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Artificial Intelligence as a Governance Tool for Sustainable Resource Management: A Thematic and Analytical Review

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ABSTRACT

This research highlights the significance of synthetic intelligence (AI) for 21st-century natural science governance, efficiency, and sustainability. The study uses a qualitative, descriptive-analytical method and is based on a systematic review of studies conducted between 2020 and 2026. Studies were organized by main themes, including AI technologies, governance frameworks, sustainability, and ethical considerations, and analyzed using a matrix-based methodology. The results indicate that artificial intelligence has become a tool of strategic governance, increasing transparency and efficiency of resource allocation as well as policy effectiveness. Nonetheless, many challenges still remain, data availability and scarcity, technology complexity, and a lack of legal and ethical frameworks. Once again, the paper highlights a gap between AI's maximum potential and its actual application -- particularly in developing contexts. It concludes that AI governance cannot be effective in isolation and must be informed by greater contextualization and ethical considerations to manage resources sustainably and equitably.

الملخص

يُسلّط هذا البحث الضوء على أهمية الذكاء الاصطناعي في حوكمة العلوم الطبيعية وكفاءتها واستدامتها في القرن الحادي والعشرين. تستخدم الدراسة منهجًا نوعيًا وصفيًا تحليليًا، وتستند إلى مراجعة منهجية للدراسات التي أُجريت بين عامي 2020 و2026. وقد نُظّمت الدراسات وفقًا لمواضيع رئيسية، تشمل تقنيات الذكاء الاصطناعي، وأطر الحوكمة، والاستدامة، والاعتبارات الأخلاقية، وحُلّلت باستخدام منهجية قائمة على المصفوفات. تُشير النتائج إلى أن الذكاء الاصطناعي أصبح أداةً للحوكمة الاستراتيجية، مما يُعزز الشفافية وكفاءة تخصيص الموارد، فضلًا عن فعالية السياسات. ومع ذلك، لا تزال هناك تحديات عديدة، منها توافر البيانات وندرتها، وتعقيد التكنولوجيا، والافتقار إلى أطر قانونية وأخلاقية. مرة أخرى، تُبرز الورقة البحثية الفجوة بين الإمكانات القصوى للذكاء الاصطناعي وتطبيقه الفعلي، لا سيما في السياقات النامية. وتُلخص أن حوكمة الذكاء الاصطناعي لا يُمكن أن تكون فعّالة بمعزل عن السياق، بل تحتاج إلى مزيد من السياق والاعتبارات الأخلاقية لإدارة الموارد بشكل مستدام وعادل.

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1. Introduction

Artificial Intelligence (AI) has recently been recognized as a transformative technology in some sectors of governance, and its use in environmental governance and natural resource management is starting to make an impact via advances in data processing, predictive modeling, and decision-making tools. These capabilities underscore the relevance of AI in tackling complex sustainability challenges, such as climate change mitigation, ecosystem resilience, and optimal resource utilization. This has led to increased adoption of AI in governance systems to improve transparency, accountability, and operational efficiency in natural resources management processes (Hanushchyn et al., 2025; Thapa et al., 2024). Merging AI and governance created a new class of models called smart governance, in which strategies based on digital technologies and data-driven advances support policy formulation and implementation. For example, AI-based governance has been shown to enhance adaptive systems and sustainable resource management, as demonstrated by Moleka (2026) and Rahman & Hossain (2025). In the same vein as pragmatic experimentation by Zhu et al. (2025) and Zhang and Cao (2025), it is well known that digital governance markedly increases resource efficiency and economic sustainability. Such findings thus suggest that AI is transitioning from a technical device to a strategic governance tool with the potential to transform institutional structures and policy outcomes. However, despite new advancements, the incorporation of AI into natural resource governance remains complex and context-dependent. Specific problems persist, as highlighted by multiple studies, including those of Lozo & Onishchenko (2021) and Camilleri (2024), who list issues such as data quality, algorithmic bias, and governance inefficiencies. Additionally, the applicability of AI-driven coexistence systems is partially determined by high-quality digital infrastructure and institutional capacity, which do not impact all regions equally, especially in developing countries (Maghsoudi et al., 2025; Okoi, 2025). It also begs some crucial questions about the scalability and inclusiveness of AI-based governance models. While artificial intelligence is adopted in natural resource management, there is a gaping knowledge gap on how AI-driven governance frameworks can be delivered and implemented successfully across varied landscapes with limited resources. Most previous research focuses on AI's technical capabilities and efficiency benefits, while relatively few studies consider ethical, institutional, and socio-political problems arising from its use (Hanushchyn et al., 2025; Tatar et al., 2024). Paradigmatically, there is a lack of context-specific governance models that accommodate differences in infrastructure, regulatory capacity, and public acceptance (especially in developing regions; Moleka, 2026; Rahman & Hossain, 2025).

