International Journal of Earth Sciences Knowledge and Applications
journal homepage: http://www.ijeska.com/index.php/ijeska
e-ISSN: 2687-5993

Review Article https://doi.org/10.5281/zenodo.22177138

Systematic Review and Descriptive Meta-Analysis of Oil and Gas Facility Siting in Africa: GIS–MCDA Approaches, Environmental Governance, and Sustainable Land Management

Michael Stanley Peprah[1]*, Edwin Kojo Larbi[2]

[1]School of Mines and Built Environment, University of Energy and Natural Resources, Sunyani, Ghana
[2]Geo-Informatics Division, Building and Road Research Institute (CSIR-BRRI), Kumasi, Ghana

INFORMATION

Article history
Received 26 January 2026
Accepted 27 May 2026
Published 31 August 2026

Contact
*Michael Stanley Peprah
mspeprah91@gmail.com (MSP)

How cite
Peprah, M.S., Larbi, E.K., 2026. Systematic Review and Descriptive Meta-Analysis of Oil and Gas Facility Siting in Africa: GIS–MCDA Approaches, Environmental Governance, and Sustainable Land Management. *International Journal of Earth Sciences Knowledge and Applications* 8 (2), 382–401. https://doi.org/10.5281/zenodo.22177138.

Abstract
This study evaluates the evolving methodologies, environmental implications, and socioeconomic outcomes associated with oil and gas facility siting across Africa, where rapid urbanization, weak institutional enforcement, and environmental vulnerability complicate infrastructure planning. Using PRISMA-guided systematic review procedures, 17,385 records published between 2000 and 2025 were screened, resulting in 40 eligible studies synthesized through descriptive meta-analysis and thematic comparative analysis. The review assessed siting criteria, methodological trends, regulatory compliance, environmental impacts, and socioeconomic outcomes across African subregions. Findings reveal a transition from traditional proximity-based siting approaches toward integrated Geographic Information Systems (GIS) and Multi-Criteria Decision Analysis (MCDA) frameworks. Hybrid models such as Fuzzy AHP–VIKOR increasingly improved uncertainty handling, stakeholder integration, and environmental risk assessment in data-scarce environments. Regional differences were evident. West African studies focused mainly on spatial optimization and compliance assessment, Southern African studies demonstrated stronger integration of Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA) frameworks, while East African studies increasingly emphasized participatory governance and environmental justice. The synthesis identified persistent challenges, including regulatory non-compliance, inadequate longitudinal datasets, fragmented institutional enforcement, and limited real-time environmental monitoring systems. The study further revealed increasing integration of social sustainability indicators such as displacement risk, stakeholder participation, and community acceptance into recent siting frameworks. The review concludes that sustainable oil and gas facilities siting in Africa require integrated, evidence-based, participatory, and regulation-driven spatial planning frameworks. Future siting models should incorporate climate resilience, renewable transition indicators, and adaptive multi-energy infrastructure planning to support sustainable land management and energy development across Africa.

Keywords
Oil and Gas Infrastructure Siting, Systematic Review, Descriptive Meta-Analysis, GIS–MCDA, Environmental Impact Assessment, Spatial Decision-Making

1. Introduction

The siting of oil and gas facilities, defined as the systematic and multi-criteria process of identifying suitable locations for petroleum infrastructure, remains a critical component of sustainable energy development, environmental protection, and land-use planning (Mahmood et al., 2023). Effective facility siting influences operational efficiency, public safety, environmental sustainability, accessibility, and long-term infrastructure resilience. Contemporary siting frameworks increasingly integrate Geographic Information Systems (GIS), Multi-Criteria Decision Analysis (MCDA), Environmental Impact Assessment (EIA), and Strategic Environmental Assessment (SEA) to evaluate spatial, environmental, socioeconomic, and technical suitability factors simultaneously (Peprah et al., 2018; Ngcofe et al., 2025). These approaches provide more transparent, evidence-based, and spatially explicit decision-support systems compared with conventional intuition-driven and proximity-based siting methods.

Africa presents a particularly complex and dynamic context for oil and gas facilities siting because of rapid urbanization, infrastructural deficits, institutional weaknesses, environmental vulnerability, and fragmented land governance systems. Across several African countries, weak regulatory enforcement and poor spatial planning have contributed to widespread non-compliance with safety and environmental standards. Studies from Nigeria and Ghana indicate that large proportions of filling stations fail to comply with prescribed separation distances from residential areas, water bodies, and public facilities, thereby increasing risks of fire outbreaks, explosions, groundwater contamination, congestion, and long-term public health exposure (Yisa et al., 2019; Anang et al., 2021). The 2015 petrol station explosion in Ghana, which caused more than 150 fatalities, illustrates the severe consequences associated with poorly regulated facility siting and inadequate environmental governance (Ngcofe et al., 2025). In addition, customary land tenure systems, urban encroachment, weak infrastructure networks, and inconsistent electricity supply continue to complicate site selection and emergency management processes in many African regions (Ogwang and Vanclay, 2021; Ulakpa et al., 2022).

These challenges position Africa at the intersection of energy security, environmental sustainability, and spatial justice. As the continent continues to expand hydrocarbon exploration, downstream petroleum distribution, liquefied natural gas infrastructure, and transition-energy investments, there is growing pressure to reconcile infrastructure expansion with climate resilience, ecological protection, and sustainable land management objectives (Bridge et al., 2018; Bos and Gupta, 2016). Recent methodological developments have shifted facility siting from conventional economically driven approaches toward integrated GIS–MCDA frameworks capable of simultaneously evaluating environmental sensitivity, accessibility, socioeconomic impacts, regulatory compliance, and stakeholder concerns (Boye and Abubakar, 2019; Ngcofe et al., 2025). Hybrid models such as Fuzzy AHP–VIKOR further improve decision robustness by addressing uncertainty, incomplete datasets, and subjective weighting challenges frequently encountered in African planning environments (Asenso-Gyambibi et al., 2023).

Despite these methodological advancements, substantial research and policy gaps remain. Existing studies are highly fragmented across countries, facility types, and analytical approaches, limiting cross-regional comparison and synthesis. Most studies employ static cross-sectional datasets and proximity-based assessments without integrating longitudinal monitoring, climate variability, real-time environmental indicators, or dynamic urban growth patterns (Zhu et al., 2024). Furthermore, many African siting studies focus predominantly on upstream extraction projects and large-scale energy corridors, while relatively limited attention has been given to downstream fuel distribution networks, retail filling stations, and urban petroleum infrastructure despite their direct implications for public safety and environmental exposure (Hughes et al., 2024; Namaganda et al., 2023). Another persistent challenge is the disconnect between scientific suitability assessments and practical implementation, as many GIS-based recommendations are rarely incorporated into formal land-use planning and regulatory enforcement systems (Peprah et al., 2018).

Methodologically, previous reviews on oil and gas infrastructure siting have largely remained narrative or regionally isolated, with limited comparative synthesis of methodological trends, socioeconomic outcomes, environmental impacts, and governance dimensions across Africa. In addition, few studies have systematically examined the emerging transition from conventional siting approaches toward hybrid GIS–MCDA and sustainability-oriented spatial planning frameworks. The lack of longitudinal and standardized datasets has also constrained the application of conventional pooled-effect statistical meta-analysis, thereby necessitating alternative descriptive and comparative meta-analytical approaches suitable for heterogeneous environmental planning studies.

This study addresses these gaps through a PRISMA-guided systematic review and descriptive meta-analysis of oil and gas facility siting studies conducted across Africa between 2000 and 2025. The study synthesizes evidence from 40 eligible studies to evaluate methodological trends, siting criteria, regulatory compliance patterns, environmental impacts, socioeconomic outcomes, and emerging sustainability considerations associated with petroleum infrastructure development across the continent. Unlike previous reviews, this study integrates comparative regional analysis to examine how siting approaches vary across West, East, and Southern Africa in relation to governance capacity, environmental regulation, participatory planning, and spatial decision-support technologies.

The analysis specifically reveals several emerging trends. First, there has been a significant increase in the adoption of GIS–MCDA and hybrid spatial decision-support models after 2015, indicating a continental methodological transition toward data-driven and sustainability-oriented siting frameworks. Second, Southern African studies demonstrate stronger integration of EIA, SEA, and regulatory enforcement systems, while West African studies predominantly focus on spatial optimization and compliance assessment. Third, East African studies increasingly emphasize stakeholder participation, land rights, and environmental justice dimensions within facility siting decisions. The synthesis additionally identifies growing incorporation of social sustainability indicators such as displacement risk, community acceptance, and participatory governance into recent siting frameworks.

The significance of this study extends beyond methodological synthesis. The findings provide policymakers, planners, and industry practitioners with evidence-based insights for improving environmental governance, regulatory enforcement, spatial planning, and sustainable infrastructure development across Africa. The study further contributes to the broader discourse on sustainable energy transitions by demonstrating how future siting frameworks may increasingly incorporate climate resilience, renewable integration potential, Green Hydrogen (GH_2), Waste-to-Energy (WtE) compatibility, and adaptive multi-energy infrastructure planning within hybrid GIS–MCDA systems.

The next section of this study is organized as follows. Section 2 presents the conceptual and theoretical framework underpinning the study. Section 3 describes the study area, and Section 4 describes the study's methodology, including the PRISMA screening process, descriptive meta-analysis procedures, and comparative thematic synthesis approach. Section 5 presents the results and synthesis of findings, discusses the policy, methodological, and sustainability implications of the study for future oil and gas infrastructure planning in Africa, while Section 6 concludes the study, discusses the limitations of the study and recommends future research directions.

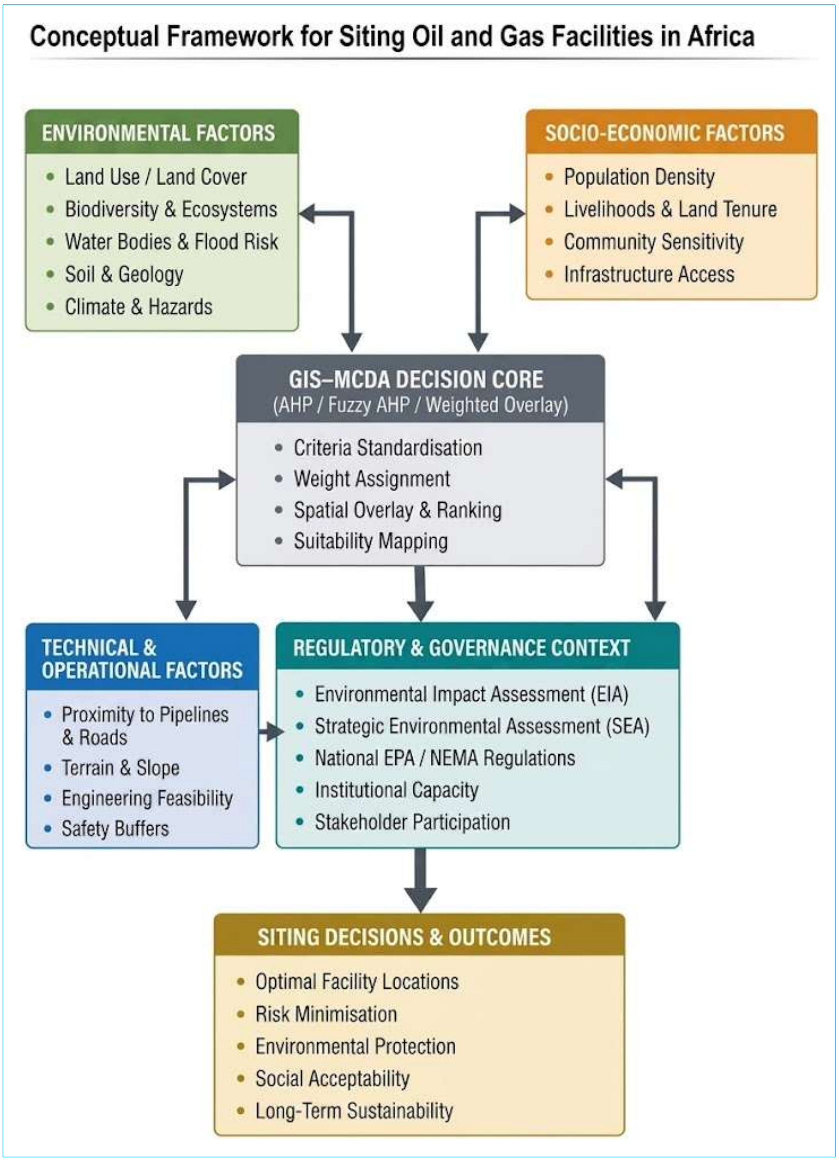

Fig. 1. Flowchart illustrating the conceptual framework of the study

2. Conceptual and Theoretical Frameworks

The conceptual and theoretical foundations underpinning oil and gas facility siting provide an integrated framework for understanding how environmental, spatial, socioeconomic, institutional, and governance factors interact to influence infrastructure suitability, sustainability, and regulatory compliance. In the African context, where rapid urbanization, institutional fragility, environmental vulnerability, and land-use conflicts frequently intersect, facility siting extends beyond a purely technical or engineering exercise and becomes a multidimensional spatial planning and governance process. The framework (Fig. 1) adopted in this study, therefore, integrates environmental management theory, spatial decision science, governance theory, sustainability transitions, and participatory planning to explain the evolving dynamics of petroleum infrastructure development across Africa.

