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DAM SUITABILITY ANALYSIS USING AN INTEGRATED GEOSPATIAL ANALYTICS, AND MULTI-CRITERIA DECISION ANALYSIS-ANALYTICAL HIERARCHICAL PROCESS (MCDA-AHP) ANALYSIS FOR OGBESE RIVER BASIN

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Abstract

This study uses an integrated GIS-based Multi-Criteria Decision Analysis (MCDA) approach, employing the Analytic Hierarchy Process (AHP), to assess dam site suitability within the Ogbese River Catchment in Ado-Ekiti, Nigeria. The aim was to find the best locations for dam construction that can sustainably address the critical water scarcity issues impacting the Federal Polytechnic Ado-Ekiti and surrounding communities. Six thematic layers—geology, soil type, elevation, slope, drainage density, and land use/land cover (LULC)—were analyzed and weighted based on their influence on dam suitability. Geology (27%) and soil type (21%) emerged as the most significant factors. Using ARCGIS Pro 3.4, a raster-based suitability map was generated, then converted to vector format to enable spatial overlay and precise identification of potential dam sites. A 500-meter buffer was applied around each suitable location to minimize risks to nearby built-up areas and support sustainable land planning. Results showed that only 3.74% of the area is highly suitable for dam construction. The integration of GIS and AHP provides a robust, data-driven framework for better infrastructure planning. The study concludes that choosing appropriate sites for dam construction can greatly improve water availability, and future planning should include detailed feasibility studies, community participation, and climate resilience strategies.

Keywords: Dam, Ogbese, River Basin, Geospatial Analytics, Multi-Criteria Decision (MCDA), Analytical Hierarchical Process (AHP)

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1. Introduction

Water accessibility is increasingly threatened by rapid urbanization, population growth, and climate change, posing significant challenges to sustainable water management. These factors exacerbate water scarcity, degrade water quality, and increase competition for limited resources. The finite nature of freshwater resources, coupled with these pressures, necessitates innovative strategies to ensure water security for future generations (Cassardo, 2014; Halmaghi & Moşteanu, 2019). In Nigeria and across Africa, water scarcity has become a serious issue, worsened by poorly planned urban development, weak regulatory frameworks, and limited access to sustainable water sources (Adeoti et al., 2023; Jideonwo, 2014). Seasonal rainfall patterns and the region's distinct tropical climate further highlight the importance of efficient water storage infrastructure (Shalizi, 2008). In Nigeria, where the demand for clean, reliable water continues to grow, the country faces significant challenges in providing access to clean and safe water, despite having abundant water resources. These challenges stem from a combination of factors, including inadequate infrastructure, pollution, lack of proper management, and the impacts of climate change. Nigeria has an abundance of water resources, but improving access to them is a major concern because of the quickly expanding demand brought on by urbanization, high population growth, and higher living standards brought on by economic expansion. Due to competing water uses, reduced irrigation potential, deteriorating watersheds and water courses, fragmented and uncoordinated development of water resources, inadequate data, and a lack of collaboration on co-riparian use of international waters, this demand surge is resulting in water shortages in both urban and rural areas (Isukuru et al., 2024; Ngene et al., 2021).

There is a need for effective water management and innovative storage solutions is especially urgent in Ekiti State. To address these issues, constructing dams has become a practical solution to boost water supply for domestic, agricultural, and industrial purposes. Building a dam at the Federal Polytechnic, Ado-Ekiti, would offer numerous benefits, such as providing reliable access to clean water for daily activities. A well-designed dam can supply a steady flow of water to students and staff, ensuring safe drinking water, supporting irrigation for school gardens, and enabling laboratory experiments. Additionally, incorporating water conservation and management practices within the school promotes environmental awareness among students, fostering a mindset geared toward sustainable water use. Traditionally, the process of selecting dam locations in Nigeria has depended on conventional decision-making approaches, often swayed by political factors. Nevertheless, the emergence of Geospatial Analytics has transformed the identification of optimal sites for dams. These technologies, alongside analytical hierarchical processes (AHP), fuzzy logic, and applications of artificial intelligence, allow for a thorough evaluation of hydrological factors, terrain features, and environmental consequences (Al-Ruzouq et al., 2019). Water scarcity remains a serious challenge at the Federal Polytechnic, Ado-Ekiti, disrupting both academic activities and daily campus operations. Like many other institutions in

Ekiti State, it faces inconsistent water supply, which negatively affects sanitation, laboratory work, agricultural research, and student welfare. Without a sustainable water storage solution, the Polytechnic risks significant disruptions to vital services, ultimately impacting the quality of education and the well-being of students and staff. This study aims to evaluate the feasibility of building a dam in the Ogbese River Basin as a sustainable, long-term solution to the institution's water supply problems. The study will therefore leverage Geospatial Analytics and Multi-Criteria Decision Analysis-Analytical Hierarchical Process (MCDM-AHP) analysis to identify an optimal site to enhance water supply for Federal Polytechnic, Ado-Ekiti, and its surrounding community that will further improve water resource management and contribute to long-term sustainability.