Moreover, the lack of a common ethical and legal framework for these technologies raises serious questions about accountability, transparency, and potential biases in AI-driven decision-making (Rassolov & Chubukova, 2022; Camilleri, 2024). While AI has shown great promise in potential for enhanced governance efficiency (Sharma et al., 2020) and improved sustainability outcomes (Vardhan et al., 2016), their implementation in practice often runs into challenges such as policy gaps, underlying technology dependency, technology complexity and a low state of institutional preparedness (Salam et al., 2023; Kumar et al., 2024). This results in a divergence between AI's theoretical promise and practical applicability, particularly in systems governing natural resources. Consequently, this study attempts to analyze the role of AI in natural resource governance by identifying key challenges, assessing existing governance frameworks, and exploring alternative approaches that are more inclusive, ethical, and context-specific (to enable sustainability and the responsible deployment of AI).

These findings are of considerable social relevance: with the increasing role that AI is playing in natural resources governance and allocation, this study provides timely insight into this. The research addresses issues such as transparency, accountability, and ethical decision-making to ensure that AI systems serve the public interest, preventing practices that reinforce inequality or exclusion. It also underlines the need to maximize public trust in how AI is applied in governance through fairness and inclusivity. The research ultimately helps promote a more sustainable, equitable, and socially responsible management of natural resources — an important consideration given the link between local communities' livelihoods and the long-term stability of ecosystems.

2. Literature Review

There has been increasing scholarly interest in understanding the governance of artificial intelligence (AI) in natural resource management, reflecting growing recognition that AI is vital to sustainable, efficient management. For example, work by Coulson et al. (1987) was integral to the introduction of a position for AI in supporting environmental decision-making processes, which they later (Stock & Rauscher, 1996) further developed by embedding AI-based decision-support systems. The literature over the past couple of years has shifted away from examining AI in general toward analyzing it within governance frameworks, focusing on transparency, accountability, and efficiency. For instance, Hanushchyn et al. (2025). Tatar et al. (2025) emphasize the significance of AI in improving transparency and operational efficiency in natural resource management. In a guided research on governance quality in natural resource rich economies, data available at which caliber of machine learning improve the governance quality (2024) Similarly, Zhu et al. (2025) and Zhang & Cao (2025) show that digital governance mechanisms play a substantial role in increasing the efficiency of resource utilization. Furthermore, recent studies have begun to address the relationship of AI with sustainability and good governance. Moleka (2026) considers AI-powered governance a key enabler of ecosystem resilience in Africa, while Rahman and Hossain (2025) call for an integrative synergy between governance, finance, and technology to realize sustainable outcomes. Simultaneously, Song and Deng (2025) connect the diffusion of artificial intelligence to improvements in green economic efficiency, and Li et al. (2024) illustrate how digital governance alleviates the resource curse by increasing economic complexity. Arguments that support these views can be found in Kulshrestha et al. (2025) and Chauhan et al. (2025), who explain how advanced analytics and artificial intelligence can be used to promote sustainable development by developing resource management strategies.

