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DIGITAL LAND GOVERNANCE AND GENDER JUSTICE: THE ROLE OF ARTIFICIAL INTELLIGENCE AND GEOSPATIAL TECHNOLOGIES IN NIGERIA'S CUSTOMARY AND STATUTORY LAND ADMINISTRATION

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Abstract

Land constitutes one of Nigeria's most valuable economic, social, cultural and environmental resources. Nevertheless, women's access to ownership and control of land remain constrained by interaction of customary institutions, statutory law, patriarchal social relations and administrative practices. Existing studies have largely examined women's land rights through legal, socio-cultural and economic perspectives, with limited attention to how Fourth Industrial Revolution technologies contributed to gender-responsive land governance. This paper examines the potential of Artificial Intelligence (AI), Geographic Information Systems (GIS), Remote Sensing, Global Navigation Satellite Systems (GNSS), block-chain, unmanned aerial vehicles (UAVs), cloud computing and digital cadastral systems in transforming Nigerian land administration and promote gender justice. African Feminist Theory, Legal Pluralism Theory, Social Relations Theory and Digital Governance Theory provide the analytical framework. The study adopted a qualitative research approach; designed based on critical analysis of scholarly literatures such as gender studies and legislation books, judicial decisions, international policy instruments and institutional publications. The paper argues that AI-assisted land administration, GIS-based cadastral mapping, gender-disaggregated spatial databases, block-chain enabled land records and digital land information systems; improve transparency, reduce administrative inefficiencies and corruption, strengthen women's tenure security and support evidence-based policy. However, technology is not yet including gender-neutral. Gender bias, historical data in accurate, digital exclusion, weak policy implementation andlow institutional capacity, inadequate infrastructure and patriarchal customary structures reproduce the existing inequalities through digital bias computation. The paper therefore proposes an interdisciplinary digital land governance framework that connects customary and statutory institutions with gender-sensitive AI and geospatial technologies. It concludes that technological innovation can contribute to sustainable gender justice only when accompanied by legal reform, institutional accountability, transparency, community participation, digital inclusion and culturally responsive governance.

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Keywords: Artificial Intelligence; geospatial technologies; Geographic Information Systems; gender justice; land administration; customary land tenure; statutory land administration; digital governance; Nigeria.

Introduction

Land has historically occupied a central position in the socio-economic, political, cultural and environmental development of human societies. It is not merely an economic commodity but also a source of identity, ancestry, livelihood, social security, political authority, cultural continuity and intergenerational inheritance. Across African societies, customary tenure institutions developed mechanisms for allocating land, regulating access to productive resources, maintaining communal identity and resolving disputes (Alden Wily, 2018; Agarwal, 2003). Although colonialism and postcolonial statutory reforms transformed the existing land institutionalised structures, customary land tenure systems continue to influence land access and administration across Nigeria. Nigeria therefore now operates a plural land governance system in which statutory and customary arrangements coexist. The Land Use Act of 1978 represents the principal statutory framework and vests land in each state in the Governor to hold in trust for the people (Olumba, and Olumba, 2026). Nevertheless, customary institutions continue to regulate family, lineage and communal land, particularly in rural areas. Family heads, traditional rulers, lineage authorities and community institutions remain influential in land allocation, inheritance and dispute settlement. This coexistence of statutory and customary systems creates both opportunities and challenges. Customary institutions provide locally legitimate mechanisms for land allocation and conflict resolution, while statutory institutions provide formal legal documentation and administrative procedures for both rural and urban communities. However, conflicting authorities, overlapping claims and different understandings of ownership create legal uncertainty. These tensions become particularly significant when customary practices conflict with constitutional principles of gender equality and equity (Olumba, 2026).

Gender inequality represents one of the most persistent dimensions of this problem. Nigerian women make substantial contributions to agriculture, environmental management, household welfare and local economic development, yet their rights to acquire, inherit, own, register, control and transfer land remain weaker than those of men in many communities. In patrilineal customary systems, inheritance is frequently structured around male lineage, while

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women's access may be mediated through fathers, husbands, brothers or sons (Babalola, Nkwemoh, Williams, Popoola, and Tunji-Adepoju, 2024). Consequently, women may have access to land for cultivation or residence without enjoying equivalent rights of ownership, control or transfer. The consequences extend beyond individual property rights. Insecure land tenure can reduce women's access to agricultural credit, investment, housing security, compensation, financial services and economic opportunities. Secure land rights, by contrast, can contribute to agricultural productivity, food security, household welfare, poverty reduction, financial inclusion and climate resilience (Doss et al., 2018; Meinzen-Dick et al., 2019; FAO, 2023).