Conceptual Framework

The conceptual framework for this study is based on the integration of Geographic Information Systems (GIS), Remote Sensing (RS), and Multi-Criteria Decision Analysis (MCDA), particularly the Analytic Hierarchy Process (AHP), to determine suitable dam locations within the River Ogbese Catchment. A crucial step in the strategic planning for the construction of dams, which are essential infrastructures for managing water resources, is dam suitability mapping. Geospatial Analytics play a crucial role in dam site selection by providing spatial data that aids in evaluating the suitability of different locations (Ibitoye & Ajeyomi, 2024; Luís & Cabral, 2021). Remote sensing technologies, including high-resolution satellite imagery and Digital Elevation Models (DEMs), play a crucial role in assessing topography, slope, and drainage patterns, which are essential for identifying potential dam sites. These technologies provide a comprehensive geospatial data foundation that aids in selecting suitable dam locations by analyzing various environmental and geological factors. The integration of remote sensing with Geographic Information Systems (GIS) enhances the ability to evaluate and visualize these factors effectively (Adamo et al., 2021). GIS facilitates multi-criteria analysis by integrating various spatial datasets, including geological stability, water availability, and proximity to settlements, ensuring optimal site selection. The combination of Geospatial Analytics and MCDA-AHP enhances decision-making by assigning weights to various factors, such as soil permeability, land cover, and hydrological flow, thereby improving the accuracy of dam location assessment (Ajibade et al., 2020; Malczewski, 2006a; Wang et al., 2021)

Review of the Dam Suitability Analysis

Biwott et al.(2023) analysed potential sites for dam construction aimed at water harvesting within the Kapseret Sub-County, located in Uasin Gishu County, Kenya. A comprehensive multiple criteria analysis coupled with

weighted overlay techniques was executed using ArcGIS to delineate suitable locations for dam establishment. The criteria employed in the site suitability assessment encompassed land use and land cover (LULC), topographical slope, and proximity to water bodies, educational institutions, transportation routes, and airports. A Digital Elevation Model (DEM) with a resolution of 30 meters was procured from the United States Geological Survey (USGS) website and utilized for the analysis of stream networks, slope gradients, and contour mapping. Landsat 8 satellite imagery captured in January 2022 was also obtained from the USGS website and employed to produce the LULC data. The findings indicated that the Kapseret basin encompasses moderate to highly favorable zones for dam placement, representing 74.66% of the total area, while only 25.34% of the land was classified as unsuitable. Additional contour analysis revealed four viable dam sites, collectively possessing a storage capacity of 3,436,500 m^3. The research concluded that the potential for water harvesting within the region is substantial, as a considerable proportion of the land is generally conducive to dam construction. It was advocated that proactive measures be undertaken by the county authorities and relevant stakeholders to facilitate the development of dams in identified suitable areas, thereby enhancing water accessibility, particularly during the dry season when shortages are prevalent. In meeting the demand for water constitutes a fundamental component for the maintenance of standard human living conditions, the advancement of industrial sectors, and the progression of agricultural development. The primary challenges faced by developing nations situated in arid regions encompass unregulated urban expansion and constrained water availability. The identification and establishment of dams represent a strategic imperative for nations aiming to conserve and allocate water resources. Recent progress in the realms of remote sensing, geographic information systems (GIS), and machine learning (ML) methodologies furnishes essential instruments for the generation of a dam site suitability map (DSSM). In this investigation, a hybrid GIS decision-making framework, augmented by an ML algorithm, was devised to ascertain the optimal site for the construction of a new dam in Sharjah, a prominent urban center in the United Arab Emirates. Nine thematic layers were evaluated to formulate the DSSM, which include precipitation, drainage stream density, geomorphology, geological composition, curve number, total dissolved solids elevation, slope, and significant fractures. The weights assigned to the thematic layers were established through the analytical hierarchy process, supported by various ML techniques, where the most effective ML approach was identified as the random forest method, achieving an accuracy rate of 76%. Precipitation and drainage stream density emerged as the most significant determinants influencing the DSSM. The constructed DSSM underwent validation against existing dams within the study area, yielding an accuracy of 83% for dams situated in the high and moderate suitability zones. Three principal sites were recognized as appropriate locations for the establishment of new dams in Sharjah.