The discussion continues to revolve around ethical issues and governance. Korol and Korol (2025) suggest different forms of AI-augmented governance that integrate moral law-making into rural resource systems; Lozo and Onishchenko (2021) discuss legal, political, and ethical limitations to classroom use of AI for environmental purposes. According to Camilleri (2024) and Rassolov & Chubukova (2022), strong legal frameworks and ethical governance are crucial to the responsible use of AI. The same holds for new studies (e.g., Amir and Nasir, 2025; Thomas et al., 2025), which acknowledge the need for more inclusive and resilient resource governance through community-based and policy-driven strategies. Moreover, technological advances such as blockchain and smart governance frameworks are increasingly incorporated into AI governance models. Huang et al. (2025) propose blockchain-enabled ecological governance systems, as do Kumar et al. (2024) and Salam et al. (2023) discuss when AI is used for smart governance in public administration. Similarly, Takeda et al. (2021) and Wang et al. (2025) demonstrate the application of AI in water and river basin governance, showing how the whole-of-system resource management can be reoriented with sector-specific utility. Even with these developments, researchers have identified limitations (Okoi, 2025; Maghsoudi et al., 2025). Such global governance challenges include planet-wide dangers and societal threats arising from the application of AI (Karn, 2025).

The literature clearly points to a shift from AI being seen as a purely technical tool to a more holistic governance instrument for sustainability outcomes in software development. Yet, there are still substantial gaps, especially in the form of context-relevant governance frameworks for transitioning regions and ethical considerations regarding AI-enabled decision-making in natural resource management. This study conducted a scoping review of the literature on AI governance for natural resource management, identifying and organizing studies that provided overviews of the state of knowledge. Table 1 summarizes the main contributions by outlining the technologies used, their applications, and the major advantages and drawbacks reported in each study. This format enables better comparisons across studies and identifies common themes, strengths, and challenges in the field. It also enables a more systematic understanding of how AI technologies are being integrated into governance frameworks to enhance efficiency, transparency, and sustainability in natural resource management.

Table 1: Comparative Analysis of AI Applications in Natural Resource Governance

Author (Year)	Technology	Application	Advantages	Challenges
Moleka (2026).	AI-driven	Ecosystem	Enhances	Lack of

	governance systems	resilience & resource management in Africa	sustainability and adaptive governance	infrastructure, governance gaps
Hanushchyn et al. (2025).	Artificial Intelligence	Natural resource management transparency	Improves efficiency and transparency	Data quality and accountability issues
Coulson et al. (1987).	Early AI systems	Environmental decision-making	Supports complex decision processes	Limited computational capabilities
Tatar et al. (2024).	Machine Learning	Oil & gas resource governance	Improves governance quality and prediction	Data dependency and model bias
Korol & Korol (2025).	AI-augmented governance	Rural Commons Management	Ethical rule enforcement, better participation	Ethical concerns and implementation barriers
Stock & Rauscher (1996).	Decision Support Systems (AI-based)	Forestry and natural resource management	Improves planning and decision-making	Limited scalability
Siripipatthanakul et al. (2024).	AI in governance	Sustainable governance frameworks	Enhances policy effectiveness	Governance readiness issues
Lozo & Onishchenko (2021).	AI systems	Climate change & resource management	Supports environmental protection strategies	Legal and ethical challenges
Chauhan et al. (2025).	AI technologies	Environmental resource optimization	Increases efficiency and sustainability	Technical complexity
Amir & Nasir (2025).	AI + policy frameworks	Rural resilience	Enhances inclusivity and sustainability	Policy gaps
Kulshrestha et al. (2025).	AI applications	Sustainable development	Optimizes resource utilization	Implementation cost
Mohammed et al. (2024).	Digital governance + AI	Resource management in China	Improves governance efficiency	Government intervention risks
Rahman & Hossain (2025).	AI + finance + governance	Sustainable resource systems	Integrated sustainability approach	Coordination complexity
Li et al. (2024).	Digital governance	Economic growth & resource use	Reduces resource curse effects	Institutional limitations
Thapa et al. (2024).	Data-driven AI	Public resource management	Detects anomalies and inefficiencies	Data privacy concerns
Huang et al. (2025).	Blockchain + AI	Resource asset management	Enhances transparency and security	High implementation cost
Takeda et al. (2021).	AI governance systems	Water management	Improves efficiency and monitoring	Regulatory challenges
Wang et al. (2025).	AI technologies	River basin governance	Enhances large-scale resource control	Data integration issues
Kumar et al. (2024).	AI-driven smart governance	Smart cities	Improves public administration	Technological dependency
Salam et al. (2023).	AI in governance	Public sector management	Increases efficiency and automation	Adoption barriers
Camilleri (2024).	AI governance frameworks	Ethical governance	Promotes responsible AI use	Ethical complexity