The emergence of the Fourth Industrial Revolution provides new possibilities for addressing some of these challenges. Artificial Intelligence (AI), Geographic Information Systems (GIS), Remote Sensing, Global Navigation Satellite Systems (GNSS), unmanned aerial vehicles (UAVs), block-chain, cloud computing, machine learning and digital cadastral systems are transforming land administration globally. AI can process large datasets, detect anomalies, support property valuation and improve administrative decision-making, while GIS and related geospatial technologies can provide accurate information on parcels, boundaries, land use, infrastructure and environmental conditions (Longley et al., 2021; Russell and Norvig, 2021). These technologies are particularly relevant to gender-responsive land administration because digital systems can make gender inequalities visible. Gender-disaggregated cadastral databases could reveal the distribution of land ownership between women and men, patterned joint ownership, inheritance outcomes, compensation and access to land-related services. GIS can display these inequalities spatially, allowing policymakers to identify communities and regions where women experience particularly severe barriers. However, technological innovation is not automatically progressive. AI systems depend on data, and historical land records may reflect discriminatory social relations. If biased data are transferred into digital systems, technology may reproduce rather than eliminate inequality. Similarly, women living in rural communities may experience limited access to smartphones, internet services, digital literacy, financial resources and formal land institutions. Feminist technology scholars therefore caution that technological systems must be analysed in relation to power and resources, representation, inequality and institutional context (D'Ignazio and Klein, 2020; Toupin, 2024). This study consequently approaches digital land governance not

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as a purely technological project but as a gender, legal, cultural and institutional transformation. It examines how emerging technologies can be integrated into Nigeria's customary and statutory land administration while respecting legitimate indigenous governance and simultaneously protecting constitutional principles of equality and women's land rights.

Knowledge Gap

There is extensive scholarship paper on gender inequality and land ownership in Nigeria. Existing research has examined customary inheritance, statutory land law, women's agricultural rights, land tenure insecurity, patriarchal institutions and legal reforms. Other studies have investigated digital governance, GIS, cadastral systems and technological transformation independently. However, relatively limited scholarship integrates these areas into a single analytical framework. Much of the literature treats gender inequality as a legal or cultural problem, while technological studies often concentrate on administrative efficiency rather than distributive justice. Similarly, land administration research may focus on cadastral accuracy without examining whose interests are represented within cadastral databases. This paper addresses this gap by bringing together Gender Studies, African Feminist Theory, Legal Pluralism, Social Relations Theory, Artificial Intelligence, geo-informatics and Digital Governance Theory. The study advances the argument that digital transformation should not simply make existing land administration easier and faster; it makes it more equitable, transparent and gender responsive. Rather than conceptualising customary institutions solely as barriers to gender equality, the study explores how legitimate customary structures can participate in digital land governance while discriminatory practices are challenged.

Conceptual Framework

Conceptualising Artificial Intelligence and Digital Land Administration

Artificial Intelligence refers to the computational systems capable of performing functions that associated with learning, reasoning, prediction, pattern recognition and decision support (Russell and Norvig, 2021). AI has potential applications throughout the process of land administration cycle. It can assist in: automated processing of land registration, applications; verification of ownership documentation; detection of duplicate applications; identification of

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fraudulent transactions; property valuation; prediction of land-use, and transfer or changed land title; analysis of land disputes; environmental monitoring and evidences; spatial planning; and gender-disaggregated analysis of land ownership. Machine-learning systems can analyse large volumes of cadastral records, satellite imagery, demographic information, transaction histories and legal documentation. This could improve administrative efficiency and identify inconsistencies that might be difficult to detect manually. AI also offers opportunities for gender-responsive governance. If land information systems contain sex-disaggregated data, AI can identify disparities in ownership, registration, inheritance, compensation and access to land-related services. For example, a digital land information system can identify communities in which female ownership is significantly lower than male ownership. Policymakers can target legal awareness, registration support or community dialogue in those areas. However, AI systems must be treated cautiously. Algorithms learn from data, and land data can contain historical inequalities. If predominantly male ownership records are interpreted as evidence of a legitimate social pattern rather than a consequence of discrimination, the resulting algorithm may reinforce existing inequalities. Therefore, ethical AI land administration should incorporate fairness, transparency, accountability, explain ability, privacy and human oversight (Bawa, 2024).