The methodology employed in this research can be generalized for application in other global locales to identify prospective sites for dam construction(Al-Ruzouq et al., 2019). Climate change has had a significant impact on Iraq's northern region over the past few decades, resulting in frequent flooding, long-term drought, and a lack of water. Dam construction in suitable sites is a primary water management strategy to solve flood and drought. The selection of a dam site is determined by a collection of qualitative and quantitative factors like geology, soil type, and elevation. Remote sensing, a geographic information system (GIS), and multi-criteria decision making were used in this study to identify suitable dam site selection areas for water management. In addition, the conventional analytic hierarchy process (AHP) was contrasted with the proposed method of site suitability for evaluation. The local government had previously suggested a novel validation technique for evaluating the accuracy of AHP and fuzzy logic based on the predetermined location of a dam in the study area (Bekhme dam). Twelve conditioning factors were derived from field/reference maps and remote sensing data (Landsat imageries and ASTER DEM) in order to create a construction-suitability map. Geological formation, soil type, tectonic line, fault line, altitude, slope, rainfall data (2000–2011), water discharge, land use/cover, road network, and dam construction material were all taken into consideration. This study utilized AHP and fuzzy logic as two mathematical models. Based on the proposed dam site (Bekhme dam), location and cluster-based accuracy assessments were used to select the best model. The outcomes demonstrated that fuzzy logic is superior to AHP. The AHP model identified 13,446,900 m2 as a highly suitable area for the identified suitable lands, while the fuzzy model identified 3,409,200 m2 out of a total area of 69,347,700 m2. In conclusion, the study identified four locations in the study area for intermediate and large dams. When the dam height is 60 meters, the proposed Dams 1, 2, 3, and 4 have total water capacities of approximately 81.5, 239.3, and 646.5 million m3. For similar applications, the proposed methods can be easily applied in other areas. The result demonstrates that the fuzzy model is better suited to clustered areas while the AHP model is dispersed throughout the entire study area (Noori et al., 2019). Using a Geographic Information System (GIS) and the Analytical Hierarchy Process (AHP) method, one of the multi-criteria decision-making (MCDM) techniques, a study conducted in Turkey attempted to identify the best places to build dams within the boundaries of Sivas, Turkey. To choose a dam site, nine factors were taken into

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consideration: elevation, slope, distance to roadways, rainfall, lineament density, distance to residential areas, land use/land cover, soil types, and stream density. For the factors taken into account when choosing the dam site within the parameters of the AHP approach, the CR (Consistency) value was computed as 0.054, and this value demonstrated that the outcomes were acceptable and consistent (Karakuş & Yıldız, 2022).

Ethiopia, the second most populous country in Africa after Nigeria, is largely a low-productivity rural community that depends largely on rain-fed agriculture. More efficient water conservation techniques are required due to population growth, global warming, and water scarcity. Consequently, there is a sharp rise in the need for dams to ensure food security. This study aimed to find possible locations for multipurpose dam building using remote sensing and geographic information system (GIS) techniques, the dam suitability stream model, and multi-criteria decision analysis. The model's suitability stream and overall suitability output maps were proposed and assessed in light of the study's six influencing factors for selecting appropriate dam locations. The findings indicated that three planned dam locations in the upper portion of the watershed are probably better for irrigation, fishing, and the provision of clean drinking water due to the topography and land usage. However, the three suggested dam locations in the lower sections of the watershed are more suitable for producing hydropower. Additionally, decision-makers can construct, modify, and maintain pertinent thematic layers using remote sensing and GIS, which makes them helpful in the selection of dam/reservoir sites (Hagos et al., 2022). Check dams are used as effective surface water harvesting structures at the watershed scale to manage flooding, runoff, and soil erosion. Nonetheless, determining the best sites for check dams is still quite difficult. The goal of this project was to produce a GIS-based map that would aid in the selection of appropriate check dam locations in Morocco's Khenifra province. The chosen approach makes use of a multi-criteria decision analysis (MCDA) that is coupled with a geographic information system (GIS). The suitability model was developed using DEM-derived variables, including the slope (S), drainage density (DD), stream order (SO), stream power index (SPI), topographic wetness index (TWI), sediment transport index (STI), terrain roughness index (TRI), and topographic position index (TPI). The accuracy of the approach is assessed using the area under the curve (AUC) and the receiver operating characteristic curve (ROC). The generated map perfectly matches the study region's flood-prone depression zones and displays sites in high and very high suitability classes along 51.5 percent of the stream's overall length in the drainage area. Furthermore, great accuracy is attained for depressions deeper than five meters. Some examples of appropriate locations have storage capacity ranging from over 500,000 m3 to over 200,000 m3. Land suitability mapping is, therefore, an easy and affordable method that promotes sustainable development among decision makers. (Abbasi et al., 2019). In Nasarawa State, Nigeria, a GIS-based Analytic Hierarchical Process (AHP) approach called Multi-criteria Evaluation (MCE) was used, with 10 criteria, including amount of precipitation, slope, geology, type of soil, distance from crop land to road, distance from road, pH of soil, drainage order, distance to the lineament, and land cover. The subject matter of the study was classified as moderately suitable (30%), unsuitable (18%), and highly unsuitable (5%). (30%), and extremely suitable (17%) for the construction of dams in a wide range of conditions, and with all selected dams within the lower part of the downstream. There were fourteen (14) potential dam sites. Six of the dams were found to be in ideal locations, while seven and one dams were respectively, on areas that are suitable and moderately suitable. According to the study, about 77% of the study area contains potential dam locations, albeit at varying levels of suitability (Ibitoye & Ajeyomi, 2024). Another study used Geographic Information Systems (GIS) and Multi-Criteria Decision Analysis (MCDA) to evaluate dam suitability along the Salt River in the Phoenix metropolitan area, Arizona. By analyzing river channel morphology dynamics from 1935 to 1997, we identify key factors influencing dam site selection, including flood impacts, sediment extraction zones, and urban expansion patterns. GIS-derived spatial data—such as low-flow/high-flow channels, engineered surfaces, and sediment mining areas—were processed into thematic layers, including flood recurrence, bedrock stability, sediment load, and anthropogenic activity. MCDA techniques, incorporating criteria weights for hydrologic, geologic, and socio-economic factors, reveal that reaches with persistent channel locations constrained by bedrock or sinuosity are optimal for dam placement due to structural stability. Conversely, zones with extensive gravel extraction (exceeding 70% active channel area) or frequent channel migration (linked to gentle gradients or flow separation) are deemed unsuitable due to sediment instability and flood risks. Probabilistic models of historical fluvial features further inform predictions of future channel behavior, ensuring alignment with urban development needs while minimizing environmental disruption. Results highlight the efficacy of combining GIS-based spatial probability mapping with MCDA to balance engineering feasibility, environmental resilience, and socio-economic demands in dam planning. This approach provides a scalable framework for prioritizing dam sites in dynamic fluvial systems influenced by both natural and anthropogenic forces (Graf, 2015). Dams assume an indispensable function in the stewardship of water resources by overseeing their spatial and temporal allocation, with judicious site selection being crucial to their operational efficacy. This investigation assesses the suitability mapping of dams within Finland, utilizing Geographic Information Systems (GIS) and Multi-Criteria Decision Analysis (MCDA) to scrutinize methodologies for site selection and the factors influencing them. An examination of the literature about dam siting over the preceding two decades has illuminated three principal methodological paradigms: (1)