Rassolov & Chubukova (2022).	Legal AI frameworks	Governance regulation	Strengthens legal accountability	Regulatory gaps
Song & Deng (2025).	AI systems	Green economy	Improves environmental efficiency	Energy consumption of AI
Okoi (2025).	AI governance	Environmental conflict management	Supports global governance strategies	Political and ethical risks
Maghsoudi et al. (2025).	AI systems	Sustainable development governance	Addresses public concerns	Trust and acceptance issues

The existing literature on AI governance in the natural resource management arena indicates an important shift away from technical applications toward integrated governance frameworks. For example, previous work by Coulson et al. (1987) and Stock and Rauscher (1996) primarily viewed AI as a decision-support tool to improve environmental management. These foundational works demonstrated the technical viability of AI but neglected governance issues like accountability, ethics, and institutional preparedness. By contrast, more recent scholarship gradually defines AI as integral to governance systems. Studies by Hanushchyn et al. (2025) and Tatar et al. (2024) describe how AI can enhance transparency, efficiency, and predictive governance in resource management. Yet, such studies tend to take a techno-optimistic view, highlighting performance improvements rather than the structural and institutional constraints faced by developing countries. There lies a divide between ideological potentiality and operational practicality.

One of the strengths of recent literature is its integration of sustainability and governance. Previous works such as Moleka (2026), Rahman and Hossain (2025), and Song and Deng (2025) show that AI has the potential to play a major role in sustainable resource management and green economic efficiency. However, many of these studies rely on existing infrastructures or high-quality digital data, and are unlikely to be achievable in many contexts. Consequently, they are still confined to applications in high-resource environments. Ethics and governance are also another important dimension considered in the literature. The need for effective legal frameworks remains crucial (Rassolov & Chubukova, 2022) while the importance of ethical rulemaking and responsible AI governance is emphasized (Korol & Korol, 2025; Camilleri, 2024). Despite these guidelines' contributions, there is no consensus on standardized ethical recommendations, and most frameworks are more theoretical than practical. Simultaneously, algorithmic bias, data privacy, and accountability issues are recognized yet undertheorized in empirical settings.

A viable trend is technological convergence, especially the fusion of AI and blockchain technologies along with novel governance networks (Huang et al., 2025; Kumar et al., 2024). These approaches will improve transparency, traceability, and trust in resource management systems. Nevertheless, they also present new challenges, such as costly implementation, sophisticated technology, and a growing reliance on digital infrastructure. Likewise, sectoral applications such as water governance (Takeda et al., 2021) and river basin management (Wang et al., 2025) demonstrate AI's versatility and raise challenges for data integration and regulatory harmonization. While many studies have been conducted, significant gaps remain. First, there is a lack of context-specific studies, especially in developing/resource-dependent regions where governance challenges are acute. Second, most research tends to emphasize efficiency and performance measures without considering social impacts such as fairness, inclusiveness, and trust towards the institutions (Maghsoudi et al., 2025; Okoi, 2025). Third, the lack of empirical validation in real-world contexts for proposed governance frameworks is notable, as most existing studies are theoretical or modeling-based. While the literature offers much on AI as a transformative tool for natural resource governance, it remains highly fragmented and tech-optimistic. Moving forward, future research should pursue a more rounded approach by combining the technical and the ethical with institutional and socio-political considerations, while providing context-specific examples of governance models and empirically validating them.

3. Methodology

A qualitative, descriptive–analytical research design is employed in this paper to examine the functions of artificial intelligence (AI) in natural resource management governance. The literature review methodology enables researchers to systematically identify, assess, and synthesize existing academic literature. Data for this study were gathered from secondary literature, including peer-reviewed journal articles, books, conference proceedings, and other policy-relevant documents. The inclusion of studies was based on three criteria: relevance to AI governance in natural resource management, recent publication date (within the last 2 years), and academic research credibility. We compiled a wide array of references to provide broad coverage of perspectives across technological, governance, sustainability, and ethical considerations. This review was conducted using a multi-stage protocol as shown in Figure 1, beginning with the identification of research objectives.