At the centre of the framework are Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA) principles, which provide the regulatory and environmental governance foundation for sustainable infrastructure planning. These approaches are grounded in the precautionary principle and proactive environmental management philosophy, which emphasize the identification, prediction, and mitigation of environmental and social risks before project implementation (Blackmore, 2015; Lamorgese et al., 2015). Across African countries such as Ghana and South Africa, EIA and SEA frameworks are increasingly incorporated into petroleum infrastructure planning to regulate buffer zones, environmental sensitivity, pollution risks, and land-use compatibility (Peprah et al., 2018; Ngcofe et al., 2025). However, despite the existence of regulatory frameworks, the reviewed studies consistently reveal significant implementation gaps associated with weak institutional enforcement, fragmented land administration systems, corruption, and inadequate monitoring capacity, resulting in persistent non-compliance with environmental and safety regulations (Anang et al., 2021; Yisa et al., 2019). This disconnects between policy formulation and practical implementation emerged as one of the major governance trends identified in the present synthesis.

The geographical and analytical dimension of the framework is primarily informed by Geographic Information Systems (GIS) and Multi-Criteria Decision Analysis (MCDA), which conceptualize facility siting as a spatial optimization and decision-support problem. GIS–MCDA frameworks integrate environmental, technical, social, regulatory, and economic criteria through spatial overlay analysis, weighted ranking systems, and suitability modelling (Peprah et al., 2018; Boye and Abubakar, 2019). Techniques such as the Analytic Hierarchy Process (AHP), Weighted Linear Combination (WLC), and hybrid Fuzzy AHP–VIKOR models have increasingly been adopted in African siting studies to improve analytical precision, uncertainty handling, and environmental risk assessment. The descriptive meta-analysis conducted in this study revealed a significant increase in the adoption of hybrid GIS–MCDA models after 2015, reflecting a continental methodological transition from conventional proximity-based siting approaches toward integrated, sustainability-oriented spatial planning systems. Nevertheless, the review also demonstrated that many African applications remain constrained by poor geospatial infrastructure, limited longitudinal datasets, insufficient real-time environmental monitoring, and inconsistent methodological standardization, thereby limiting reproducibility and policy integration (Zhu et al., 2024; Bawuah, 2024).

The framework is further strengthened through Environmental Justice Theory and Stakeholder Participation Models, which explain facility siting as a socio-political and institutional process rather than solely a technical exercise. These perspectives emphasize that siting decisions frequently reflect unequal power relations, spatial inequalities, governance failures, and competing land-use interests (Cotton, 2015). In many African contexts, particularly in Ghana, Nigeria, Uganda, and Mozambique, conflicts surrounding customary land ownership, displacement, compensation, environmental exposure, and public safety demonstrate that infrastructure siting often disproportionately affects vulnerable communities (Ogwang and Vanclay, 2021; Namaganda et al., 2023).

The concept of a "social license to operate" therefore becomes central to sustainable infrastructure planning because it emphasizes transparency, public trust, stakeholder inclusion, and community participation within decision-making processes (Bridge et al., 2018). The reviewed studies revealed a growing integration of stakeholder engagement, community acceptance, and participatory GIS approaches within recent siting frameworks, particularly in East African studies where governance and environmental justice considerations increasingly shape spatial planning decisions.

The sustainability and risk governance dimension of the framework integrates concepts from Sustainability Science, Systems Thinking Theory, and Risk Governance Theory. These perspectives conceptualise oil and gas facility siting as part of a complex and adaptive human–environment–infrastructure system characterized by interconnected ecological, technical, institutional, and socioeconomic processes (Basile et al., 2021). Systems Thinking Theory explains how environmental degradation, regulatory failure, urban growth, and infrastructure expansion interact through feedback mechanisms that influence long-term sustainability outcomes. Risk Governance Theory further emphasizes the need for adaptive and evidence-based management strategies capable of addressing hazards such as explosions, groundwater contamination, biodiversity loss, fire outbreaks, air pollution, and climate-related vulnerabilities. The synthesis undertaken in this study demonstrated that recent siting frameworks increasingly incorporate environmental sensitivity indicators, cumulative risk assessments, climate resilience considerations, and lifecycle planning principles into infrastructure planning processes. These trends reflect the broader transition toward sustainable land management and resilience-based infrastructure development across Africa.

The framework additionally draws upon Governance and Institutional Theory to explain how institutional capacity, regulatory coherence, enforcement systems, and policy integration influence infrastructure siting outcomes. The review identified significant regional disparities in governance approaches across Africa. Southern African studies demonstrated stronger integration of EIA, SEA, and spatial planning legislation within formal regulatory systems, while West African studies focused more heavily on spatial optimization and regulatory compliance assessment. East

African studies increasingly emphasized participatory governance and socio-environmental conflict management. These regional differences reveal that effective facility siting depends not only on technological sophistication but also on governance quality, institutional coordination, and environmental accountability.

Finally, Sustainability Transition Theory situates facility siting within the broader context of Africa's evolving energy transition agenda. Although the continent continues to expand petroleum infrastructure, emerging transition technologies such as Green Hydrogen (GH_2), Waste-to-Energy (WtE), carbon reduction systems, and adaptive multi-energy infrastructure are increasingly influencing spatial planning priorities (Hansson et al., 2020). Future siting frameworks are therefore expected to integrate renewable compatibility, climate resilience, circular economy principles, and low-carbon transition indicators into hybrid GIS–MCDA models. This emerging transition from fossil fuel-centred planning toward integrated sustainability-oriented infrastructure systems represents one of the major conceptual trends identified by this study.

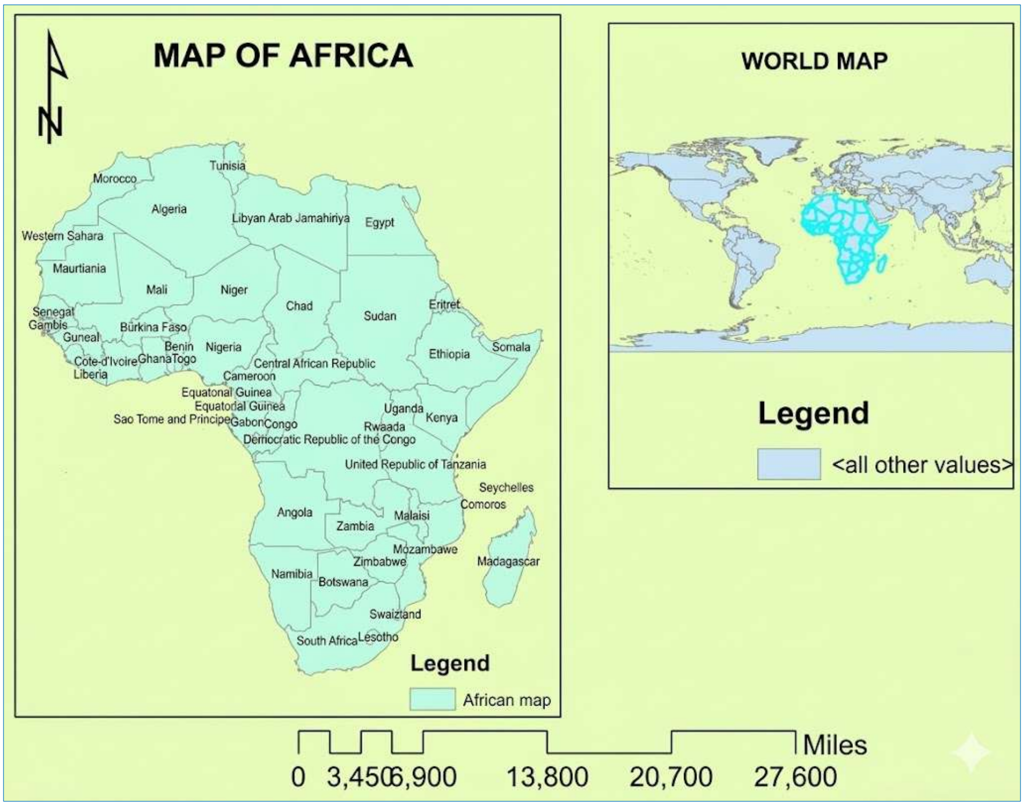

Fig. 2. Geospatial analysis of the study area

Overall, the conceptual and theoretical framework developed in this study demonstrates that oil and gas facility siting in Africa is a multidimensional process involving the interaction of environmental governance, spatial optimization, institutional capacity, social legitimacy, sustainability planning, and technological innovation. The findings of this review indicate that although methodological advancements such as GIS–MCDA, hybrid fuzzy models, and participatory planning frameworks have significantly improved spatial decision-making, persistent challenges related to weak enforcement, fragmented governance, limited longitudinal data, and inadequate environmental monitoring continue to constrain sustainable outcomes. Consequently, future infrastructure planning frameworks in Africa must increasingly integrate environmental management, hybrid spatial analytics, stakeholder participation, climate resilience, and adaptive sustainability transitions to achieve equitable, scientifically robust, and environmentally sustainable energy infrastructure development.

3. Study Area Description

Africa (Fig. 2) provides a highly diverse environmental, geological, climatic, and socio-political setting for oil and gas infrastructure development and spatial planning. The continent contains extensive hydrocarbon-bearing sedimentary basins distributed along the West and East African continental margins, the Gulf of Guinea, North African basins, and the East African Rift system, making it one of the world's emerging energy development regions (Priestley et al., 2008; Davison ang Steel, 2017). These petroleum-rich geological formations are associated with Precambrian cratons, mobile belts, coastal sedimentary basins, and tectonically active rift systems that create both opportunities and constraints for infrastructure siting. While coastal zones support export-oriented petroleum infrastructure and liquefied natural gas developments, several regions remain exposed to geohazards, including flooding, coastal erosion, seismic activity, land instability, and salt tectonics, all of which significantly influence infrastructure suitability and environmental risk assessment (Davies, 2015).

In addition, inadequate transportation systems, limited natural harbours, weak electricity networks, and fragmented regional infrastructure continue to increase logistical and operational challenges associated with oil and gas facility development across many African countries (Venables, 2010; Bosker and Garretsen, 2012).

The continent further exhibits substantial climatic and ecological variability, ranging from humid equatorial environments in Central Africa to hyper-arid desert systems in North Africa and semi-arid savannah regions across the Sahel and Southern Africa. Rainfall variability, prolonged droughts, flooding events, increasing temperatures, and climate-induced environmental stressors continue to affect infrastructure resilience, water availability, and operational sustainability (Hulme et al., 2001; Nicholson, 2017). Africa is projected to experience temperature increases above the global average, while regional rainfall patterns remain highly uncertain because of the interactions among the Inter-Tropical Convergence Zone (ITCZ), El Niño–Southern Oscillation (ENSO), sea-surface temperature variability, and land–atmosphere feedback systems (Hope Sr, 2009; Barry et al., 2018).

These climatic conditions introduce major uncertainties into long-term infrastructure planning, particularly in regions already characterized by weak environmental monitoring systems and limited adaptive capacity. Furthermore, rapid urbanization, land degradation, deforestation, wetland encroachment, biodiversity loss, and increasing industrial pollution continue to intensify environmental vulnerability across many African petroleum-producing regions (Abernethy et al., 2016). Such conditions highlight the importance of incorporating climate resilience, environmental sensitivity analysis, and sustainability-based spatial planning frameworks into oil and gas facility siting decisions.