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GIS/remote sensing (RS)-based techniques, which demonstrate proficiency in the acquisition of spatial data and environmental assessment; (2) MCDA and integrated MCDA-GIS frameworks, which methodically evaluate multi-factor relationships encompassing ecological, hydrological, and socio-economic determinants; and (3) machine learning methodologies, which adeptly analyze intricate datasets for predictive modeling. In the context of Finland, the factors pertinent to site selection exhibit considerable variation contingent upon the function of the dam: irrigation and water supply dams prioritize water quality and nearness to demand zones, hydropower dams accentuate hydrological potential (e.g., flow rates, elevation gradients), and flood control dams prioritize topographical stability and geological appropriateness. The study underscores Finland's distinctive Nordic environmental characteristics—such as its vast lake systems, seasonal hydrology, and sensitive ecosystems—as paramount considerations in the decision-making process regarding siting. Although the extant methodologies display notable merits, deficiencies remain in the integration of interdisciplinary approaches (e.g., amalgamating MCDA with machine learning) and in addressing the emergent functions of dams, such as climate resilience and renewable energy storage. Subsequent research ought to concentrate on hybrid methodologies and context-specific frameworks to reconcile Finland's sustainability aspirations, stakeholder interests, and evolving requirements in water management. This endeavor contributes to the advancement of spatially informed, multi-criteria dam planning in boreal regions, in alignment with global initiatives aimed at sustainable infrastructure development (Wang et al., 2021). This review provides a foundation for analyzing dam suitability in the River Ogbese Catchment, integrating hydrological, geological, and decision-making methodologies. The inclusion of GIS, remote sensing, and MCDA techniques ensures a robust framework for selecting optimal dam sites while considering sustainability, hydrological factors, and socioeconomic impacts.

Materials And Methods

Description of Study Area

The River Ogbese Catchment is in Ado-Ekiti. It lies at a latitude and longitude of 7° 45N and 5° 30E, within the tropical rain forest of Ekiti State, Nigeria, extending from Ogbese in Ondo State through the Federal Polytechnic, Ado-Ekiti. It has a tropical climate with wet and dry seasons, and rainfall between 1,200mm and 1,500mm. The terrain is undulating, with basement complex geology influencing water retention. Land use includes agriculture, forests, urban areas, and riparian ecosystems. The region's growing water demand makes it crucial for a dam suitability assessment, ensuring sustainable water management and flood control.