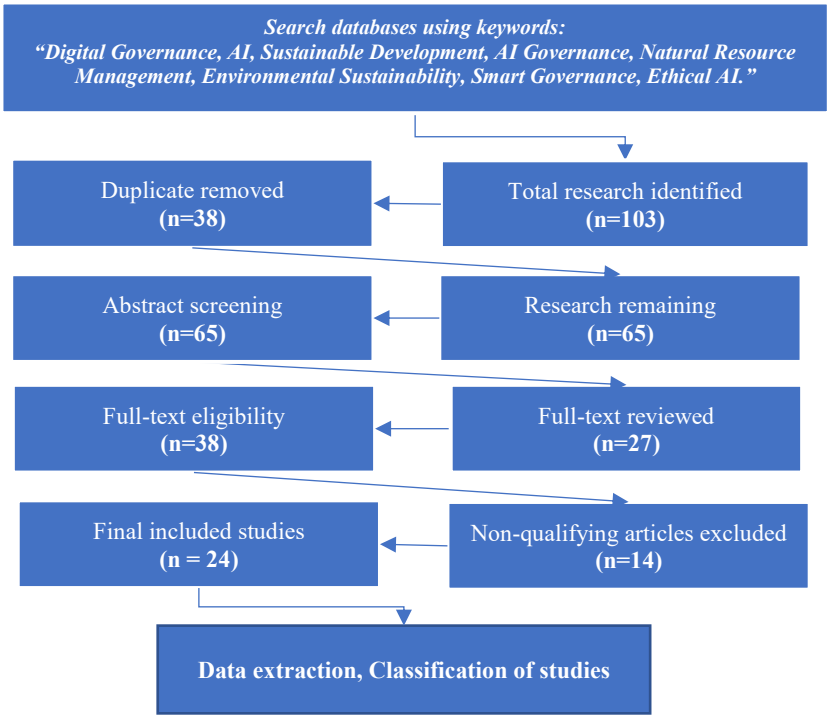

Figure 1. Framework showing the multi-stage review process from study selection to literature classification

Relevant studies were identified from major scientific databases (IEEE Xplore, Scopus, Web of Science, and ScienceDirect). The keywords combined in the search included Digital Governance, AI, Sustainable Development, AI Governance, Natural Resource Management, Environmental Sustainability, Smart Governance, and Ethical AI. We included only peer-reviewed journal articles and conference papers providing experimental validation. Identified studies were grouped into four main categories:

- AI technologies in resource management
- Governance frameworks and digital governance
- Sustainability and environmental impact
- Ethical and legal considerations

Table 2 shows that the studies reviewed were categorized into key thematic areas that correspond to important aspects of AI governance in natural resource management. This classification is designed to organize the literature by the main focus of interest, allowing for a more transparent analysis of research trends, areas of concentration, and gaps. The themes chosen are AI technologies in resource management,

governance frameworks, digital governance, sustainability and environmental impact, and ethical and legal considerations. Together, these themes reflect the complex nature of AI applications and governance challenges in natural resource management.

Table 2: Classification of Literature by Key Themes

Theme	Studies
AI Technologies in Resource Management	Coulson et al. (1987). Stock & Rauscher (1996); Chauhan et al. (2025); Kulshrestha et al. (2025); Thapa et al. (2024); Wang et al. (2025); Takeda et al. (2021)
Governance Frameworks and Digital Governance	Moleka (2026); Tatar et al. (2024); Zhu et al. (2025); Zhang & Cao (2025); Kumar et al. (2024); Salam et al. (2023); Mohammed et al. (2024); Rahman & Hossain (2025)
Sustainability and Environmental Impact	Song & Deng (2025); Li et al. (2024); Amir & Nasir (2025); Okoi (2025); Maghsoudi et al. (2025); Lozo & Onishchenko (2021)
Ethical and Legal Considerations	Camilleri (2024); Rassolov & Chubukova (2022); Korol & Korol (2025); Hanushchyn et al. (2025); Huang et al. (2025); Thomas et al. (2025)