Socioeconomic and governance conditions across Africa also significantly influence infrastructure siting outcomes. Many petroleum-producing regions continue to experience weak institutional enforcement, fragmented land administration systems, customary land tenure conflicts, inadequate urban planning, and environmental governance challenges (Warf, 2017). In several countries, rapid expansion of petroleum infrastructure has occurred alongside informal urban growth, resulting in increasing land-use conflicts, settlement encroachment, environmental injustice, and safety concerns. The continent additionally exhibits substantial regional variation in governance quality, regulatory effectiveness, and political stability, ranging from relatively stable institutional systems in countries such as Botswana and Ghana to conflict-prone extractive regions affected by corruption and political instability. These governance disparities directly affect regulatory compliance, environmental management, stakeholder participation, and implementation of spatial planning regulations. Consequently, Africa represents an important and highly heterogeneous context for evaluating how environmental conditions, institutional capacity, climatic vulnerability, and socioeconomic pressures collectively shape sustainable oil and gas facility siting and infrastructure development.

4. Methodology

4.1. Study Design

This study employed a PRISMA-guided systematic review and descriptive meta-analysis framework to synthesize evidence relating to oil and gas facility siting across Africa between 2000 and 2025. The methodological design integrated systematic review procedures, descriptive quantitative synthesis, comparative regional analysis, and thematic narrative interpretation to evaluate siting methodologies, environmental impacts, socioeconomic outcomes, governance dimensions, and sustainability implications associated with petroleum infrastructure development. Unlike conventional pooled-effect clinical meta-analyses, this study adopted a mixed-method evidence synthesis approach because the reviewed studies exhibited substantial heterogeneity in methodological design, spatial scale, facility type, analytical techniques, reporting standards, and outcome variables. Consequently, the study focused on descriptive meta-analysis, frequency-based synthesis, subgroup comparison, and thematic integration rather than pooled inferential effect-size modelling.

The review framework was structured using the PECO model (Population, Exposure, Comparator, Outcome) to ensure analytical consistency and conceptual clarity. Within this framework, the Population comprised African countries, urban centres, and communities hosting or proposed to host oil and gas infrastructure. Exposure referred to facility siting methodologies and planning frameworks, including Geographic Information Systems (GIS), Multi-Criteria Decision Analysis (MCDA), Environmental Impact Assessment (EIA), Strategic Environmental Assessment (SEA), and hybrid decision-support systems. Comparator represented differences in siting approaches, regulatory systems, and regional planning practices across African subregions, while Outcomes included spatial suitability, environmental impacts, regulatory compliance, socioeconomic effects, stakeholder participation, and sustainability performance indicators.

4.2. Search Strategy

A comprehensive and multi-source search strategy was developed to capture the broad spectrum of literature associated with oil and gas facility siting, spatial planning, environmental governance, and petroleum infrastructure development across Africa. Search terms combined keywords related to oil and gas infrastructure, facility siting, GIS, MCDA, environmental assessment, regulatory compliance, sustainability, and spatial optimization. Boolean operators (AND, OR) were systematically used to improve search sensitivity and thematic coverage. The search incorporated country-specific terms, including Ghana, Nigeria, South Africa, Mozambique, Uganda, Angola, Kenya, Algeria, Egypt, Libya, and Tanzania, to ensure regional representation.

The databases and repositories searched included Scopus, ScienceDirect, Google Scholar, ResearchGate, and Academia.edu. The inclusion of broader academic search engines such as Google Scholar and ResearchGate was intentional because a considerable proportion of African infrastructure-planning studies, technical reports, conference proceedings, postgraduate theses, and applied GIS studies are not comprehensively indexed in highly selective bibliographic databases such as Scopus and ScienceDirect.

This strategy helped minimize regional publication bias and improved the retrieval of context-specific African studies and grey literature relevant to infrastructure planning and environmental management. However, despite the large number of records initially retrieved from these broader repositories, all studies were subjected to rigorous PRISMA-based screening, eligibility assessment, duplicate removal, and quality appraisal procedures before inclusion in the final synthesis. The review covered publications from 2000 to 2025 to capture the evolution of siting methodologies from conventional proximity-based approaches toward integrated GIS–MCDA, hybrid fuzzy systems, and sustainability-oriented spatial planning frameworks. Table 1 presents the search strings used in various databases.

Table 1. Search strings used in various databases

No	Database	Search String
1	Google Scholar	("Oil and Gas" OR "Petroleum Facilities" OR "Oil Refinery" OR "Gas Processing Plant" OR "Pipeline") AND ("Site Selection" OR "Facility Siting" OR "Location Optimisation" OR "Spatial Analysis") AND ("Multi-Criteria Decision Analysis" OR "MCDA" OR "GIS" OR "Geographic Information System") AND (Africa OR Nigeria OR Angola OR Ghana OR "Sub-Saharan Africa")
2	Scopus	("Oil and Gas" OR "Petroleum Facilities" OR "Oil Refinery" OR "Gas Processing Plant" OR "Pipeline") AND ("Site Selection" OR "Facility Siting" OR "Location Optimisation" OR "Spatial Analysis") AND ("Multi-Criteria Decision Analysis" OR "MCDA" OR "GIS" OR "Geographic Information System") AND (Africa OR Nigeria OR Angola OR Ghana OR "Sub-Saharan Africa")
3	ScienceDirect	("Oil and Gas Facilities" OR "Petroleum Infrastructure") AND ("Site Selection" OR "Location Optimisation") AND ("Environmental Assessment" OR "Impact Assessment") AND (Africa OR "Developing Countries")
4	ResearchGate	("Oil and Gas" OR "Petroleum") AND ("Facility Siting" OR "Site Selection" OR "MCDA") AND (Africa OR Nigeria OR Ghana)
5	Academia.edu	("Oil and Gas Facilities" OR "Petroleum Infrastructure") AND ("Site Selection" OR "Location Analysis") AND (Africa OR "West Africa")

4.3. Study Selection Procedure

The study selection process followed the four-stage PRISMA framework comprising identification, screening, eligibility, and inclusion. Two independent reviewers conducted the screening process to minimize selection bias and improve methodological reliability. Disagreements between reviewers were resolved through discussion and consensus. A total of 17,385 records were initially identified from all databases and repositories. After removing 387 duplicate records using Mendeley reference management software, 16,998 studies underwent title and abstract screening. During this stage, 6,498 studies were excluded because they lacked relevance to oil and gas facility siting, did not involve spatial or environmental planning components, or focused exclusively on exploration and production activities without siting analysis. Subsequently, 10,500 full-text articles were assessed against predefined inclusion and exclusion criteria. A total of 10,460 studies were excluded because of methodological deficiencies, lack of transparent siting criteria, absence of geospatial analysis, insufficient outcome reporting, non-African focus, or failure to meet the study's analytical scope. Ultimately, 40 studies satisfied all eligibility requirements and were retained for qualitative and descriptive quantitative synthesis. The PRISMA flow diagram illustrating the selection process is presented in Fig. 3.

4.4. Inclusion and Exclusion Criteria

The inclusion and exclusion criteria were carefully developed to ensure methodological consistency, regional relevance, and analytical rigour throughout the review process. Studies were included if they focused on oil and gas facility siting within African contexts, employed systematic spatial or environmental planning approaches such as Geographic Information Systems (GIS), Multi-Criteria Decision Analysis (MCDA), Analytic Hierarchy Process (AHP), Environmental Impact Assessment (EIA), Strategic Environmental Assessment (SEA), fuzzy logic, or hybrid decision-support models, and reported explicit siting criteria, compliance indicators, environmental impacts, or socioeconomic outcomes. Eligible studies were restricted to publications produced between 2000 and 2025 in either English or French. The review incorporated studies relating to upstream, midstream, and downstream petroleum infrastructure, including refineries, processing plants, storage terminals, pipelines, liquefied natural gas (LNG) facilities, compressor stations, and filling stations. Studies were excluded if they focused solely on hydrocarbon exploration or extraction without incorporating siting analysis, lacked methodological transparency or reproducibility, employed purely narrative or descriptive approaches without analytical or geospatial components, or contained insufficient reporting of outcomes relevant to facility siting and environmental planning. Editorials, promotional materials, and opinion-based publications lacking scientific validation were also excluded from the synthesis. The inclusion of technical reports, conference proceedings, dissertations, and institutional publications reflected the applied and multidisciplinary nature of infrastructure planning research and helped improve the representation of African case studies, often absent from mainstream indexed academic databases.

4.5. Data Extraction

Data extraction was conducted using a structured Microsoft Excel template specifically developed for this review. Two independent reviewers extracted information relating to study characteristics, publication year, geographic location, facility type, analytical methods, spatial datasets, siting criteria, stakeholder participation, environmental impacts, socioeconomic outcomes, and regulatory compliance indicators. The extracted methodological variables included Geographic Information Systems (GIS) techniques, Multi-Criteria Decision Analysis (MCDA) approaches, Analytic Hierarchy Process (AHP), Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), weighted overlay analysis, fuzzy logic systems, Boolean overlay methods, and hybrid decision-support frameworks such as Fuzzy AHP–VIKOR. Environmental variables extracted from the reviewed studies included proximity to water bodies, biodiversity sensitivity, slope, geology, soil characteristics, land-use compatibility, and climatic risk factors.

Social variables included settlement proximity, displacement risk, livelihoods, community participation, and environmental justice considerations. Additional information was extracted regarding regulatory compliance, integration of Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA), stakeholder engagement, environmental risk mitigation strategies, and sustainability planning indicators. The extracted data formed the basis for comparative regional analysis, descriptive meta-analysis, thematic synthesis, and subgroup assessment across the reviewed studies.

4.6. Quality Assessment

The methodological quality of the included studies was assessed using a modified Joanna Briggs Institute (JBI) Critical Appraisal Framework adapted for spatial planning and infrastructure siting research. The evaluation focused on five major domains: methodological rigour, transparency and reproducibility, appropriateness of siting criteria, stakeholder engagement, and outcome validation. Each study received a quality score ranging from 0 to 20. Studies scoring between 16 and 20 were classified as high quality, reflecting strong analytical rigour, transparent methodologies, and reliable validation procedures. Scores ranging from 11 to 15 indicated moderate-quality studies with minor methodological limitations, while studies scoring below 10 were considered lower quality because of weak validation procedures, insufficient methodological transparency, or limited analytical rigour. The quality scores were not used as exclusion criteria but instead informed sensitivity analysis and weighting during comparative interpretation of the findings. Sensitivity assessments were conducted to evaluate the robustness and consistency of the results after excluding lower-quality studies and comparing outcomes across temporal periods and methodological categories.

4.7. Data Analysis

The analytical framework combined descriptive meta-analysis, comparative quantitative synthesis, and thematic narrative analysis. Because the reviewed studies exhibited substantial heterogeneity in terms of analytical methods, spatial scales, datasets, facility types, and reported variables, a conventional pooled-effect statistical meta-analysis using standardized effect sizes was not methodologically appropriate. Many studies lacked the uniform quantitative indicators required for calculating pooled effect estimates, conducting inferential heterogeneity tests, or applying random-effects statistical modelling. Consequently, the study adopted a descriptive quantitative synthesis approach focusing on frequency analysis, cross-tabulation, subgroup comparison, trend analysis, and thematic integration. Quantitative synthesis was performed using Microsoft Excel and descriptive statistical procedures. Frequency distributions and cross-tabulations were used to evaluate the prevalence of siting criteria, methodological trends, environmental impacts, compliance patterns, and regional differences across African subregions.

