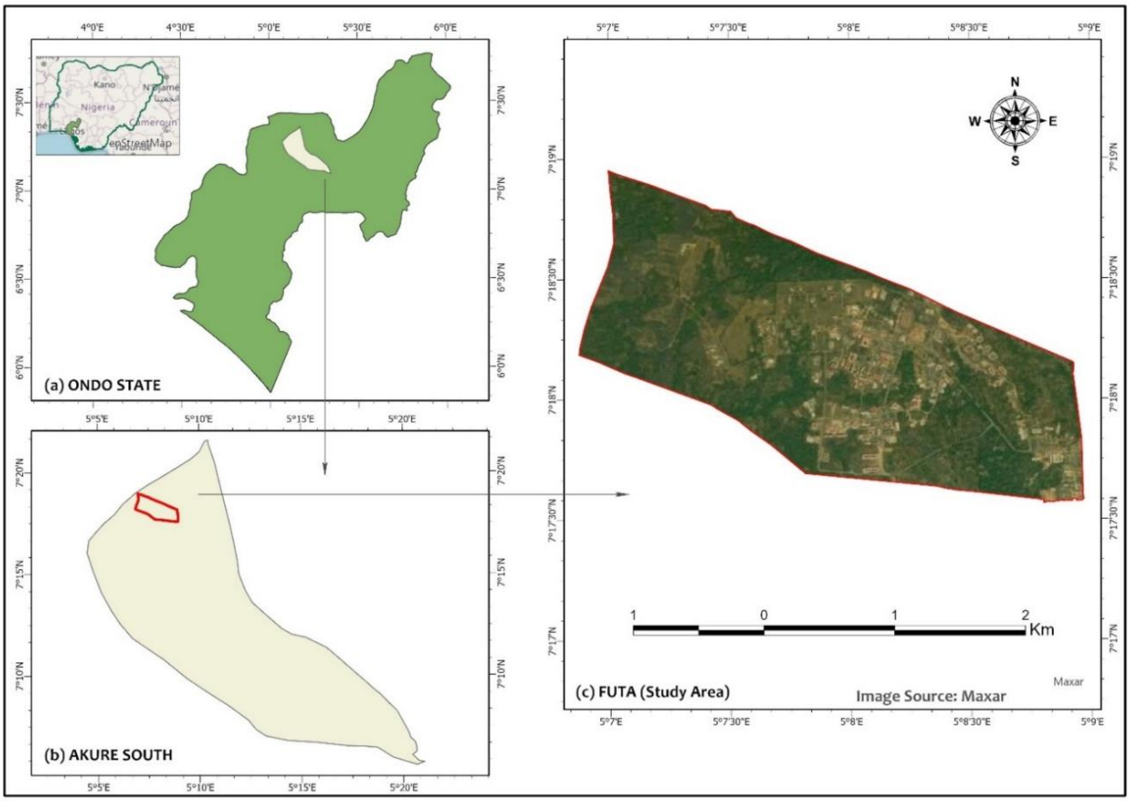

Figure 1. Study area map

2.2 Data and Sources

The intended use of a dam is crucial in selecting criteria for dam site selection. The quality of water is important in selecting a dam for irrigation purpose while the geological structure is paramount for flood control (Wang et al., 2021). Based on previous studies (Luís & Cabral, 2021; Al-Ruzouq, 2019a; Njiru & Siriba, 2018; Dai, 2016), local knowledge/peculiar attributes of the study area, and the available data for the study area, five criteria were considered for this study. These criteria are drainage density, slope, elevation, soil texture, and land cover. Precipitation was not used in this study because the study area is very small with very little variation in rainfall distribution. The data used to achieve the objectives of this study and their respective sources are contained in Table 1.