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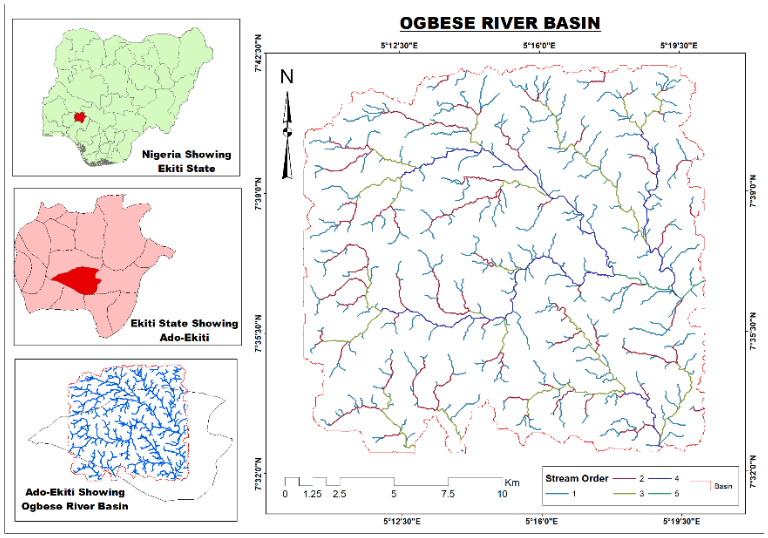

Figure 1: Map showing the Study Area

Methodological Approach

A comprehensive methodology for dam siting involves integrating geological, topographical, hydrological, and socio-economic considerations using Geospatial Analytics and Multi-Criteria Decision Analysis (MCDA). This approach helps identify suitable locations by evaluating factors like topography, climate, hydrology, soil, land use, and proximity to infrastructure, while also assessing geological stability and potential environmental and social impacts (Masi et al., 2024). This study adopted a systematic approach to identifying the most appropriate locations for a dam in the Ogbese River Basin. Table 1 shows the various spatial datasets in vector and raster formats, with different scales and resolutions were sourced and used in the study to create the factors to be included in the MCE modelling in order to achieve the aim of the study. Figure 2 shows the methodology flowchart on how the datasets were then processed and modeled. This study adopts the Multi-Criteria Decision Analysis (MCDA) and Analytic Hierarchy Process (AHP) approach to calculate the weight of each criterion that was selected for this analysis (Saaty, 2013). Geospatial Analytics (weighted overlay), combined with the calculated AHP weight, was used in integrating the various datasets to produce the final suitability map (Malczewski, 2006b, 2006a)

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Table 1: Dataset's requirements, their resolution, and sources

SN	Data	Year	Format	Scale/Resolution	Source
1	Geological Data	2024	Digital	1:250,000	Nigeria Geological Survey Agency
2	Land Use Land Cover	2024	Digital	20 m	Sentinel-2
3	Soil data	2024	Digital	30 arc-second	HWSD/FAO-UNESCO
4	SRTM-DEM	2024	Digital	30 m	https://earthexplorer.usgs.gov

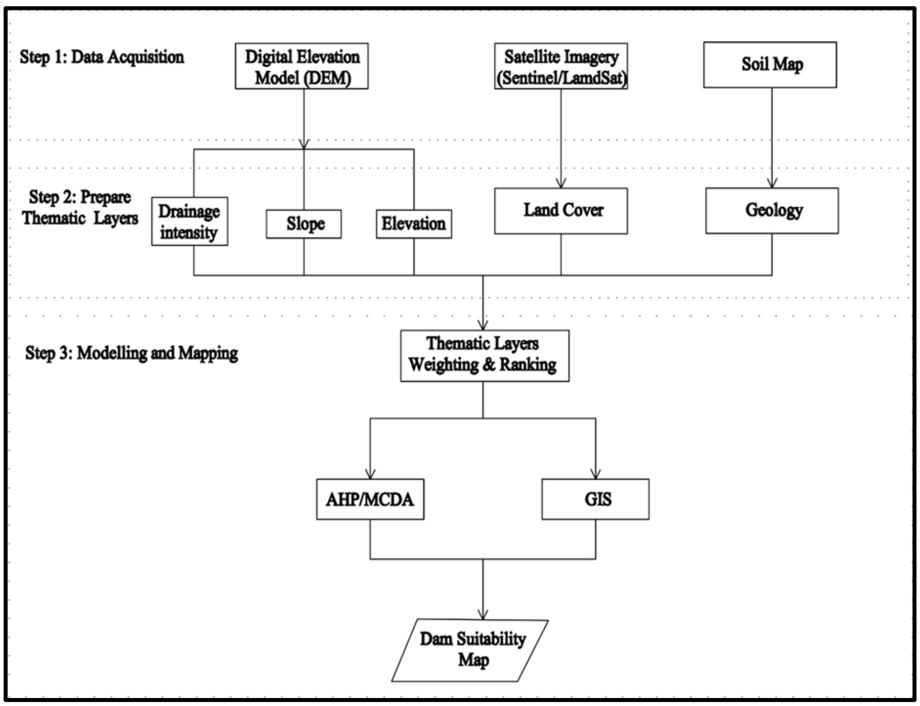

Figure 2: Flowchart showing the research methodology for the study.