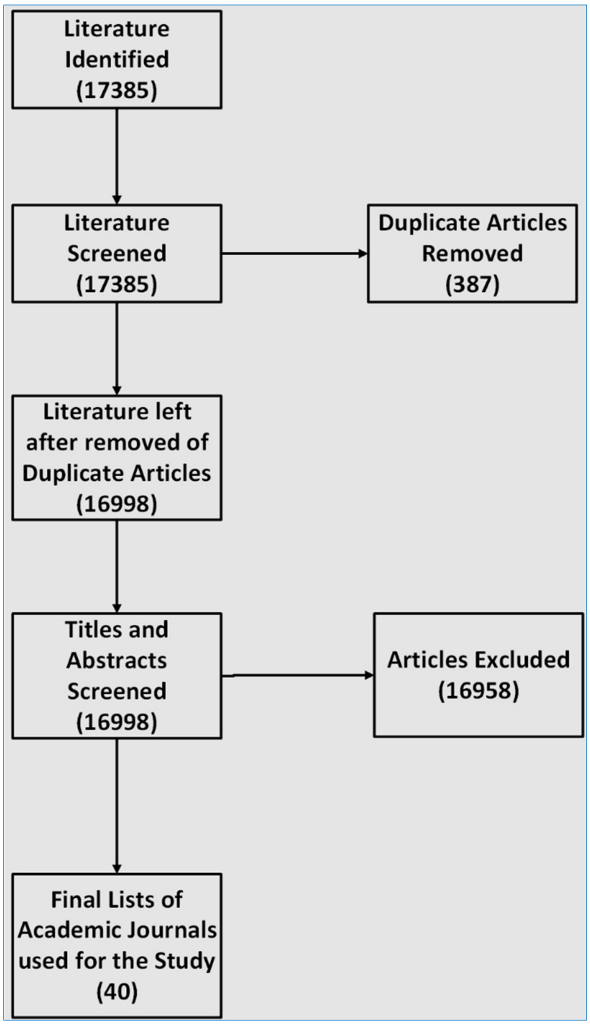

Fig. 3. PRISMA flow diagram for the selection process of studies

Subgroup analyses were conducted according to geographic region, including West, East, North, and Southern Africa, facility type such as upstream, midstream, and downstream infrastructure, and methodological approach, including GIS-only, MCDA-based, and hybrid decision-support systems. Temporal trend analysis was additionally performed for the periods 2000–2010, 2011–2020, and 2021–2025 to evaluate the evolution of siting methodologies and sustainability integration over time. Forest plots and funnel plots were generated as descriptive visual synthesis tools to illustrate variability in reported compliance patterns, environmental risks, and methodological distributions across studies. The forest plots presented aggregated comparative proportions and variability ranges rather than conventional biomedical effect sizes, while the associated 95% confidence intervals reflected variability and uncertainty among reported siting outcomes across geographic and regulatory contexts. Funnel plots were cautiously interpreted to assess potential publication asymmetry and methodological concentration within the literature. Because of the heterogeneity and non-standardized reporting structures of the included studies, inferential heterogeneity statistics such as Cochran's Q-test and Higgins' I^2 statistics were not applied. Thematic narrative synthesis was organised around methodological evolution, environmental governance, stakeholder participation, socioeconomic outcomes, sustainability transitions, regulatory compliance, and hybrid spatial decision-support systems. This mixed-method analytical framework improved methodological transparency while aligning the study with interdisciplinary environmental planning and spatial analysis research standards.

4.8. Ethical Considerations

Ethical approval was not required because the study synthesized publicly available literature and secondary data sources. Nevertheless, ethical rigour was maintained throughout the review process. Attention was given to how the included studies addressed stakeholder participation, community displacement, indigenous land rights, environmental justice, and transparency in environmental governance. Studies funded or influenced by industry actors were critically evaluated for potential methodological bias or conflicts of interest. The review further emphasized the importance of participatory planning, informed consent, transparent spatial data use, and equitable environmental management within future infrastructure siting frameworks across Africa.

5. Results and Discussion

5.1.1. Study Selection and PRISMA Synthesis

The systematic literature search conducted across Scopus, ScienceDirect, Google Scholar, ResearchGate, and Academia.edu identified 17,385 records relating to oil and gas facility siting, spatial planning, environmental governance, and petroleum infrastructure development within African contexts. Following duplicate screening using Mendeley reference management software, 387 duplicate records were removed, resulting in 16,998 studies being retained for title and abstract screening. During the screening stage, 6,498 studies were excluded because they lacked direct relevance to facility siting, did not incorporate spatial or environmental decision-support components, or focused exclusively on petroleum exploration and production without siting analysis. Subsequently, 10,500 full-text articles were assessed against predefined inclusion and exclusion criteria. Of these, 10,460 studies were excluded because of methodological limitations, insufficient analytical transparency, absence of geospatial methodologies, non-African focus, or inadequate reporting of siting criteria and environmental outcomes. Ultimately, 40 studies satisfied all eligibility requirements and were retained for descriptive quantitative synthesis and thematic comparative analysis.

The disproportionately high number of records retrieved from Google Scholar and ResearchGate compared with Scopus and ScienceDirect reflects the fragmented and multidisciplinary nature of infrastructure-planning research in Africa, where substantial numbers of applied geospatial studies, institutional reports, conference proceedings, postgraduate theses, and technical documents are not comprehensively indexed within highly selective scientific databases. The inclusion of broader academic repositories, therefore, improved regional representation and reduced publication bias, particularly for context-specific African studies frequently absent from mainstream indexing systems. Nevertheless, all identified studies underwent rigorous PRISMA-guided screening, quality appraisal, and eligibility assessment before inclusion in the final synthesis, thereby ensuring methodological reliability and analytical consistency. Fig. 4 presents the distribution of records retrieved across databases and search platforms.

The synthesis demonstrates that research relating to oil and gas facility siting in Africa remains relatively limited but has expanded substantially since 2015, largely because of increasing adoption of Geographic Information Systems (GIS), Multi-Criteria Decision Analysis (MCDA), environmental governance frameworks, and sustainability-oriented spatial planning systems (Peprah et al., 2018; Ngcofe et al., 2025). This trend reflects the growing recognition of the need for evidence-based and spatially explicit approaches to petroleum infrastructure development within environmentally vulnerable and rapidly urbanizing African regions.

5.2. Temporal Trends in Oil and Gas Facility Siting Research

The temporal distribution of the reviewed studies revealed substantial variation in publication intensity between 2000 and 2025. Although isolated studies emerged during the early 2000s, publication activity remained relatively limited until the mid-2010s. The years 2015 and 2019 recorded the highest number of publications, with five studies each representing 12.5% of the total dataset. Following 2015, publication frequency increased steadily, reflecting heightened continental and international interest in GIS-based siting models, environmental risk assessment, sustainability planning, and regulatory compliance frameworks for oil and gas infrastructure.

This temporal growth coincides with rapid urbanization and infrastructure expansion across African cities, increasing environmental and public safety concerns associated with poorly regulated petroleum facilities, advances in geospatial technologies, and the emergence of hybrid GIS–MCDA and fuzzy logic-based decision-support systems (Anang et al., 2021; Yisa et al., 2019). The publication trend additionally reflects broader sustainability transitions within the energy sector, where siting decisions increasingly incorporate climate resilience, environmental justice, and stakeholder participation (Basile et al., 2021; Hughes et al., 2024). Fig. 5 presents the publication trends in oil and gas facilities siting studies across Africa (2000-2025).

The descriptive meta-analysis further revealed a significant methodological transition over time. Earlier studies relied predominantly on proximity-based and observational approaches, whereas more recent studies increasingly integrated GIS spatial overlay analysis, MCDA, Analytic

Hierarchy Process (AHP), fuzzy logic systems, environmental sensitivity modelling, and participatory planning frameworks (Peprah et al., 2018; Adu et al., 2025). This transition confirms one of the major analytical trends identified by the present study, namely that African infrastructure siting research is evolving from reactive and compliance-driven approaches toward integrated, sustainability-oriented spatial planning systems.

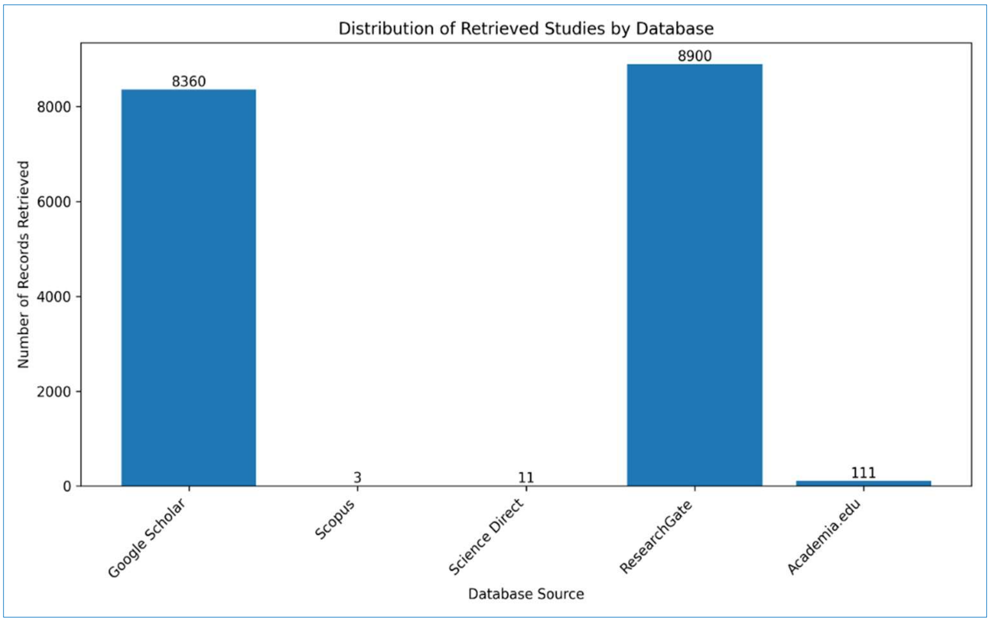

Fig. 4. Distribution of records retrieved across databases and search platforms

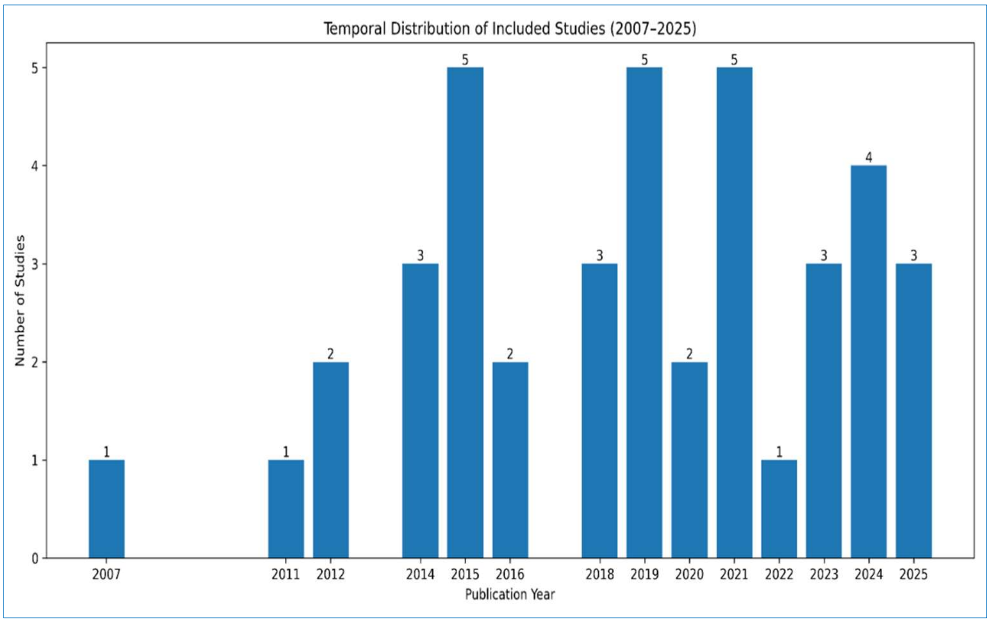

Fig. 5. Publication trends in oil and gas facility sitting studies across Africa (2000-2025)

5.3. Geographical Distribution of Studies

The reviewed literature demonstrated considerable regional variation in the geographical distribution of oil and gas facility siting studies across Africa. Southern Africa accounted for the highest concentration of region-specific studies, followed by West Africa and East Africa. Ghana, Nigeria, and South Africa emerged as the most frequently studied countries because of their relatively advanced petroleum infrastructure systems, urbanization pressures, and increasing application of GIS–MCDA approaches within environmental planning and regulatory assessment (Peprah et al., 2018; Ngcofe et al., 2025).

West African studies focused primarily on regulatory compliance, filling station clustering, urban safety risks, and spatial optimization, reflecting increasing concern over hazardous petroleum infrastructure expansion within densely populated urban centres (Anang et al., 2021; Yisa et al., 2019). East African studies placed greater emphasis on participatory governance, land rights, community displacement, and socio-environmental conflict management, particularly in relation to emerging upstream petroleum developments in Uganda and Mozambique (Ogwang and Vanclay, 2021; Namaganda et al., 2023).