Table 1. Data used and sources

S/N	Criteria	Data	Source	Year
1	Elevation, Slope and Drainage Density	Shuttle Radar Topographic Mission (SRTM)	USGS	2014
2	Soil texture	Soil texture layer	Geology Department, FUTA	
3	Land cover	Sentinel-2 MSI	Copernicus	2023
4	Study Area	Base Map	Google, Maxar	2018, 2022
5	Administrative boundaries	Vector boundaries of Nigeria	Diva GIS	
6	Dam locations	Coordinates and pictures	Authors	2023

2.3 Research Methodology

2.3.1 Generating Thematic Layers

The elevation layer was generated directly from the Digital Elevation Model (DEM). The slope map and drainage density were derived from the DEM using the spatial analyst tools in ArcGIS Pro (Figure 2).

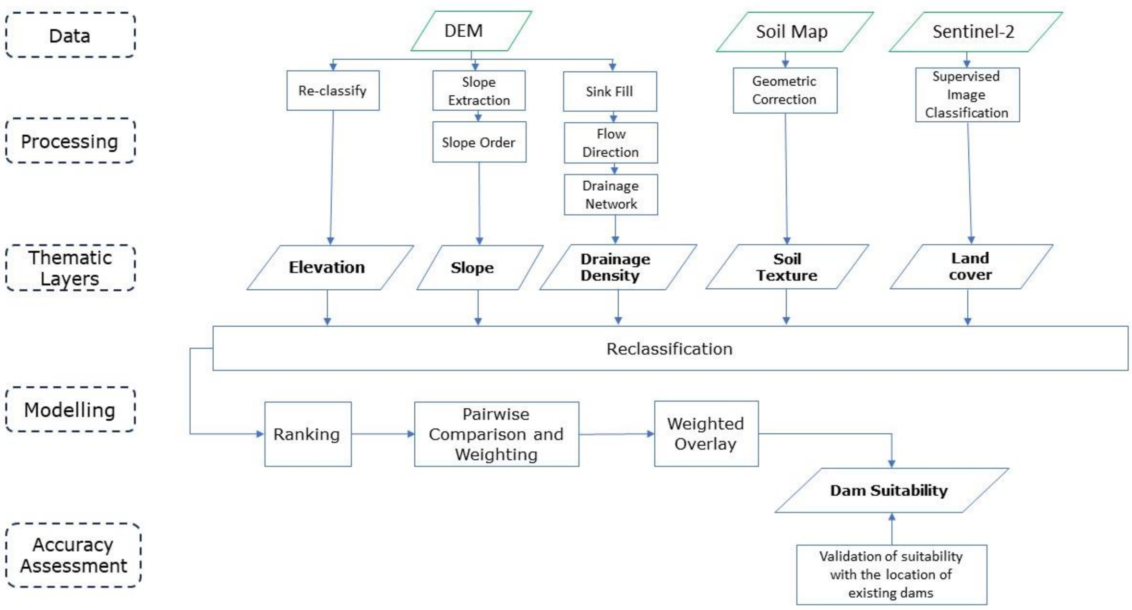

Figure 2. Methodology framework

For the land cover map, the optical (B, G, R) and NIR bands of the sentinel-2 image were used to make a composite image, training signatures were created using authors' knowledge of the study area and Google Earth imagery, and maximum likelihood classification algorithm was used for the supervised land cover classification. To ensure uniformity across layers and enable subsequent Weighted Overlay Analysis (WOA), the initial soil texture layer, initially presented as a vector, was transformed into a raster format. Concurrently, all thematic layers were subjected to reprojection using the WGS84 UTM 31N projected coordinate system, and they were re-sampled to a 10 m resolution to generate seamlessly clipped layers encompassing the complete study area.

2.3.2 Criteria Ranking

Each of these five layers was reclassified into discrete classes (1-5) using the reclassify tool in ArcGIS Pro. For the continuous surfaces, the intervals for the thematic layers were determined using the natural breaks jenk as used by (Luís & Cabral, 2021). The preference values correspond to the levels of the suitability of the sub-criterion of each layer for mini dam selection. The higher the class value, the more suitable for a mini dam site selection; the maximum preference value (5) was ranked highly suitable for the location of a dam site, and the minimum preference value (1) was ranked least suitable for the location of a dam site (Table 2). These five levels of suitability have also been used in previous studies on dam site selection to rank criteria (Luís & Cabral, 2021; Njiru & Siriba, 2018).