Data Processing and Preparation of Thematic Layers

The raw data were processed to generate the thematic layers. Six thematic layers were developed for the study area based on the factors for dam suitability mapping, which include slope, elevation, soil, stream order, geology, and land use. Hydrological parameters that include slope, flow accumulation, stream density, stream network, and altitude will be extracted from the 30m Digital Elevation Model (DEM). Six thematic layers were extracted from the three sets of data obtained for this study. The thematic layers were generated using ArcGIS Pro 3.4 to model and further map the most suitable locations for a dam (Figure 3).

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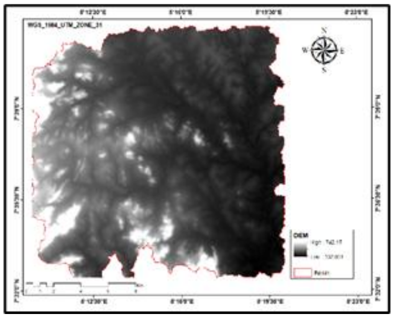
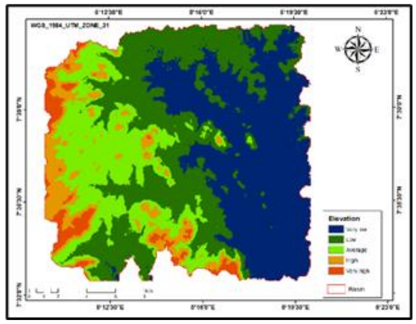
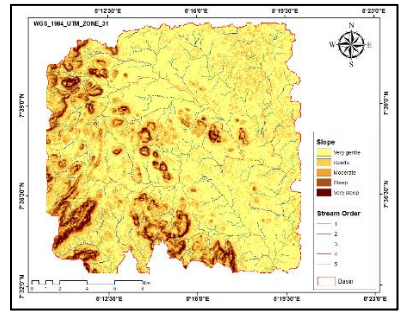
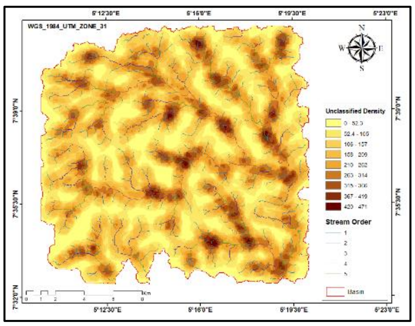
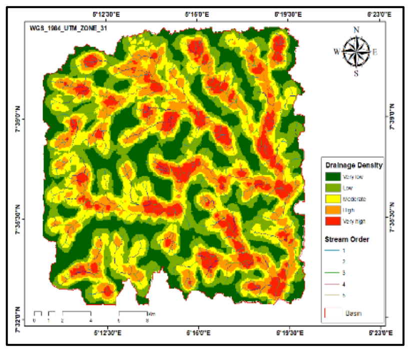
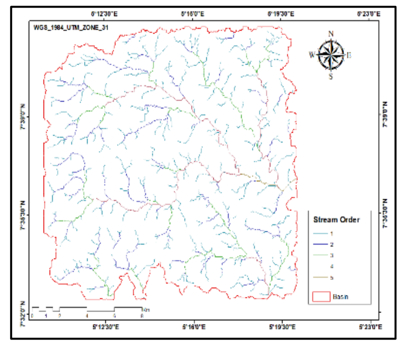

Digital Elevation Model (DEM)

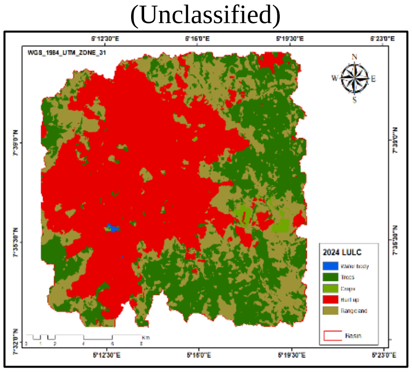

ElevationMap

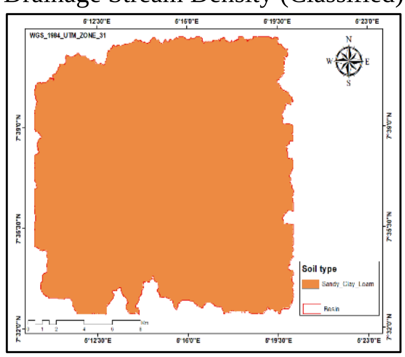

Slope Map


Drainage Stream Density (Unclassified)


Drainage Stream Density (Classified)


Generated Stream Map


Land use / Land cover (LULC)


Soil Map

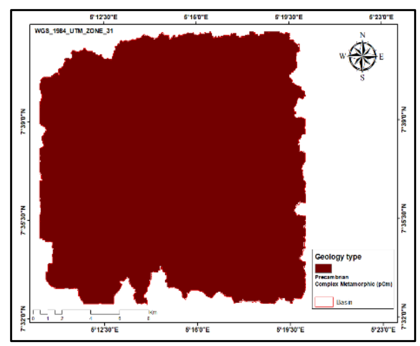

Geological Map

Figure 3: Thematic Layers generated from the study using ArcGIS Pro 3.4

Analytical Hierarchical Process (AHP):

So, the parameters were weighted using a square framework by assigning a value to the diagonal element. The weightage of these parameters then decided the eigenvalue and the corresponding right eigenvector of the AHP correlation grid.