Southern African studies demonstrated stronger integration of Environmental Impact Assessment (EIA), Strategic Environmental Assessment (SEA), climate-transition modelling, and sustainability-oriented infrastructure planning frameworks (Blackmore, 2015; Chamberlain and Murombo, 2015).

Several globally comparative studies from Europe, North America, and East Asia were also reviewed to provide a broader methodological context and policy benchmarking. However, these studies were excluded from the quantitative African synthesis because they lacked direct contextual relevance to African infrastructure planning conditions. Fig. 6 depicts the geographical distribution of reviewed studies across African subregions.

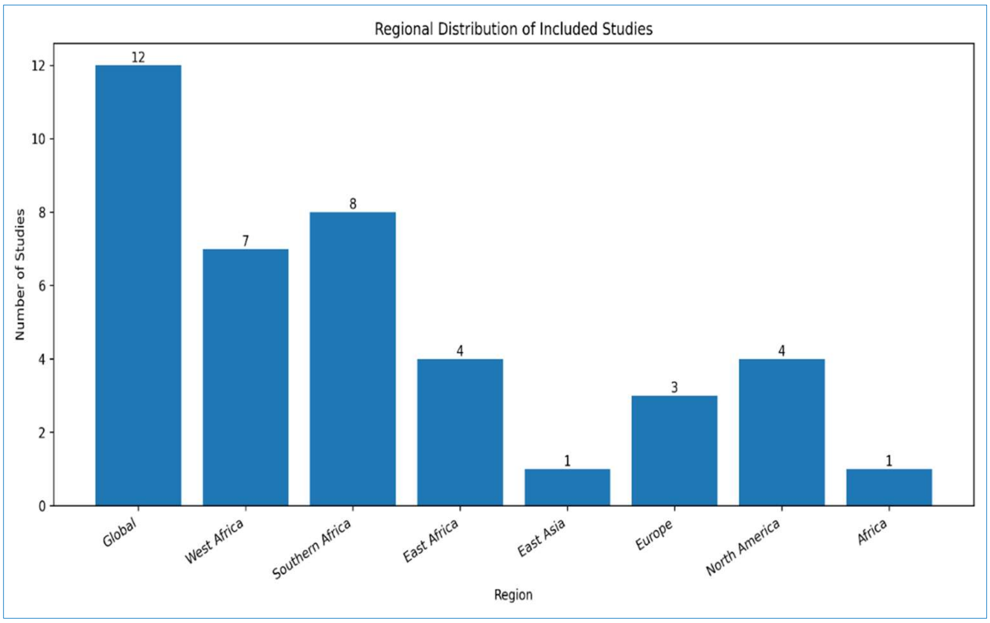

Fig. 6 Geographical distribution of reviewed studies across African Subregions

The regional distribution reveals substantial disparities in research capacity, geospatial infrastructure, environmental governance systems, and methodological sophistication across the continent. The descriptive synthesis further indicates that regions with stronger institutional systems and environmental legislation, particularly South Africa, demonstrate more advanced integration of spatial technologies and regulatory frameworks within infrastructure planning processes. In contrast, several West African studies continue to reveal persistent enforcement deficiencies despite improvements in analytical capabilities (Warf, 2017; Ulakpa et al., 2022).

5.4. Methodological Approaches for Oil and Gas Facility Siting

The reviewed studies revealed a clear methodological transition from conventional intuition-driven and proximity-based siting approaches toward integrated GIS–MCDA and hybrid spatial decision-support frameworks. Geographic Information Systems (GIS) and Multi-Criteria Decision Analysis (MCDA) emerged as the dominant analytical approaches across the reviewed literature because they enabled simultaneous evaluation of environmental, technical, social, economic, and regulatory criteria within spatially explicit decision-making systems (Peprah et al., 2018; Boye and Abubakar, 2019). Frequently applied siting variables included proximity to roads, distance from residential areas, proximity to water bodies, slope, land-use compatibility, and environmental sensitivity indicators.

The Analytic Hierarchy Process (AHP) was the most widely applied weighting technique, while hybrid systems such as Fuzzy AHP–VIKOR increasingly emerged within recent studies to improve uncertainty handling, stakeholder integration, and sensitivity analysis (Asenso-Gyambibi et al., 2023).

The descriptive meta-analysis demonstrated that hybrid models became increasingly common after 2015, particularly within Ghana and South Africa, reflecting the growing need for adaptive and robust decision-support systems capable of operating under conditions of incomplete or uncertain spatial datasets. Table 2 summarizes the common methodological approaches for oil and gas facility siting, and Table 3 compares the analysis of siting methodologies and decision-support systems.

The findings demonstrate that traditional field-based approaches remain useful for rapid assessments and regulatory compliance verification, while GIS-only systems improve spatial visualization and mapping efficiency. MCDA frameworks enhance analytical transparency and multi-criteria evaluation, whereas hybrid fuzzy and AI-assisted systems provide greater flexibility under uncertain environmental and governance conditions (Fox et al., 2019; Wanasinghe et al., 2020). Nevertheless, despite methodological improvements, implementation challenges remain substantial because many African countries continue to experience inadequate geospatial infrastructure, fragmented land administration systems, weak institutional enforcement, and limited longitudinal environmental datasets (Bawuah, 2024).

Table 2 Summary of common approaches to siting oil and gas facilities

Reference	Title of Article	Location of Study	Journal of Publication	Study/Project Application
Peprah et al., 218	Suitability Analysis for Siting Oil and Gas Filling Stations Using Multi-Criteria Decision Analysis and GIS Approach: A Case Study in Tarkwa and Its Environs	Ghana	*Journal of Geomatics*	Applied GIS–MCDA (AHP, buffer analysis) to assess siting suitability and compliance.
Yisa et al., 2018	Utilization of GIS Techniques as Decision Support System for Location of Filling Stations in Minna, Niger State, Nigeria	Nigeria	*Geosfera Indonsia*	Used GIS and field assessment to check compliance with DPR regulations.
Anang et al., 2021	Petrol Filling Station Safety Assessment and Fire Safety Knowledge of Fuel Pump Attendants	Ghana	*Journal of Ghana Science Association*	Combined interviews, field measurements, and regulatory review for compliance evaluation.
Ngcofe et al., 2025	Geospatial Analysis of Potential Petrol Station Locations in the Cape Town District, South Africa	South Africa	*South African Journal of Geomatics*	Integrated AHP with regulatory criteria to identify environmentally safe siting zones.
Asenso-Gyambibi et al., 2023	Site Suitability Assessment for Petroleum Hubs and Oil Retail Assets in the Jomoro District: A Hybrid Approach Using Fuzzy AHP and VIKOR Method	Ghana	*Journal of Geomatics*	Employed hybrid Fuzzy AHP–VIKOR for multi-criteria site evaluation.
Adu et al., 2025	Optimal Siting of Waste-to-energy Facilities in Cape Coast Metropolis Using an Integrated GIS-Based MCDA and Waste Characterization Approach	Ghana	*Cleaner Waste Systems*	Incorporated participatory planning into the MCDA-based GIS siting framework.
Cordes et al., 2016	Environmental Impacts of the Deep-Water Oil and Gas Industry: A Review to Guide Management Strategies	Global	*Frontiers in Environmental Science*	Applied EIA, spatial and temporal management for offshore facility siting.
Makka et al., 2021	An Environmental Risk Assessment of Filling Stations Using the Principles of Security Management: A Case Study in the Slovak Republic	Europe	*Sustainability*	Applied multi-country environmental risk models (EAI, ERA, Proteus).

The comparative regional synthesis revealed that West Africa primarily prioritizes compliance assessment and spatial optimization, East Africa increasingly emphasizes participatory governance and socio-environmental planning, while Southern Africa demonstrates stronger integration of GIS–MCDA systems with environmental legislation and sustainability frameworks. This geographical differentiation indicates that successful infrastructure siting in Africa depends not only on analytical sophistication but also on governance quality, institutional capacity, and stakeholder legitimacy.

5.5. Key Siting Criteria and Decision Factors

The reviewed studies consistently identified environmental protection, public safety, accessibility, and regulatory compliance as the dominant siting considerations across Africa. The most frequently applied criteria included proximity to roads and transportation infrastructure, separation distances from residential areas, distance from water bodies and wetlands, land-use compatibility, slope and topographic stability, proximity to emergency services, and environmental sensitivity indicators (Peprah et al., 2018; Ngcofe et al., 2025). Environmental variables emerged as the most consistently weighted criteria within GIS–MCDA models, particularly in studies integrating EIA and SEA frameworks. Social variables such as population density, stakeholder participation, displacement risk, and environmental justice considerations also became increasingly prominent within recent studies, indicating a methodological transition toward participatory and sustainability-oriented planning frameworks (Ogwang and Vanclay, 2021; Bridge et al., 2018).

Table 4 summarizes the key sitting factors and decision criteria across reviewed studies.

The descriptive quantitative synthesis further revealed important regional differences in criteria prioritization. West African studies placed greater emphasis on accessibility, urban market proximity, and regulatory compliance because of rapid urbanization pressures and petroleum retail expansion (Anang et al., 2021). Southern African studies prioritized biodiversity protection, environmental sensitivity, and climate resilience within infrastructure planning processes (Blackmore, 2015). East African studies increasingly integrated land rights, stakeholder participation, and socio-political conflict management variables within siting frameworks (Ogwang and Vanclay, 2021).

This evolution reflects a broader continental transition from purely technical and economically driven siting frameworks toward multidimensional systems integrating environmental sustainability, social legitimacy, governance accountability, and long-term resilience planning (Basile et al., 2021). The integration of renewable transition indicators, including Green Hydrogen (GH_2), Waste-to-Energy (WtE), renewable retrofit suitability, and climate adaptation potential within recent siting studies further indicates the emergence of adaptive multi-energy infrastructure planning frameworks across Africa (Hansson et al., 2020; Hussein et al., 2025).

Table 3 Comparative analysis of siting approaches for oil and gas facilities

Approach Type	Representative Methods/Tools	Key Advantages	Key Limitations	Recent Innovations / Enhancements	Supporting Sources
Traditional / Conventional Approaches	Manual field assessment, expert judgment, buffer zoning (without GIS), visual mapping	Simple, low-cost, and adaptable to local contexts; suitable for preliminary siting or compliance verification	Lacks spatial precision and reproducibility; highly subjective; poor handling of multi-factor interactions; difficult to validate.	Use of GPS mapping and handheld GIS devices for improved field accuracy.	Anang et al., 2021; Yisa et al., 2019; Peprah et al., 2018
GIS-Based Approaches	GIS spatial overlay, buffer analysis, raster reclassification	Enables spatial visualisation of hazards, proximity, and environmental sensitivity; supports regulatory enforcement; adaptable to diverse data layers.	Data-dependent and limited by poor spatial infrastructure, static datasets fail to capture temporal dynamics; results are sensitive to weighting assumptions.	Integration with real-time satellite imagery and spatial web data for dynamic monitoring.	Ngcofe et al., 2025; Boye and Abubakar, 2019; Adu et al., 2025
Multi-Criteria Decision Analysis (MCDA)	Weighted Linear Combination (WLC), Analytic Hierarchy Process (AHP)	Systematic weighting and ranking of multiple factors; quantifiable, transparent, and transparent; reproducible for policy and research.	Over-reliance on expert judgment; inconsistent weighting methods; limited stakeholder inclusion.	Integration with participatory decision-making and automated weighting via machine learning.	Peprah et al., 2018; Asenso-Gyambibi et al., 2023; Ngcofe et al., 2025
Hybrid GIS–MCDA Models	GIS + AHP or WLC combined	Combines spatial accuracy with decision structure; allows for balancing environmental, social, and economic variables; highly adaptable.	Computationally intensive; requires technical expertise and high-quality input data; sensitive to data scale mismatches.	Development of hybrid Fuzzy AHP–VIKOR models for uncertainty handling and sensitivity analysis.	Asenso-Gyambibi et al., 2023; Zhu et al., 2024; Adu et al., 2025
Fuzzy Logic and Artificial Intelligence Models	Fuzzy AHP, Fuzzy VIKOR, Neural Networks, Genetic Algorithms	Handles uncertainty, ambiguity, and incomplete data; better captures subjective expert knowledge; enhances decision robustness.	Requires advanced computation and calibration; limited accessibility in low-resource African settings.	Integration of fuzzy MCDA with machine learning for adaptive siting and dynamic environmental modelling.	Asenso-Gyambibi et al., 2023; Zhu et al., 2024; Bawuah, 2024
Regulatory and Environmental Assessment Frameworks	EIA, SEA, spatial planning policy integration	Ensures legal compliance and environmental accountability; links siting to risk mitigation and sustainability.	Implementation gaps due to weak institutions, corruption, and political interference; often applied post hoc instead of preemptively	Institutionalisation of Strategic Environmental Assessment (SEA) and digital EIA platforms to improve transparency.	Cordes et al., 2016; Anang et al., 2021; Ngcofe et al., 2025
Participatory/Governance Approaches	Stakeholder consultations, community-based siting, and land-use negotiation	Promotes social legitimacy, reduces conflict, and enhances long-term sustainability.	Time-intensive; prone to elite capture and unequal representation; often sidelined in private-sector-driven projects	Integration of participatory GIS (PGIS) and crowd-sourced geospatial feedback tools.	Ogwang and Vanclay, 2021; Adu et al., 2025; Bridge et al., 2018