Table 2. Ranking explanation

Preference Value	Suitability
1	Not Suitable
2	Least Suitable
3	Marginally Suitable
4	Suitable
5	Highly Suitable

2.3.3 Pairwise Comparison Matrix and Weighting

The steps in AHP involve stating the problem, developing a hierarchical structure, determining the relative importance of attributes (pair-wise comparison) using Saaty's scale, calculating the relative weights, checking the consistency, and obtaining the total weights and overall rating (Saaty, 1990). A pairwise comparison matrix was created based on the relative importance of each thematic layer to the selection of a dam site. Each layer was ranked against the other layers on a scale of 1 to 9. 1 represents equal importance of two layers and 9 means uppermost importance of a layer over another layer (Saaty, 1987). The ranking and pairwise comparison of the criteria in this study was done using rankings from previous studies (Karakuş & Yıldız, 2022; Shao et al., 2020; Njiru & Siriba, 2018) where experts' opinions were used. The AHP analysis was done using the AHP calculator (Goepel, 2018) and the validity of the AHP was evaluated by calculating the consistency ratio (CR) (equation 2) using the consistency index (CI) (equation 1). The consistency ratio (CR) is a measure of the consistency of the square matrix. To compute the CR, the consistency index (CI), a measure of departure from consistency, was calculated using equation 1. Then CR was computed using equation 2.

$$CI = (\lambda - n)/(n - 1) \quad (1)$$

n = number of criteria. λ = average value of the consistency vector (Principal Eigen value). λ = Relative criteria weights / weighted sum vector. RI = Random Index.

$$CR = CI\ /\ RI \quad (2)$$

2.3.4 Mini dam Suitability

Weighted Sum (a spatial analyst tool) in ArcGIS Pro was used to multiply the weights with each raster layer and combine all the resulting layers to produce a suitability map depicting areas suitable for sitting mini dams within the study area. The suitable areas were divided into five classes: highly suitability, suitable, marginally suitability, least suitability, and not suitability.

2.3.5 Result Validation

For the validation of the dam suitability map, the location of the existing dams, which are located at the university's research farms, were overlaid on the suitability map. Furthermore, the existing dams were digitized from Google Earth Imagery as polygons. Twenty random points were created for each polygon and the corresponding values of the suitability layer were extracted for these points using the "Extract Values to Points" tool in ArcGIS Pro. The location of existing dams for validating suitability maps has been used in previous studies (Jozaghi et al., 2018; Luís & Cabral, 2021).

3. Results and Discussion

The results of the geoprocessing operations, reclassifications, weighting of the criteria, AHP ranking, and the overall weighted overlay operation are presented with explanations.

3.1 Thematic Layers and Mini Dam Site Suitability Criteria

3.1.1 Drainage Density

Drainage density reveals information about permeability and surface runoff of areas. The dry areas are those areas with low values of drainage density, while areas with high drainage density values are wet areas (Figure 3a). The preference values for drainage density are shown in Table 3 and the reclassified map is shown in Figure 3a. Areas with high drainage density have a high groundwater potential and are most suitable for the location of a mini dam site. Drainage density has been given high priority in dam-site selection because it is crucial for dam water storage capacity (Hagos et al., 2022; Karakuş & Yıldız, 2022).

3.1.2 Slope

The slope significantly influences the speed of water flow or velocity within both the drainage channel and the watershed (Rincón et al., 2018). Thus, dams are preferably located on gentle slopes with relatively flat topography because of the high chances of accumulating water and they are less susceptible to flooding or landslides (Njiru & Siriba, 2018). Figure 3b shows the reclassified slope map. In this study, areas with the lowest degree of slope (0–2.142) were given the highest preference value for the location of dam sites, while areas with the highest degree of slope (7.373–16.067) were ranked lowest (Table 3).