Geospatial Technologies and Gender-Responsive Land Governance.

Geospatial digital technologies include GIS, Remote Sensing, GNSS, UAVs, LiDAR, digital photogrammetry and spatial databases. They allow information to be collected, stored, analysed and visualised according to the geographical location. GIS is particularly important because land ownership is inherently spatial. GIS can integrate parcel boundaries with ownership information, land use, infrastructure, demographic characteristics and environmental conditions. A gender-responsive GIS can map: female land ownership; male land ownership; joint land ownership; agricultural land access; inheritance patterns; access to roads and markets; access to agricultural infrastructure; areas of land conflict; climate vulnerability; and spatial patterns of land registration. Such maps can make gender inequalities visible to policymakers and communities. Remote Sensing complements GIS by providing satellite observations of land-use change, urban expansion, agricultural activity, flooding, deforestation and environmental degradation. UAVs can produce high-resolution images for cadastral mapping, while GNSS improves the positional accuracy of boundaries.

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Together, these technologies can strengthen cadastral surveys, boundary demarcation, land-use planning and dispute resolution (Bearman, 2025).

Digital Land Governance and Gender Justice

Digital land governance involves the use of digital technologies to improve land registration, cadastral management, public access, policy implementation, planning and institutional accountability. Traditional land administration systems may experience: incomplete records; paper-based documentation; multiple allocations; fraudulent transactions; bureaucratic delays; poor record management; limited public access; corruption; and weak coordination between institutions. Digital land information systems can address some of these challenges through electronic records, automated workflows, online applications, spatial databases and integrated cadastral systems. From a gender perspective, digital registration can help document women's land rights. Joint spousal registration can strengthen women's security, while gender-disaggregated records can provide statistical evidence for policy monitoring. However, digitisation can also create exclusion. Women without digital skills, internet access, financial resources or knowledge of formal land procedures may remain marginalised. Therefore, digital transformation should include community education, affordable access, assisted registration and local-language information (Bawa, 2024; Barry, and Stephenson, 2025).

Nigerian Customary and Statutory Land Administration

Nigeria's statutory land administration is primarily governed by the Land Use Act of 1978. The Act vests land in each state in the Governor, who holds it in trust for the citizens. Rights of occupancy provide the principal formal mechanism for recognising land interests. Customary tenure, however, remains important, particularly in rural and peri-urban communities. Family heads, traditional rulers and community institutions continue to influence allocation, inheritance and dispute resolution (Olumba, and Olumba, 2026).This pluralism creates administrative complexity. A parcel may have a customary history that is not adequately reflected in formal documentation. Conversely, formal documentation may not be fully accepted within a community where customary authority remains strong on women, these institutional overlaps are significant in Nigeria ethnics society. A woman may possess a customary entitlement through social status that is socially recognised but not

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formally documented, and formal legal right is difficult to enforce within a patriarchal community. Digital governance can potentially bridge this gap by establishing interoperable systems that record statutory and legitimate customary interests. Such a system does not easily convert every customary practice into a digital record; it should distinguish between legitimate customary rights and practices inconsistent with constitutional equality (Nigerian Institution of Surveyors. 2022).

Artificial Intelligence, GIS and Fourth Industrial Revolution

The Fourth Industrial Revolution has expanded the boundaries of Gender Studies by introducing AI, big data, machine learning, GIS, computational social science and digital governance into the study of inequality. AI can reveal patterns of inequality in administrative datasets. GIS can reveal spatial dimensions of gender inequality. Big data can facilitate large-scale analysis, while digital platforms can support advocacy and public participation. Technology has also transformed feminist activism. Social media enables women and feminist organisations to organiseawareness campaigns, share information and influence public policy. However, digital spaces create challenges, including online harassment, surveillance, misinformation and unequal access. This relevance to Nigerian land governance lies in the possibility of combining digital technologies with gender analysis. Rather than studying gender inequality through interviews and legal documents, researchers increasingly examined spatial and administrative datasets in different studies. For example, GIS could identify communities with gender disparities in women's land ownership. AI could analyse registration patterns and identify whether particular administrative processes disproportionately disadvantage women (Bike, Emoh, and Oladejo, 2025). Nevertheless, technological systems must remain subject to human rights and ethical principles. Digital colonialism is also an important concern because African digital infrastructures and data systems may depend heavily on external technologies and assumptions. Nigeria therefore requires locally responsive digital governance that incorporates African knowledge systems and gender perspectives (Okorie, and Olagunju, 2025).