5.2. Discussion

5.2.1. Methodological Trends in Oil and Gas Facility Siting

The findings of this review demonstrate a substantial methodological transition in oil and gas facility siting research across Africa. Earlier studies relied predominantly on conventional proximity-based approaches, manual field observations, and economically driven location decisions with limited integration of environmental and social variables (Anang et al., 2021; Yisa et al., 2019). However, recent studies increasingly employ Geographic Information Systems (GIS), Multi-Criteria Decision Analysis (MCDA), Environmental Impact Assessment (EIA), and hybrid analytical frameworks to improve decision-making transparency and spatial accuracy (Peprah et al., 2018; Ngcofe et al., 2025; Asenso-Gyambibi et al., 2023).

This transition reflects the growing recognition that petroleum infrastructure siting requires multidimensional evaluation frameworks capable of simultaneously integrating environmental, technical, socioeconomic, regulatory, and governance-related factors (Bridge et al., 2018; Zhu et al., 2024).

The descriptive synthesis further revealed that hybrid approaches such as Fuzzy AHP–VIKOR and GIS–machine learning systems have become increasingly important in addressing uncertainty, incomplete datasets, and subjective weighting challenges frequently encountered in African planning environments (Asenso-Gyambibi et al., 2023; Adu et al., 2025). These approaches improve analytical flexibility and sensitivity assessment while supporting more adaptive spatial decision-making. Nevertheless, despite methodological progress, implementation remains uneven because many African countries continue to experience weak geospatial infrastructure, inadequate technical capacity, fragmented institutional systems, and limited access to high-quality spatial datasets (Bawuah, 2024; Ogwang and Vanclay, 2021). Consequently, the effectiveness of advanced siting frameworks often depends more on governance capacity and institutional enforcement than on analytical sophistication alone (Ngcofe et al., 2025).

Table 4. Key siting factors and criteria used across studies on oil and gas facility siting

Siting Factor/Criterion	Type of Influence	Rationale for Inclusion	Common Thresholds/Benchmarks	Empirical Evidence/Reference
Proximity to Roads/Highways	Accessibility and Logistics	Ensures accessibility for fuel distribution, reduces transport costs, and supports emergency response.	15–100 m setback from major roads to prevent fire hazards and congestion.	Peprah et al., 2018; Yisa et al., 2019; Ngcofe et al. 2025
Distance from Residential Areas	Safety and Health	Minimises public exposure to explosions, fumes, and noise pollution.	≥100 m in Ghana; ≥75 m in Nigeria; ≥500 m in South Africa's NEMA guideline.	Anang et al., 2021; Yisa et al., 2019; Ngcofe et al., 2025
Proximity to Water Bodies/Wetlands	Environmental Risk	Prevents groundwater and surface contamination from leaks and runoff.	80–500 m depending on terrain sensitivity.	Peprah et al., 2018; Asenso-Gyambibi et al., 2023; Cordes et al., 2016
Distance Between Stations	Safety and Competition	Prevents oversaturation, cascading fire hazards, and market redundancy.	400–450 m (DPR Nigeria); 3 km minimum (South Africa).	Yisa et al., 2019; Ngcofe et al., 2025
Slope / Topography	Engineering and Fire Risk	Flat to gentle slopes facilitate drainage and construction safety; steep slopes heighten fire risk.	0°–10° slope recommended for a stable foundation.	Peprah et al., 2018; Asenso-Gyambibi et al., 2023; Ngcofe et al., 2025
Soil Type/Geology	Environmental Safety	Stable, impermeable soils reduce leakage risk and structural collapse.	Preference for lateritic or clay soils; avoidance of sandy or fractured substrates.	Peprah et al., 2018; Asenso-Gyambibi et al., 2023; Bawuah, 2024
Land Use/Zoning Compatibility	Planning and Regulation	Ensures alignment with urban land-use plans and minimises conflict with residential or institutional zones.	Must comply with Town and Country Planning and EPA zoning categories.	Anang et al., 2021; Ngcofe et al., 2025
Proximity to Fire and Emergency Services	Risk Mitigation	Closer proximity allows rapid response to fires and spills, minimising fatalities and property loss.	≤3 km from fire service stations.	Boye and Abubakar, 2019; Anang et al., 2021
Proximity to Markets/Demand Centres	Economic Viability	Ensures commercial success by maximising customer access and sales volume.	Within 1–5 km of major urban centres.	Yisa et al., 2019; Adu et al., 2025
Environmental Sensitivity/Protected Areas	Ecological Protection	Avoids biodiversity hotspots, floodplains, and conservation zones.	Buffer zones of ≥400 m for vulnerable ecosystems.	Cordes et al., 2016; Ngcofe et al., 2025; Zhu et al., 2024
Population Density	Health & Social Impact	High density increases potential exposure to risk; low-density zones are preferred for safety.	Avoid sitting in areas >2000 people/km².	Anang et al., 2021; Yisa et al., 2019
Cumulative Risk Zones/Hazard Clustering	Sustainability and Safety	Avoid concentration of multiple hazardous facilities in one locality.	Limit clustering to <1 facility per 2 km² in urban zones.	Ngcofe et al., 2025; Makka et al., 2021
Community Acceptance / Stakeholder Engagement	Social Legitimacy	Reduces conflicts, ensures local support, and secures "social license to operate."	Continuous consultation from planning to the operation phases.	Ogwang and Vanclay, 2021; Bridge et al., 2018; Adu et al., 2025
Regulatory Compliance (EIA/SEA)	Legal and Institutional	Ensures adherence to environmental laws, safety standards, and zoning acts.	Must obtain EIA certification before construction.	Anang et al., 2021; Cordes et al., 2016; Ngcofe et al., 2025
Energy Transition/Future Compatibility	Sustainability and Policy	Considers long-term adaptability for renewable integration and decommissioning.	Favour sites suitable for renewable retrofits (solar, hydrogen).	Basile et al., 2021; Hansson et al., 2020; Bawuah, 2024

5.2.2. Regional Variations and Comparative Global Perspectives

The review revealed significant regional disparities in siting practices, regulatory integration, and governance frameworks across Africa. West African studies, particularly from Ghana and Nigeria, concentrated mainly on spatial optimization, regulatory compliance assessment, and hazard exposure analysis (Peprah et al., 2018; Yisa et al., 2019). These studies consistently reported widespread violations of safety buffers, environmental regulations, and land-use zoning standards, reflecting rapid urbanisation pressures and weak enforcement systems (Anang et al., 2021; Ulakpa et al., 2022). The findings indicate that although GIS–MCDA frameworks are increasingly applied in West Africa, institutional implementation remains inconsistent, thereby limiting the practical effectiveness of technically robust siting models.

Southern African studies demonstrated comparatively stronger integration of Environmental Impact Assessment (EIA), Strategic Environmental Assessment (SEA), and sustainability-oriented legislation within infrastructure planning processes (Blackmore, 2015; Ngcofe et al., 2025). South Africa, in particular, exhibited more advanced institutionalization of GIS–MCDA frameworks within formal environmental governance systems. This stronger integration reflects higher levels of regulatory maturity, institutional coordination, and environmental policy enforcement compared with many other African contexts (Jobodwana, 2011; Chamberlain and Murombo, 2015).

East African studies adopted a comparatively different analytical orientation by emphasizing participatory governance, land rights, environmental justice, and stakeholder engagement within infrastructure planning processes (Ogwang and Vanclay, 2021; Johannes et al., 2015). This reflects the region's increasing recognition that infrastructure siting decisions are closely linked to socio-political conflict management, customary land tenure systems, and community legitimacy. The findings therefore suggest that African siting practices vary not only according to technological capacity but also according to governance structures, environmental policy frameworks, and regional development priorities.

Comparative global studies from Europe and North America further demonstrated that successful infrastructure siting systems increasingly integrate real-time environmental monitoring, climate-risk modelling, cumulative impact assessment, and adaptive sustainability planning within spatial decision-making frameworks (Cordes et al., 2016; Makka et al., 2021). These international experiences provide important methodological and policy benchmarks for strengthening infrastructure planning systems across Africa, particularly in relation to environmental governance, climate resilience, and adaptive spatial planning.

5.2.3. Environmental Implications and Ecological Risks

The findings of this study demonstrate that poorly regulated oil and gas facility siting contribute significantly to environmental degradation across Africa. Major environmental impacts identified within the reviewed literature included groundwater contamination, soil degradation, air pollution, biodiversity loss, habitat fragmentation, and increased fire hazards (Anang et al., 2021; Cordes et al., 2016; Namaganda et al., 2023). These impacts were particularly severe in regions characterized by overlapping infrastructure clusters, weak environmental governance systems, and inadequate enforcement of environmental regulations. Studies from Ghana, Nigeria, and Mozambique consistently revealed that petroleum facilities located near residential areas, wetlands, and water bodies significantly increased ecological vulnerability, environmental pollution, and public health risks (Peprah et al., 2018; Yisa et al., 2019; Asenso-Gyambibi et al., 2023).

The review further demonstrated that offshore petroleum development contributes to marine ecosystem degradation through drilling discharges, seismic exploration, and oil spill risks (Chang et al., 2014; Cordes et al., 2016). These findings align with broader environmental governance literature, which emphasizes that inadequate spatial planning and weak regulatory oversight amplify long-term ecological instability in extractive regions (Warf, 2017; Basile et al., 2021). The synthesis also indicates that cumulative environmental risks become more severe where multiple hazardous facilities are concentrated within densely populated urban areas without adequate environmental buffering and land-use planning (Ngcofe et al., 2025).

Importantly, the review identified increasing incorporation of climate resilience and environmental sensitivity indicators within recent GIS–MCDA frameworks (Zhu et al., 2024; Bawuah, 2024). This reflects a broader shift toward sustainability-oriented spatial planning approaches capable of balancing infrastructure expansion with ecological protection and long-term environmental management objectives.

5.2.4. Research Gaps and Emerging Trends

One of the major contributions of this review is the identification of important methodological and analytical gaps within African oil and gas facility siting research. The synthesis revealed that most reviewed studies relied predominantly on static cross-sectional datasets and short-term suitability assessments with limited integration of longitudinal monitoring, climate variability analysis, dynamic urban growth modelling, and cumulative environmental risk assessment frameworks (Zhu et al., 2024; Bawuah, 2024).

This limitation constrains the ability of existing siting models to effectively evaluate long-term infrastructure sustainability, adaptive resilience, and evolving environmental risks under changing climatic and urbanization conditions across Africa. This limitation significantly constrains the ability of existing frameworks to evaluate long-term infrastructure sustainability and adaptive resilience under changing environmental and socioeconomic conditions.

The descriptive meta-analysis further revealed several important emerging trends. First, there has been a substantial increase in the adoption of GIS–MCDA and hybrid decision-support systems after 2015, indicating a continental shift toward evidence-based and sustainability-oriented spatial planning (Peprah et al., 2018; Asenso-Gyambibi et al., 2023; Ngcofe et al., 2025). Second, there is growing incorporation of stakeholder participation, environmental justice, and governance considerations within siting frameworks, particularly in East African studies (Ogwang and Vanclay, 2021; Bridge et al., 2018). Third, recent studies increasingly integrate renewable transition indicators such as Green Hydrogen (GH_2), Waste-to-Energy (WtE), and climate adaptation variables within infrastructure planning models (Hansson et al., 2020; Hussein et al., 2025; Adu et al., 2025).