3.1.3 Elevation

Elevation is crucial to a dam site selection because of water accumulation. The variation of the elevation in the study area is shown in Table 3. The elevation ranges from 346.001 – 403.0 meters. The higher values are in the northern part. The preference values for the sub-criteria of the elevation layer are shown in Figure 3c. Areas with lower elevations are most suitable for a mini dam site because of natural water accumulation, simplified construction, sediment trapping and catchment area advantages (Al-Ruzouq et al., 2019b). Therefore, lower elevations were ranked 5, which is the highest preference value for the location of a mini dam site. Conversely, areas with high elevation values were ranked least suitable.

3.1.4 Soil Texture

Particle sizes in the soil affect the soil water-holding capacity and soil plays a significant role in the linkage between surface water features and groundwater recharge. Preference values were assigned to soil types based on their infiltration rates (Dai, 2016), which have a strong relationship with their water holding capacity, groundwater movement and recharge potential. As shown in Table 3, the clay soil ranked highest in the unified preference value table because it has the lowest infiltration rate, and the location of each preference value of soil texture within FUTA is shown in Figure 3d.

3.1.5 Land Cover

The land cover map is grouped into 5 classes, which are bare soil, light vegetation, forest/bushland, built-up environment, and water (Table 3). Bare soil and vegetation are the preferred land cover classes for dam site selection (Karakuş & Yıldız, 2022). Because of safety and avoiding economic loss from the potential destruction of existing structures and properties, the built environment was considered not suitable. Also, the bare soil such as unpaved roads are mainly located within the built-up areas, so they were also considered not suitable. Water bodies, which are mainly the existing dams were ranked highest with a score of 5 as highly suitable for dam site location (Figure 3e).