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Table 2: Pairwise Comparison Matrix

Matrix	ELEVATION 1	DRAINAGE DENSITY 2	SOIL TYPE 3	GEOLOGY 4	LULC 5	SLOPE 6	Normalized Principal Eigenvector
ELEVATION 1	1	1	1	1/7	1	7	19.70%
DRAINAGE DENSITY 2	1	1	1/7	1	1	1/7	8.09%
SOIL TYPE 3	1	7	1	1	5	1	20.75%
GEOLOGY 4	7	1	1	1	5	1	28.93%
LULC 5	1	1	1/5	1/5	1	1	7.07%
SLOPE 6	1/7	7	1	1	1	1	15.45%

Table 2 signifies a Pairwise Comparison Matrix used in Analytic Hierarchy Process (AHP) to determine the relative importance (weights) of the six criteria of the study (dam site suitability mapping and analysis). These criteria are: Elevation, Drainage Density, Soil Type, Geology, Land Use/Land Cover (LULC), and Slope; thus, Table 3 illustrates how the thematic layers were ranked and weighted.

Table 3: Ranks and weights

S/N	Thematic Layer	Thematic Layer Weight	Class	Ranks
1	Geology	29%	0	0
			pCm	5
2	Soil Type	21%	Sandy_Clay_Loam	4
3	Elevation	20%	Very low	1
			Low	4
			Moderate	5
			High	3
			Very high	2
4	Slope	15%	Very gentle	5
			Gentle	4
			Moderate	3
			Steep	2
			Very steep	1
5	Drainage Density	8%	Very low	5
			Low	4
			Moderate	3
			High	2
			Very high	1
6	LULC	7%	Water body	5
			Trees	2
			Crops	3
			Built up	1
			Vegetation	4

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The multi-criteria decision analysis (MCDA) process, empowered by the AHP weight assignment, provided a ranked list of these potential dam sites. The criteria, such as proximity to water sources, favorable topography, and acceptable soil permeability, were weighted based on their relative importance, ensuring a data-driven selection process. This aligns with the literature by Ahmed et al. (2021) and Ogunbiyi et al. (2022), who emphasize the crucial role of Geospatial Analytics for site suitability by analyzing terrain, hydrology, land use, and soil characteristics. Figure 4 shows the identified sites for potential dam sites spread across the basin that are significant for water storage capacity, which is crucial for meeting the escalating demand for a clean and reliable water supply in the region. Figure 5 shows the final suitability map. The area was chosen due to proximity to the Federal Polytechnic, Ado-Ekiti,