The review additionally identified major geographical research imbalances. Most reviewed studies originated from Ghana, Nigeria, and South Africa, while several Central African and North African countries remain underrepresented. This uneven spatial distribution limits continental comparability and highlights the need for more regionally balanced research.

Another important gap identified by this study relates to the limited application of machine learning, real-time environmental monitoring, remote sensing time-series analysis, and adaptive modelling frameworks within African infrastructure planning systems (Wanasinghe et al., 2020; Fox et al., 2019). The limited integration of these advanced analytical approaches constrains predictive capacity, long-term environmental monitoring, and adaptive infrastructure planning across rapidly urbanizing and environmentally vulnerable regions. Consequently, future studies should prioritise dynamic, predictive, and climate-resilient spatial planning frameworks capable of addressing evolving environmental conditions, urban expansion, climate variability, and sustainability challenges across the continent.

5.2.5. Socioeconomic and Governance Implications

The review demonstrates that oil and gas facilities siting in Africa produce complex socioeconomic outcomes characterized by both developmental opportunities and social vulnerabilities. Infrastructure expansion frequently generates employment opportunities, improves transportation networks, and stimulates local economic activity (Shuen et al., 2014; Hughes et al., 2024). However, these benefits are often accompanied by social displacement, environmental injustice, occupational safety risks, and uneven distribution of socioeconomic benefits (Namaganda et al., 2023; Ogwang and Vanclay, 2021). The findings indicate that downstream petroleum sectors in several African countries are dominated by informal and low-skilled employment with limited occupational protection and inadequate safety training (Anang et al., 2021; Yisa et al., 2019). Large-scale upstream projects, particularly in Mozambique, additionally contributed to forced displacement, livelihood disruption, and socio-political conflict (Namaganda et al., 2023). These findings reinforce broader governance literature suggesting that infrastructure planning frameworks focused solely on economic efficiency frequently fail to adequately address social sustainability, environmental justice, and community welfare concerns (Bridge et al., 2018).

The review also revealed strong relationships between governance quality and infrastructure sustainability outcomes. Countries with stronger institutional systems and environmental enforcement frameworks demonstrated relatively better integration of stakeholder participation, environmental monitoring, regulatory compliance, and risk mitigation strategies within infrastructure planning processes (Ngcofe et al., 2025; Blackmore, 2015). In contrast, weak governance environments were consistently associated with hazardous facility clustering, land-use conflicts, regulatory non-compliance, and declining public trust in environmental governance systems (Yisa et al., 2019; Warf, 2017). The findings therefore demonstrate that sustainable facility siting requires not only technical optimization but also strong institutional accountability, participatory governance, and equitable distribution of environmental risks and socioeconomic benefits across affected communities.

5.2.6. Sustainability Transitions and Future Infrastructure Planning

An important emerging trend identified by this review is the gradual integration of sustainability-transition considerations into African infrastructure planning systems. Recent studies increasingly incorporate Green Hydrogen (GH_2), Waste-to-Energy (WtE), renewable integration potential, climate adaptation, and circular economy principles within oil and gas facility siting frameworks (Hansson et al., 2020; Hussein et al., 2025; Adu et al., 2025). These developments indicate that African infrastructure planning is gradually moving beyond conventional fossil-fuel-centred approaches toward adaptive multi-energy systems and low-carbon transition pathways. Further findings suggest that future siting algorithms will likely prioritize renewable compatibility, climate resilience, adaptive land-use planning, environmental restoration, and carbon reduction targets within sustainability-oriented spatial planning systems (Basile et al., 2021; Hughes et al., 2024).

Consequently, hybrid GIS–MCDA systems integrated with machine learning, remote sensing, and predictive climate modelling may become increasingly important for supporting long-term sustainable infrastructure planning across Africa (Wanasinghe et al., 2020; Fox et al., 2019).

The review further demonstrates that achieving sustainable energy transitions in Africa will depend heavily on the continent's ability to strengthen environmental governance, institutional coordination, geospatial infrastructure, participatory planning systems, and regional policy harmonization (Bridge et al., 2018; Ogwang and Vanclay, 2021). Ultimately, the findings indicate that the future of oil and gas facility siting in Africa lies in integrated spatial planning systems that combine scientific analytical precision, environmental accountability, social legitimacy, and adaptive sustainability planning to support safer, more equitable, and climate-resilient infrastructure development across rapidly urbanizing and environmentally vulnerable African regions.

6. Conclusion

This systematic review and descriptive meta-analysis demonstrate that oil and gas facility siting in Africa is shaped by a complex interaction of environmental, technological, socioeconomic, institutional, and governance-related factors. The synthesis revealed a significant methodological transition from traditional proximity-based and intuition-driven siting approaches toward integrated Geographic Information Systems (GIS) and Multi-Criteria Decision Analysis (MCDA) frameworks capable of supporting evidence-based, transparent, and sustainability-oriented spatial planning. The increasing adoption of hybrid approaches such as Fuzzy AHP–VIKOR further illustrates the growing effort to improve uncertainty handling, stakeholder integration, and environmental risk assessment within African infrastructure planning systems.

The findings additionally revealed substantial regional disparities in siting practices and institutional capacity across the continent. Southern African studies demonstrated relatively stronger integration of Environmental Impact Assessment (EIA), Strategic Environmental Assessment (SEA), and sustainability-oriented regulatory frameworks, particularly within South Africa.

In contrast, studies from West Africa, especially Ghana and Nigeria, consistently reported persistent regulatory non-compliance, hazardous facility clustering, weak enforcement of buffer regulations, and increasing urban encroachment around petroleum infrastructure. East African studies increasingly emphasized participatory governance, stakeholder inclusion, environmental justice, and land-right considerations, indicating an evolving recognition of the social dimensions of infrastructure siting.

The synthesis further demonstrated that poorly regulated siting practices contribute significantly to environmental degradation, groundwater contamination, biodiversity loss, air pollution, fire hazards, social displacement, and increased public health risks across Africa. These environmental and social impacts were particularly evident in regions characterized by weak environmental governance, rapid urbanization, overlapping infrastructure clusters, and inadequate enforcement of spatial planning regulations. At the same time, the review revealed that well-planned and scientifically informed siting frameworks were consistently associated with improved environmental compliance, reduced hazard exposure, enhanced spatial efficiency, and stronger levels of community acceptance. These findings confirm that sustainable facility siting extends beyond technical optimization and should instead be understood as a multidimensional governance and sustainability challenge requiring the integration of spatial analytics, environmental management, institutional accountability, stakeholder participation, and long-term climate resilience planning.

The review additionally revealed that emerging transition technologies such as Green Hydrogen (GH_2), Waste-to-Energy (WtE), and adaptive multi-energy systems are beginning to influence infrastructure planning across Africa. These developments suggest that future siting frameworks will increasingly incorporate renewable integration potential, carbon reduction targets, climate adaptation indicators, and circular economy principles within GIS–MCDA and hybrid decision-support systems. Overall, the study concludes that evidence-based, participatory, and regulation-driven siting frameworks are essential for ensuring that oil and gas infrastructure development contributes to sustainable land management, environmental protection, social equity, and long-term energy resilience across Africa.

The findings further demonstrate that the integration of geospatial technologies, environmental governance systems, and inclusive planning approaches provides the most viable pathway toward achieving safer, more equitable, and environmentally sustainable infrastructure development within rapidly urbanizing and climate-vulnerable African contexts.

7. Limitations of the Study

Despite the important insights generated by this study, several limitations should be acknowledged. First, the reviewed studies exhibited substantial heterogeneity in terms of methodological approaches, spatial scales, facility types, analytical techniques, reported variables, and outcome measures. This diversity limited the feasibility of conducting conventional pooled-effect statistical meta-analysis using standardized effect sizes and inferential heterogeneity statistics. Consequently, the study adopted a descriptive meta-analysis and thematic comparative synthesis approach rather than a fully pooled inferential statistical framework. Second, many African studies lacked standardized quantitative indicators, longitudinal datasets, and transparent reporting structures, thereby constraining direct statistical comparability across studies and regions. Most reviewed studies relied predominantly on static cross-sectional datasets and short-term spatial assessments, with relatively limited incorporation of temporal environmental monitoring, climate variability analysis, real-time geospatial datasets, and dynamic urban growth modelling. These limitations restricted the ability of existing studies to comprehensively evaluate long-term infrastructure sustainability, cumulative environmental impacts, and adaptive resilience under changing climatic and urbanization conditions.

Third, although broader repositories such as Google Scholar and ResearchGate improved coverage of African literature and reduced regional publication bias, the inclusion of grey literature may have introduced variability in methodological rigor, analytical consistency, and reporting quality. However, this limitation was minimized through rigorous PRISMA-guided screening, eligibility assessment, and quality appraisal procedures.

Fourth, the geographical distribution of reviewed studies was uneven across the continent, with a greater concentration of research originating from Ghana, Nigeria, and South Africa, while several Central African and North African regions remained underrepresented. This imbalance may affect the continental generalizability and regional comparability of some findings.

Finally, rapidly evolving energy-transition technologies, environmental regulations, climate adaptation policies, and sustainability frameworks imply that infrastructure-planning trends may continue to evolve beyond the review period covered by this study.

8. Recommendations

Based on the findings of this review, several recommendations are proposed to strengthen sustainable oil and gas facility siting and infrastructure governance across Africa. African governments and regulatory institutions should prioritise the strengthening of environmental governance and spatial planning systems by improving coordination among planning authorities, environmental protection agencies, fire services, petroleum regulators, and local governments. Stronger enforcement of siting regulations, buffer requirements, zoning standards, and Environmental Impact Assessment (EIA) procedures is essential for reducing environmental risks, minimizing hazard exposure, and improving public safety across rapidly urbanizing and environmentally vulnerable regions.

Governments and infrastructure regulators should institutionalize GIS–MCDA-based decision-support systems within national and local infrastructure planning frameworks. The formal integration of geospatial technologies into regulatory procedures would improve transparency, analytical consistency, environmental accountability, and evidence-based spatial planning for petroleum and energy infrastructure development. Future siting frameworks should additionally prioritize participatory and socially inclusive planning approaches. Community engagement, participatory GIS, stakeholder consultations, and comprehensive social impact assessments should be integrated throughout all stages of infrastructure planning to improve public acceptance, environmental justice, conflict reduction, and long-term project legitimacy.

There is also an urgent need to strengthen Africa's spatial data infrastructure and environmental monitoring systems. Investments should focus on digital mapping, remote sensing, real-time environmental monitoring, geospatial databases, and climate-risk modelling to improve adaptive planning capacity and long-term environmental management. African universities, research institutions, and planning agencies should further expand training programmes in GIS, spatial analytics, environmental modelling, and sustainability planning to address technical capacity gaps across the continent.

Future research should prioritise longitudinal and dynamic spatial analyses, real-time environmental monitoring, climate-resilient infrastructure planning, cumulative risk assessment, and machine-learning-assisted siting frameworks capable of addressing rapidly evolving environmental and urbanization pressures. Greater emphasis should also be placed on integrating climate adaptation, renewable energy compatibility, carbon reduction pathways, and circular economy principles within future oil and gas infrastructure planning models.

Finally, continental and regional institutions such as the African Union and Economic Community of West African States should support the development of harmonized regional siting guidelines, environmental governance standards, and cross-border spatial planning frameworks to improve policy coherence, regulatory consistency, and knowledge sharing across Africa's rapidly evolving energy sector.

Acknowledgment

The authors convey appreciation to everybody who assisted in the original text creation and enabled the final draft's publication.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Competing Interests

The authors have no relevant financial or non-financial interests to disclose.

Ethics Approval

This article is based on a systematic review and meta-analysis of previously published studies. Therefore, ethics approval was not required for this research.

Consent to Participate

Not applicable

Consent for Publication

Not applicable.

Declaration of Generative AI and AI-assisted Technologies in the Writing Process

During the preparation of this work, the authors used Quillbot to paraphrase text to enhance the readability of the work. After using this tool, the authors reviewed and edited the content as needed and took full responsibility for the content of the publication.