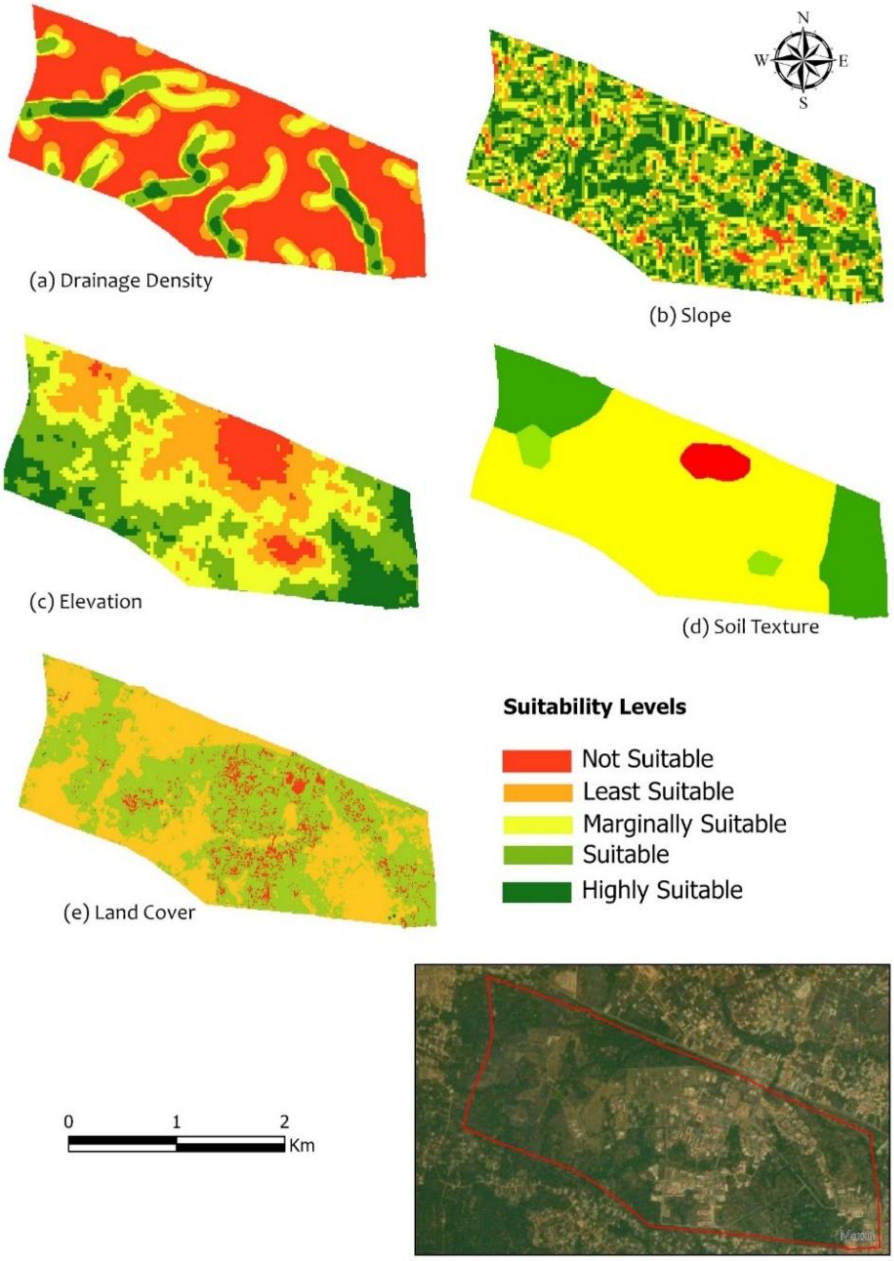

Figure 3. Reclassified thematic layers

3.2 Analytical Hierarchy Process (AHP)

The criteria weights are shown in Table 3 and Pairwise Comparison Matrix is shown in Table 4. The normalized pair-wise matrix is computed by dividing all the elements of the column by the sum of the columns. The Relative Criterion Weights (RCW) is calculated by averaging all the elements in the rows of the normalized matrix.

Table 3. Criteria ranking and weighting

Criteria	Weight (%)	Rank	Sub-Criterion	Preference Value
Drainage Density	34.0	1	0.001 – 1.811	1
			1.812 – 5.433	2
			5.434 – 10.362	3
			10.363 – 16.398	4
			16.399 – 25.654	5
Elevation (m)	28.0	2	346.001 – 364	5
			364.001 – 371	4
			371.001 – 378	3
			378.001 – 387	2
			387.001 – 403	1
Slope (°)	15.1	3	0.001 – 2.142 (Gentle)	5
			2.143 – 3.591 (Moderate)	4
			3.592 – 5.167 (Steep)	3
			5.168 – 7.372 (Very Steep)	2
			7.373 – 16.067	1
Soil Texture	14.2	4	Sandy Clay	3
			Clay	4
			Sand	1
			Clayey Sand	2
LULC	8.6	5	Bare Soil	1
			Light Vegetation	4
			Bushland / Forest cover	2
			Built-up / Road	1
			Water	5

Table 4. Pairwise Comparison Matrix

	Drainage Density (C1)	Slope (C2)	Elevation (C3)	Soil Texture (C4)	Land Cover (C5)
Drainage Density (C1)	1	2	2	3	3
Slope (C4)	0.50	1	2	3	3
Elevation (C3)	0.50	0.50	1	1	2
Soil Texture (C4)	0.50	0.33	1	1	2
Land Cover (C5)	0.33	0.33	0.50	0.50	1

The consistency ratio (CR), a measure of the consistency of the square matrix, should be less than 10% for the judgment to be considered valid (Saaty, 2008).

Table 5. Random index (RI) used to compute CR (Saaty, 2008)

Number of criteria	1	2	3	4	5	6	7	8	9	10
Random Index (RI)	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

Sum of consistency vector = 25.62

$\lambda = 25.62 / 5 = 5.12$

In this study, n = number of criteria = 6. λ = average value of the consistency vector. Using the formula in equation (1)

$$CI = \frac{5.12 - 5}{5-1} = 0.031$$

The Consistency Ratio (CR) was calculated using equation (2). RI is the random inconsistency index. The value of RI (1.12) is determined from Table 5.

$$CR = \frac{0.031}{1.12} = 0.0278$$

Thus, the square matrix is consistent because the computed CR is less than 10% i.e. (0.0278 < 0.1). So, the criteria weights can be used for the selection of the mini dam sites.