Block-chain and Digital Land Records

Block-chain technology offers another potential component of digital land administration. Block-chain can create and distributed records that difficult to alter retrospectively. Potential

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applications include: Any properly secure register land can reduce multiple allocations; improved traceable transactions protect unauthorised alterations; improved transparency; and enhanced public confidence. However, block-chain should not be regarded as a substitute for legal and institutional governance. Bock-chain system can preserve inaccurate information if incorrect information is entered into the system. Therefore, verification of land ownership and protection of vulnerable groups remain necessary to ensure equity and justice. Block-chain should consequently be integrated with cadastral mapping, statutory registration, customary verification, AI-supported auditing and human oversight (Russell, and Norvig, 2021).

Theoretical Framework

The study adopts an interdisciplinary theoretical framework consisting of African Feminist Theory, Legal Pluralism Theory, Social Relations Theory and Digital Governance Theory.

African Feminist Theory

African Feminist Theory provides an appropriate framework because Nigerian gender relations are embedded in historical, cultural, religious, kinship and community structures. African feminist scholars have questioned the universal application of Western feminist categories and emphasised the importance of African histories and indigenous social institutions (Oyěwùmí, 1997, 2005). (Nnaemeka's, 2004) concept of nego-feminism emphasises negotiation, dialogue, cooperation and culturally situated transformation. This approach is particularly useful for Nigerian land governance because traditional rulers, family heads, women's associations, religious institutions and community leaders remain influential in land acquisition and administration, African Feminist Theory suggested that gender reforms should not simply impose external models but should engage communities in transforming discriminatory practices. Digital land governance should therefore incorporate culturally legitimate institutions while ensuring women's rights are protected. African feminist approaches are also increasingly relevant to AI governance. Emerging feminist technology scholarship argues that technological systems should recognise local knowledge, communal values, social justice and historical inequalities rather than assuming that technological models developed elsewhere are universally appropriate for Nigeria land governance (Ebunoluwa, 2009).

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Legal Pluralism Theory

Legal Pluralism explained the coexistence of multiple legal and normative systems within a society. Nigeria provides an important example because statutory law operates alongside with customary law and, in some contexts, inheritance and religious norms. In land administration, the Land Use Act operates alongside customary systems governing family, lineage and communal land. This produced overlapping authority and sometimes conflicting interpretations of land rights. For women, legal pluralism produced different outcomes depending on whether statutory law, customary norms or community authority predominates land transactions. Woman's constitutional right may therefore coexist within a customary rule that limits women's inheritance sharing right. Digital land administration provided opportunity to document land transactions and connect the transactions with different systems. Digital platforms record legitimate customary rights, link them with statutory documentation and creates transparent mechanisms for addressing competing claims (Singler, and Babalola, 2025).

Social Relations Theory

Social Relations Theory, associated with (NailaKabeer 1994), explained gender inequality through institutional relationship's governing access to resources, authority, responsibilities and opportunities. This approach is especially relevant because women's land rights are shaped by relationships within families, lineages, communities, markets and state institutions. A woman' may have formal right to acquire land but face barriers from family heads, customary authorities, financial institutions or land administrators. Social Relations Theory therefore demonstrates that gender land inequality cannot be solved by legal reform alone. Institutions and relationships through which rights are exercised must also change in realise justice.

Digital Governance Theory

Digital Governance Theory explained how information and communication technologies transform public administration, transparency, accountability, citizen participation and service delivery. Electronic land registration, digital cadastral systems, GIS, AI, block-chain and cloud-based databases can reduce administrative delays and improve public access to

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information. Digital systems can also reduce opportunities for document manipulation and provide audit trails for administrative decisions. Nevertheless, technology may reproduce institutional inequality if the underlying data or governance arrangements are bias, discriminatory and manipulated. Digital governance must therefore incorporate gender responsiveness, privacy, accessibility, accountability, transparency and algorithmic fairness. The four theories collectively provide a comprehensive framework. African Feminist Theory explained cultural and gender relations; Legal Pluralism explained overlapping legal systems; Social Relations Theory explained institutional power; Digital Governance Theory explained technological transformation (UNESCO. (2021).

Methodology

The study adopted a qualitative research Approach, with critical reviewing and analysing scholarly literatures such as, Journals and books on legislation, judicial decisions, digital land management, Gender studies, international policy instruments and institutional publications. Qualitative approach is the best applicable method for the study of this nature because it provides rooms for contexts analysis and theoretical framework that providedeeper insight and knowledge into the subject matter through available literatures.