References

Abernethy, K., Maisels, F., White, L.J.T., 2016. Environmental Issues in Central Africa. Annual Review of Environment and Resources 41, 1-33. https://doi.org/10.1146/annurev-environ-110615-085415.

Abernethy, K., Maisels, F., White, L.J.T., 2016. Environmental Issues in Central Africa. Annual Review of Environment and Resources 41, 1-33. https://doi.org/10.1146/annurev-environ-110615-085415.

Adu, T.F., Brew, E.P., Mensah, L.D., Rockson, M.A.D., Kemausuor, F., 2025. Optimal Siting of Waste-to-Energy Facilities in Cape Coast Metropolis Using an Integrated GIS-Based MCDA and Waste Characterization Approach. Cleaner Waste Systems 12, 100353, 1-18. https://doi.org/10.1016/j.clwas.2025.100353.

Anang, D.A., Anyomi, K., Afotey, B., Rockson, M.A.D., Kwao-Boateng, E., Antwi, E., Tagoe, A.T., 2021. Petrol Filling Station Safety Assessment and Fire Safety Knowledge of Fuel Pump Attendants. Journal of the Ghana Science Association 20, (2), 47-54.

Asenso-Gyambibi, D., Danquah, J.A., Larbi, E.K., Quaye-Ballard, N.L., Peprah, M.S., Asante, B.A., Asamoah, E.A., 2023. Site Suitability Assessment for Petroleum Hubs and Oil Retail Assets in the Jomoro District: A Hybrid Approach Using Fuzzy AHP and VIKOR Method. Journal of Geomatics 17 (2), 119-133. https://doi.org/10.58825/jog.2023.17.2.59.

Barry, A.A., Caesar, J., Tank, A.M.G.K., Aguilar, E., McSweeney, C., Cyrille, A.M., Nikiema, M.P., Narcisse, K.B., Sima, F., Stafford, G., Touray, L.M., Ayilari-Naa, J.A., Mendes, C.L., Tounkara, M., Gar-Glahn, E.V.S., Coulibaly, M.S., Dieh, M.F., Mouhaimouni, M., Oyegade, J.A., Sambou, E., Laogbessi, E.T., 2018. West Africa Climate Extremes and Climate Change Indices. International Journal of Climatology 38 (1), e921-e938. https://doi.org/10.1002/joc.5420.

Basile, V., Capobianco, N., Vona, R., 2021. The Usefulness of Sustainable Business Models: Analysis from Oil and Gas Industry. Corporate Social Responsibility and Environmental Management 28, 1801-1821. https://doi.org/10.1002/csr.2153.

Bawuah, M.C., 2024. Environmental Impacts of Oil and Gas Well

Plugging and Abandonment: Best Practices and Future Directions. SAMRIDDHI: A Journal of Physical Sciences, Engineering and Technology 16 (4), 1-10. https://doi.org/10.18090/samriddhi.v16i04.06.

Blackmore, A., 2015. The relationship between the NEMA and the public trust doctrine: The importance of the NEMA principles in safeguarding South Africa's Biodiversity'. South African Law Journal 20 (2), 89-118.

Bos, K., Gupta, J., 2016. Inclusive Development, Oil Extraction and Climate Change: A Multilevel Analysis of Kenya. Int. J. Sustain. International Journal of Sustainable Development & World Ecology 23 (6), 482-492. https://doi.org/10.1080/13504509.2016.1162217.

Bosker, M., Garretsen, H., 2012. Economic Geography and Economic Development in Sub-Saharan Africa. World Bank Economic Review 26 (3), 443-485.

Boye, C.B., Abubakar, T., 2019. Application of Geographic Information System in Emergency Service Delivery – A Case of Ghana National Fire Service. Ghana Journal of Technology 3 (2), 65-72.

Bridge, G., Ozkaynak, B., Turhan, E., 2018. Energy Infrastructure and the Fate of the Nation: Introduction to Special Issue. Energy Research & Social Science 41, 1-11. https://doi.org/10.1016/j.erss.2018.04.029.

Chamberlain, L., Murombo, T., 2015. Environmental Law in South Africa. The implementation of international law in Germany and South Africa, 1-277.

Chang, S.E., Stone, J., Demes, K., Piscitelli, M., 2014., Consequences of Oil Spills: A Review and Framework for Informing Planning. Ecology and Society 19 (2), 1-26. http://dx.doi.org/10.5751/ES-06406-190226.

Cordes, E.E., Jones, D.O.B., Schlacher, T.A., Amon, D.J., Bernardino, A.F., Brooke, S., Carney, R., DeLeo, D.M., Dunlop, K.M., Escobar-Briones, E.G., Gates, A.R., Génio, L., Gobin, J., Henry, L-A., Herrera, S., Hoyt, S., Joye, M., Kark, S., Mestre, N.C., Metaxas, A., Pfeifer, S., Sink, K., Sweetman, A.K., Witte, U., 2016. Environmental Impacts of the Deep-Water Oil and Gas Industry: A Review to Guide Management Strategies. Frontiers in Environmental Science 4 (58), 1-26. https://doi.org/10.3389/fenvs.2016.00058.

Cotton, M., 2015. Stakeholder Perspectives on Shale Gas Fracking: A Q-Method Study of Environmental Discourses. Environ. Plan. A, 47:1944-1962.

Davies, T.C., 2015. Urban Geology of African Megacities. Journal of African Earth Sciences 110, 188-226. http://dx.doi.org/10.1016/j.jafrearsci.2015.06.012.

Davison, I., Steel, I., 2017. Geology and Hydrocarbon Potential of the East African Continental Margin: A Review. Petroleum Geoscience 24, 59-91. https://doi.org/10.1144/petgeo2017-028.

Fox, T.A., Barchyn, T.E., Risk, D., Ravikumar, A.P., Hugenholtz, C.H., 2019. Erratumi: A Review of Cloase-Range and Screening Technologies for Mitigating Fugitive Methane Emissions in Upstream Oil and Gas. Environmental Research Letters 14 (069601), 1-20. https://doi.org/10.1088/1748-9326/ab20f1.

Hansson, A., Fridahl, M., Haikola, S., Yanda, P., Pauline, N., Mabhuye, E., 2020. Preconditions for Bioenergy with Carbon Capture and Storage (BECCS) in Sub-Saharan Africa: The Case of Tanzania. Environ. Dev. Sustain., 22:6851-6875. https://doi.org/10.1007/s10668-019-00517-y.

Hope Sr, K.R., 2009. Climate Change and Poverty in Africa. Int. J. International Journal of Sustainable Development & World Ecology 16 (6), 451-461. https://doi.org/10.1080/13504500903354424.

Hughes, A., Caetano, T., Cunliffe, G., Hartley, F., Marquard, A., McCall, B., Merven, B., 2024. Developing and Maintaining a Policy-Focused, Comprehensive, Energy Systems Model in a Developing Country Context: The Case of SATIM in South Africa. Energy Strategy Review 56 (101594), 1-14. https://doi.org/10.1016/j.esr.2024.101594.

Hulme, M., Doherty, R., Ngara, T., New, M., Lister, D., 2001. Africa Climate Change: 1900-2100. Climate Research 14, 145-168.

Hussein, M., Jen, T.C., Imoisilli, P.E., 2025. South Africa Clean Energy Transition: The Future of Green Hydrogen Energy Technology. Energy Reports 13, 5501-5511. https://doi.org/10.1016/j.egyr.2025.05.005.

Jobodwana, Z.N., 2011. Integrating International Environmental Principles and norms into the South African Legal System and Policies. U.S.-China Law Rev., 8, 701.

Johannes, E.M., Zulu, L.C., Kalipeni, E., 2015. Oil Discovery in Turkana County, Kenya: A Source of Conflict or Development? African Geographical Review 34 (2), 142-164. https://doi.org/10.1080/19376812.2014.884466.

Lamorgese, L., Geneletti, D., Partidario, M.R., 2015. Reviewing Strategic Environmental Assessment Practice in the Oil and Gas Sector. Journal of Environmental Assessment Policy and Management 17 (2), 1-26. https://doi.org/10.1142/S1464333215500179.

Mahmood, Y., Afrin, T., Huang, Y., Yodo, N., 2023. Sustainable Development for Oil and Gas Infrastructure from Risk, Reliability, and Resilience Perspectives. Sustainability 15 (4953), 1-22. https://doi.org/10.3390/su15064953.

Makka, K., Kampova, K., Lovecek, T., Petrlova, K., 2021. An Environmental Risk Assessment of Filling Stations Using the Principles of Security Management: A Case study in the Slovak Republic. Sustainability 13 (12452), 1-15. https://doi.org/10.3390/su132212452.

Namaganda, E., Otsuki, K., Steel, G., 2023. Understanding the Cumulative Socioenvironmental Impacts of Energy Transition-Induced Extractivism in Mozambique: The Role of Mixed Methods. Journal of Environmental Management 338 (117811), 1-10. https://doi.org/10.1016/j.jenvman.2023.117811.

Ngcofe, L., Makhanga, S.P., Mpopiya, S., Klaas, L., Adams, C., 2025. Geospatial Analysis of Potential Petrol Station Locations in the Cape Town District, South Africa. South African Journal of Geomatics 14 (2), 317-332. https://dx.doi.org/10.4314/sajg.v14i2.9.

Nicholson, SE., 2017. Climate and Climatic Variability of rainfall Over Eastern Africa. Reviews of Geophysics 55, 590-635. https://doi.org/10.1002/2016RG000544.

Ogwang, T., Vanclay, F., 2021. Cut-Off and Forgotten?: Livelihood Disruption, Social Impacts and Food Insecurity Arising from the East African Crude Oil Pipeline. Energy Research & Social Science 74 (101970), 1-11. https://doi.org/10.1016/j.erss.2021.101970.

Peprah, M.S., Boye, C.B., Larbi, E.K., Appau, P.O., 2018. Suitability Analysis for Siting Oil and Gas Filling Stations Using Multi-Criteria Decision Analysis and GIS Approach – A Case Study in Tarkwa and Its Environs. Journal of Geomatics 12 (2), 158-166.

Priestley, K., McKenzie, D., Debayle, E., Pilidou, S., 2008. The African Upper Mantle and Its Relationship to Tectonics and Surface Geology. Geophysical Journal International 175, 1108-1126. https://doi.org/10.1111/j.1365-246X.2008.03951.x.

Shuen, A., Feiler, P.F., Teece, D.J., 2014. Dynamic Capabilities in the Upstream Oil and Gas Sector: Managing Next Generation Competition. Energy Strategy Reviews 3, 5-13.

http://dx.doi.org/10.1016/j.esr.2014.05.002.

Ulakpa, R.O.E., Ulakpa, W.C., Eyankware, O.E., 2022. Petroleum Filling Stations and their Impact on the Environment in Nigeria. Journal of Environmental Earth Sciences 4 (1), 1-14. https://doi.org/10.30564/jees.v4i1.4073.

Venables, A.J., 2010. Economic Geography and African Development. Papers in Regional Science 89 (3), 469-483. https://doi.org/10.1111/j.1435-5957.2010.00312.x.

Wanasinghe, T.R., Wroblewski, L., Petersen, B.K., Gosine, R.G., James, L.A., de Silva, O., Mann, G.K.T., Warrian, PJ., 2020. Digital Twin for the Oil and Gas Industry: Overview, Research Trends, Opportunities, and Challenges. IEEE Access, 1-23. https://doi.org/10.1109/ACCESS.2020.2998723.

Warf, B., 2017. Geographies of African Corruption. PSU Research Review: An International Journal 1 (1), 20-38. https://doi.org/10.1108/PRR-12-2016-0012.

Yisa, J., Olubadewo-Joshua, O., Okosun, O.S., 2019. Utilization of GIS Techniques as Decision Support System for Location of Filling Stations in Minna, Niger State, Nigeria. Geosfera Indonesia 4 (3), 247-263. https://doi.org/10.19184/geosi.v4i3.9713.

Zhu, J., Zhu, M., Chen, L., Luo, L., Wang, W., Zhu, X., Sun, Y., 2024. Multi-Objective Optimization of Urban Gas Station Site Selection Under Territorial; Spatial Planning Constraints. ISPRS International Journal of Geo-Information 13 (375), 1-20. https://doi.org/10.3390/ijgi13110375.