3.3 Dam Suitability Map and Selection of Mini Dam Sites

A suitability map showing areas with five levels of suitability and a chart showing the area of coverage of each suitability level are shown in Figure 4 and Figure 5, respectively. The highly suitable areas are mainly in the eastern part and partly in the western parts, where the existing dams are located. The northern and central parts of the study area are not suitable for a dam site and the southern part has a very low suitability level for a mini dam site (Figure 4). The lack of suitability of the northern and central parts of the study area can be attributed to the dominance of built-up areas with high elevation and low drainage density. 90.16 ha (17%) of the study area are "not suitable" for a mini dam at all, a larger part of the study area 142.40 ha (26%) "least suitable" for a mini dam, closely followed by "marginally suitable" areas with 163.43 ha (30%). The "suitable" areas cover 95.68 ha (18%), and only 47.71 ha (9%) of the study area is highly suitable for mini dam location (Figures 6a & 6b). The suitable areas have high drainage density and are in the runoff receiving places characterized by low elevation and gentle slope and mainly covered with clay soil. This result is consistent with the findings of Hagos et al. (2022) and Karakuş & Yıldız (2022), where areas with high drainage/stream density were found to be most suitable for a dam site.

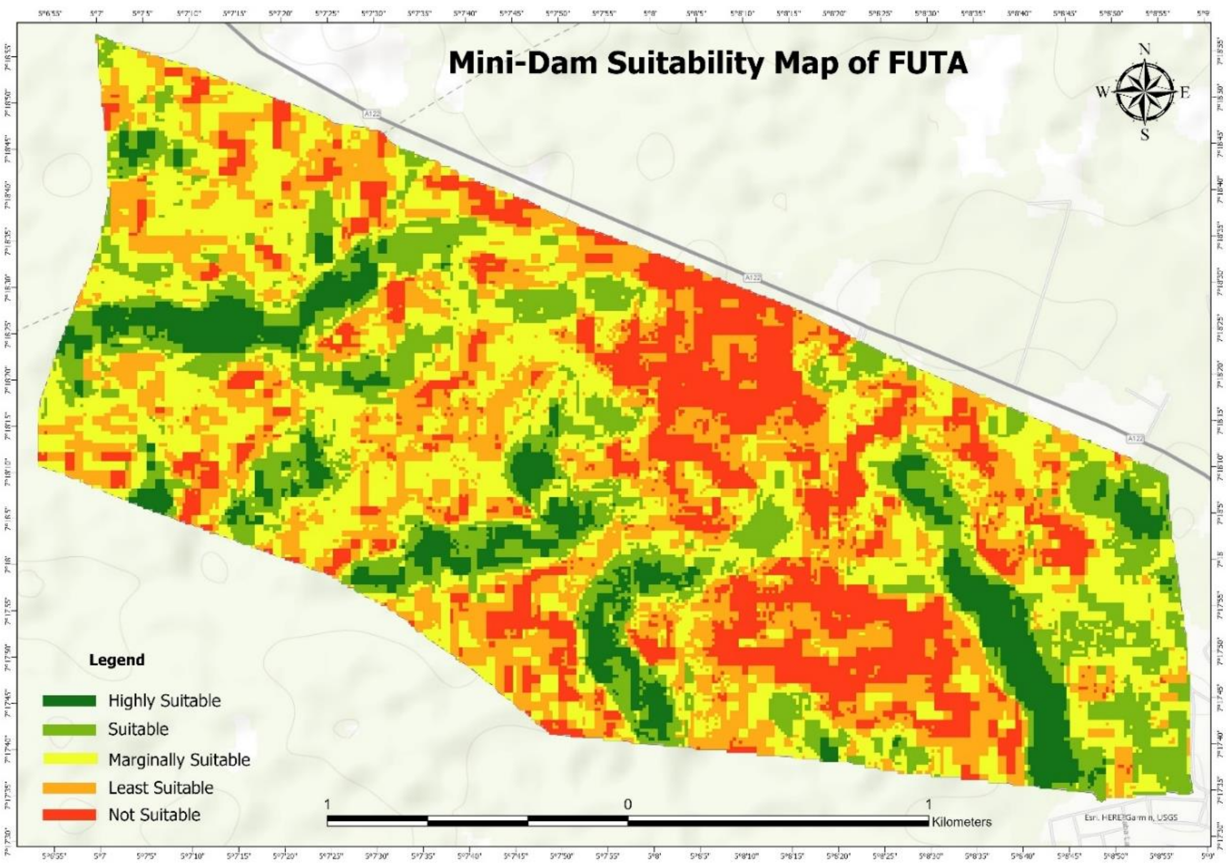

Figure 4. Mini dam suitability map

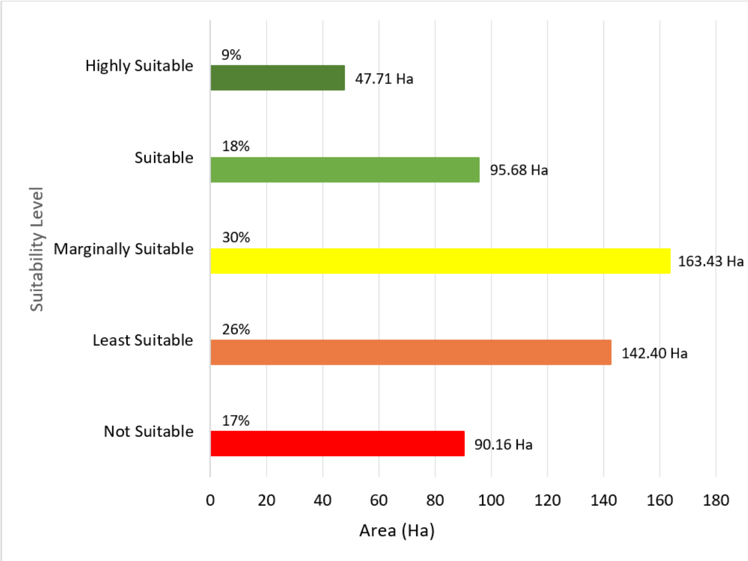

Figure 5. Areas of suitability levels for min-dam location in FUTA

3.4 Validation of the Result

The locations of the two existing dams in the study area, which are located at the university's research farms (Obakekere and Obanla) are overlaid on the suitability map (Figure 6). The existing dam site at the Obanla farm is located at longitude 5.122951° and latitude 7.306256°, while the geographical location of the dam at the Obakekere area is 5.145496°, 7.293657°. The dam in Obakekere has two segments, so two polygons were created for this dam (Figure 6b-d & 8). All the 20 points in Obakekere dam1 fall in "highly suitable" areas while 18 out of the 20 points inside Obakekere dam2 fall in "highly suitable" areas (Figure 7). The presence of water in Obakekere dam has remained relatively the same from 2018-2022 (Figure 6b & c). For the other existing dam, which is the Obanla dam, only 1 point falls in the "highly suitable" area while the remaining points are "suitable" or "marginally suitable" area (Figure 7), this explains the reason why the dam shrank extremely in 2022 and almost going into extinction (Figure 6e-f & 8).