Discussion

This paper analysis demonstrated that gender inequality in Nigerian land administration is produced through interconnected cultural, legal, institutional and technological factors. Customary inheritance systems produce gender differences in land ownership right. while, statutory gender neutral policy experiences weak implementations and not accessible to rural women. Administrative procedures may create delays and high costs. Inadequate land records make ownership difficult to verify. Finally, digital exclusion creates another layer of inequality. However, these problems cannot be solved through technology alone. AI and GIS can improve the visibility and management of land rights, but they cannot determine whether a particular customary rule is just. Similarly, block-chain can protect records but cannot decide whether the information recorded is equitable. The study therefore argues that technology must operate within broader gender-responsive institutional framework. The integration of AI, GIS and digital cadastral systems can create a new forms of land governance in which information is more accessible, decisions are more traceable and gender

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disparities are measurable. The key transformation should therefore be from: paper-based administration, gender-blind digital administration, gender-responsive digital governance and integrated digital administration must be more important. The distinction became the study contribution and proposed interdisciplinary framework for the sustainable Gender-Responsive Digital Land Governance (Ayanwale, and Kehinde, 2025; World Bank. (2024).

Conclusion

This paper examined the relationship between digital technologies, gender justice and land administration within Nigeria's customary and statutory land governance systems. The analysis demonstrated that women's unequal access to land cannot be understood solely as a legal problem; produced through the interaction of customary inheritance, patriarchal social relations, statutory institutions, administrative structures, economic constraints and technological inequalities. Nigeria's plural land governance system creates a particularly important context for digital transformation. Customary institutions remain influential in many communities, while statutory law provides formal mechanisms for land administration. The future of Nigerian land governance should therefore not be based on the complete replacement of customary institutions but on the development of accountable relationships between digital technologies, customary and statutory systems.

Limitations of the Study

This study based primarily on doctrinal and documentary analysis. It does not contain primary empirical data collected directly from women landholders, customary authorities, land administrators, surveyors or other stakeholders. The proposed framework therefore requires empirical validation. Future research should employ quantitative and mixed-method method that involving interviews, focus group discussions, household surveys, participatory GIS, cadastral mapping and AI-supported spatial analysis. Comparative studies across different Nigerian states would also be useful because customary land institutions differ considerably across ethnic, ecological and socio-economic contexts.

Recommendations

Based on the study analysis, the paper recommends the following: Federal and state governments should modernise land administration through integrated digital land

information systems incorporating AI and geospatial technologies. State land agencies should establish gender-disaggregated cadastral databases capable of monitoring women's land ownership, inheritance, registration and compensation. Relevant provisions of the Land Use Act should be reviewed to strengthen gender equality, administrative efficiency and protection of legitimate land rights. Customary land records should be progressively digitised in partnership with legitimate traditional institutions while ensuring that discriminatory practices are not reproduced in digital systems. Digital land registration should facilitate joint ownership, including appropriate mechanisms for recording spouses' interests. AI applications should be governed by ethical principles, including fairness, transparency, explain ability, accountability, privacy and non-discrimination. Women should participate directly in digital land governance, including community mapping, registration campaigns, policy development and monitoring. Universities should develop interdisciplinary programmes connecting Gender Studies, Artificial Intelligence, GIS, Land Administration, Law and Public Policy. Professional institutions should provide continuing education for surveyors, lawyers, planners and land administrators on gender-responsive digital governance. Government should strengthen rural digital infrastructure so that technological transformation does not deepen the digital gender divide. Development partners should support capacity-building, digital literacy, infrastructure and gender-responsive land governance initiatives. Future empirical studies should test the proposed framework through interviews, focus groups, household surveys, participatory GIS, cadastral analysis and AI-assisted spatial modelling.

Contribution to Knowledge

This study therefore makes several contributions to knowledge: It develops an interdisciplinary framework connecting African Feminist Theory, Legal Pluralism Theory, Social Relations Theory and Digital Governance Theory. Extends existing gender-and-land scholarship by introducing AI and geospatial technologies as instruments for gender-responsive land administration. Connects customary and statutory land governance with digital transformation rather than examining these systems separately. Demonstrated how gender-disaggregated spatial databases can make inequalities in land ownership and access visible. Contributed to African scholarship on the gender implications of the Fourth Industrial Revolution. Finally provides a framework for moving beyond questions of whether

technology can modernise land administration and whether digital transformation can make land governance more just, inclusive and accountable.

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