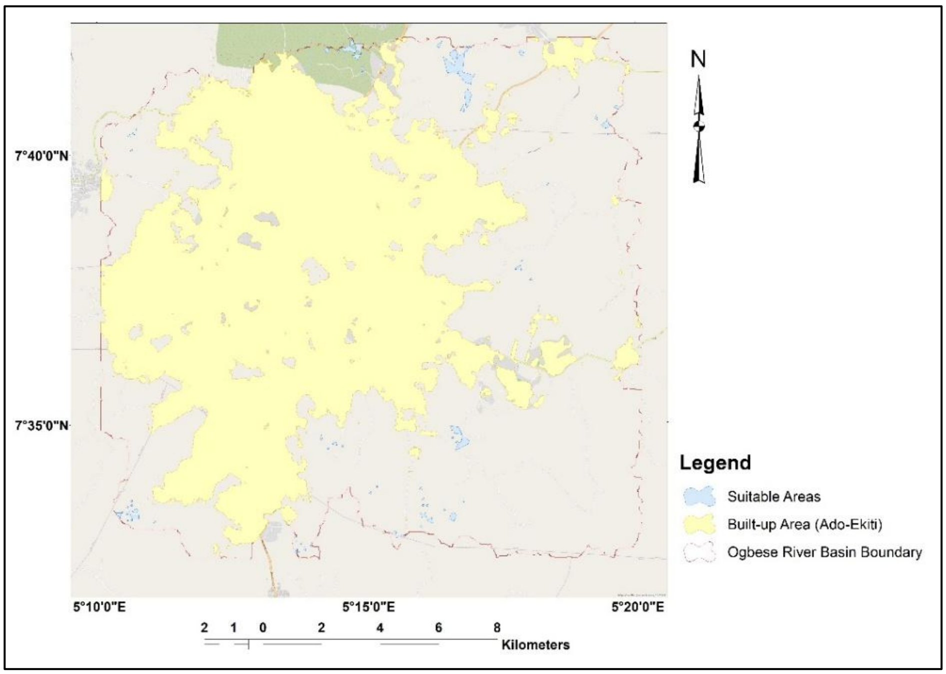

Figure 4: Dam potential locations on the suitability map

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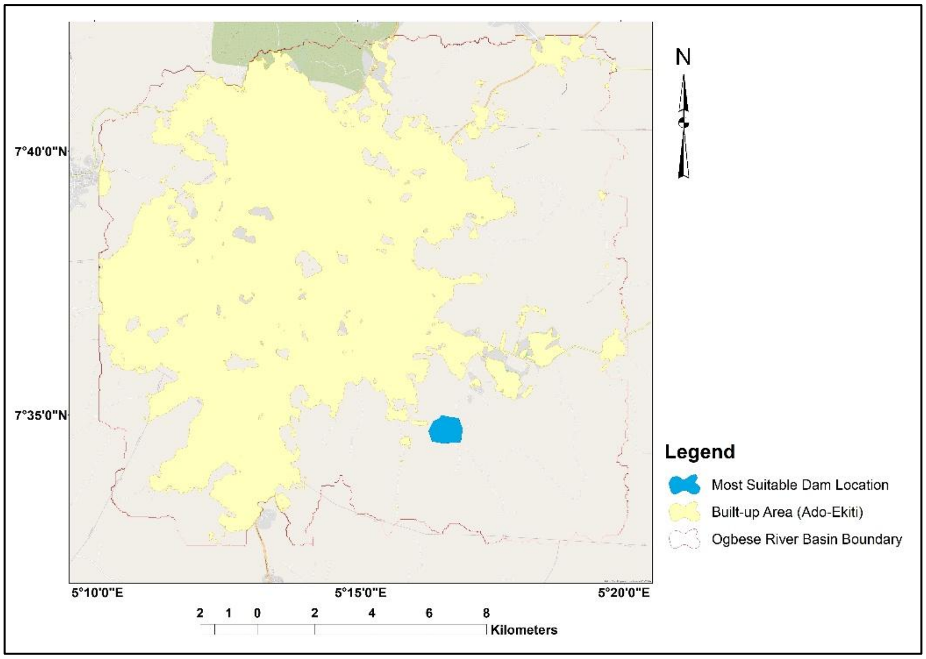

Figure 5: Final Suitability Map

Conclusion

This study aimed to identify suitable dam sites within the Ogbese River Catchment in Ado-Ekiti, Nigeria, utilizing a of integrating Geospatial Analytics with Multi-Criteria Decision Analysis-Analytical Hierarchical Process (MCDM-AHP) analytical approach. The findings provide valuable insights into optimal locations for a dam, offering a sustainable solution to water scarcity at the Federal Polytechnic, Ado-Ekiti, and its surrounding community. The research successfully demonstrated the utility of integrating Geospatial Analytics with Multi-Criteria Decision Analysis-Analytical Hierarchical Process (MCDM-AHP) analytical framework to identify and map suitable dam construction sites within the Ogbese River Catchment in Ado-Ekiti, Nigeria. It also synthesized multiple thematic factors, namely geology, soil type, elevation, slope, drainage density, and land use/land cover, into a weighted model that objectively ranked site suitability. The suitability mapping, derived from the integration of geospatial datasets, revealed areas for dam construction within the Ogbese River Catchment. The identification of optimal dam sites within the Ogbese River Catchment provides a concrete, data-driven solution to the pressing water scarcity challenges faced by the Federal Polytechnic, Ado-Ekiti, and its surrounding community. A strategically located dam will not only ensure a reliable water supply for domestic, academic, and agricultural purposes but also contribute to flood

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control and potentially economic development in the area. This aligns with the overall purpose of the study to enhance water supply and ensure sustainable water management.

Overall, the study provides a replicable geospatial methodology that not only supports infrastructure planning at institutional and regional levels but also contributes to climate adaptation and water resource resilience in semi-urban tropical settings. Based on the findings of this study, the following recommendations are proposed:

i) Conduct Detailed Feasibility Studies: The locations identified as highly suitable should undergo engineering feasibility analyses, including hydrological modeling, soil mechanics testing, seismic assessments, and cost–benefit evaluations to validate technical viability.
ii) Community and Stakeholder Engagement: Active participation from residents, campus authorities, environmental agencies, and policymakers is crucial to ensure transparent planning and socially inclusive implementation.
iii) Institutional Water Management Policy: Federal Polytechnic Ado-Ekiti should develop and implement a campus-wide water management plan that integrates dam infrastructure with rainwater harvesting, boreholes, and efficient water use practices.

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