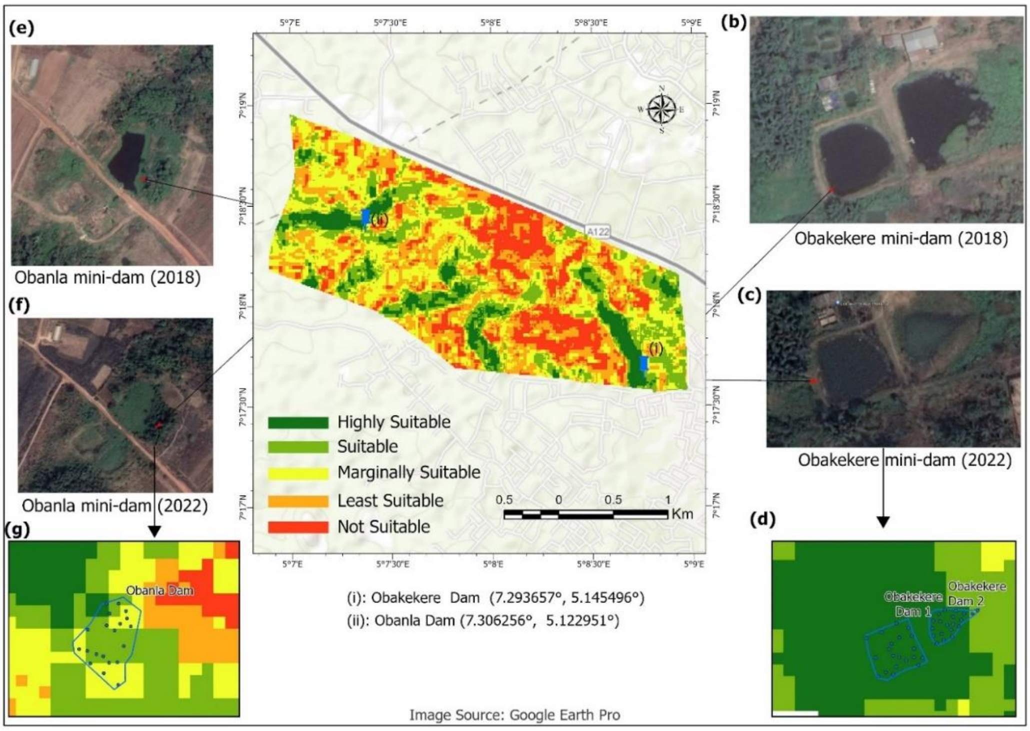

Figure 6. Validation of the suitability of mini dam locations

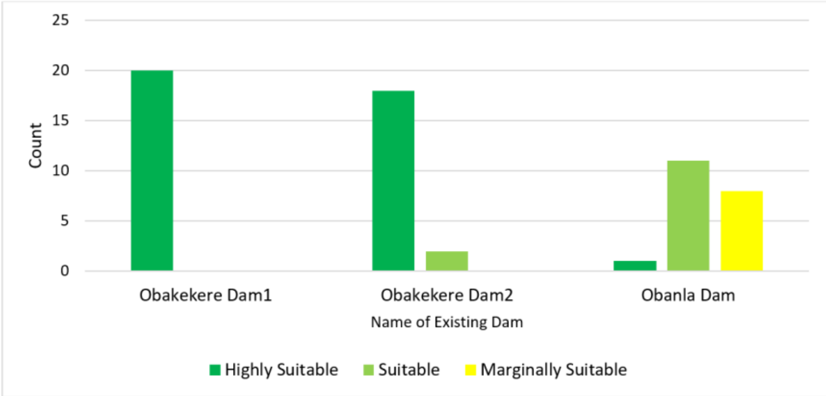

Figure 7. Validation of dam site suitability map using random points inside existing dams

Figure 8. a) Obanla mini dam, and b) Obakekere mini dam (Source: Authors, 18/10/2023)

4. Conclusion and Recommendation

Locating optimum mini dam sites involves consideration of different criteria. Thus, AHP was used in this study to provide a suitable location for a mini dam site for a relatively small study area using five criteria. The results of this process and the standardized thematic layers of the criteria were integrated using ArcGIS to generate a map that shows the potential mini dam sites with five levels of suitability. The suitability map revealed that the area with the highest suitability for locating a mini dam is the eastern and western parts of the university, which covers just 9% of the study area. Most of the potential areas for mini dams are in downstream areas, the runoff receiving places of the study area, which is mainly covered with clay soil. It is worth noting that the weighted overlay result is highly influenced by the drainage density, and a similar result was observed in a study by Karakuş & Yıldız (2022).

The GIS-based MCDA employed in this research for a relatively small study region provides an objective result to indicate areas suitable for locating a min-dam, it is important to state that a few parts of the built-up areas were adjudged to be fit for siting a mini dam. Thus, there is a need for more defined ground investigation and on-site geophysical surveys on suitable sites when the decision to construct a mini dam in the study area is made in the future. With the growing population at the Federal University of Technology, Akure, the construction of a mini dam is crucial. The result of this study is a valuable contribution towards improving water resources and future development planning as it will serve as a fundamental guide for mini dam construction in FUTA. Further study could include more criteria to improve the judgment of the methodology used in this study.

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