The classification contained in the table shows the diversity and development of research on AI governance for natural resource management. This shows a strong clustering of studies in governance frameworks and technology applications, suggesting an increasing focus on efficiency and digital transformation. Nonetheless, relatively fewer studies provide extensive coverage of ethical and legal issues, indicating a significant gap in the research landscape. The thematic overlap also shows the interdisciplinary nature of our field, comprising technological, environmental, and governance aspects that are tightly interconnected. This thematic structure provides greater clarity in synthesizing existing research while also setting the stage for identifying critical gaps this research aims to fill.

The reviewed studies were analyzed, categorized, and placed on a timeline from 2020 to 2026 to enhance understanding of the evolution of AI research in natural resource governance. This classification emphasizes the evolution of key technologies and changing research priorities over time. In particular, it demonstrates how attention has shifted from rudimentary AI (and decision-support systems) to more mature, integrated governance roadmaps aligned with sustainability, ethics, and digital transformation. Table 3 provides an overview of the key technologies that predominated each time period and maps the key areas addressed by researchers to show pathways of developed studies, revealing emerging trends in practice.

Table 3: Chronological Classification of Studies (2020–2026)

Period	Key Technologies Used	Research Focus
2020 – 2021	Foundations of Machine Learning, Decision Support Systems, Early models of AI	Research mainly examined the application of AI as a decision-support software platform for effective natural resource management, while climate change and environmental governance topics are emerging (Frey, 2020; Lozo & Onishchenko, 2021).
2022 – 2023	Artificial intelligence in governance systems; Digital Governance tools; NLP-based analytical approaches	The research trajectory moved more toward an analysis of artificial intelligence under governance systems, focusing on legal mechanisms (Rassolov & Chubukova, 2022), interest

		in algorithmic policy approaches to public administration (Dong & Liu, 2023), and reinforced digital structural transformation alongside models of electronic political–administrative governance (Salam et al., 2023).
2024	AI & ML, AI systems based on data, Solutions for smart governance	The research focused on enhancing efficiency and resource management through AI-led governance, particularly in developing economies and resource-dependent states (Tatar et al., 2024; Mohammed et al., 2024; Thapa et al., 2024).
2025	AI + Blockchain integration, Environment-Friendly Services-based AI, Advanced AI system, Integrated Intelligent Systems.	Massive growth of research on sustainable development, effective green economy, and the merging of AI with new emerging technologies. The emphasis on ethical governance and transparency is also reinforced (Zhu et al., 2025; Song & Deng, 2025; Huang et al., 2025; Maghsoudi et al., 2025)
2026	Highly advanced AI, Blockchain + AI combinations, ESG-driven AI & converged intelligent systems	Models of emerging AI governance are characterized in recent studies by considerations of resilience and its components, long-term orientation, sustainability, and implications for policy integration in the global cotton textile ecosystem (Moleka, 2026; Khan & Akhtar, 2026).

The temporal analysis indicates a clear change over time in the relative levels of technology sophistication and research types surrounding AI products used in natural resource governance. While initial studies (2020–2021) considered AI mainly a technical entity, supporting decision-making processes. But starting in 2022, the nature of that research began to change, with an increasing focus on governance and AI within legal, institutional, and policy frameworks. The literature underscoring efficiency, optimization, and applications of AI in governance systems is not outside the context for resource-poor environments by 2024. In 2025 and 2026, that trend continues with additional research on issues such as sustainability, ethics, and AI, alongside emerging technologies such as blockchain. This evolution points to a shift from discrete tech-based solutions to whole-of-ecosystem governance. While it demonstrates this progress over time, the analysis also identifies remaining gaps, notably the scarcity of empirical studies and the absence of context-specific research in developing countries. In essence, these findings indicate that AI is increasingly perceived not only as a technology but also as a strategic tool for governance towards sustainable resource management.

4. Experimental Results

Based on the literature reviewed, there are three major takeaways about AI in natural resource management governance. The thematic classification (Table 4) clearly shows that a large proportion of the discussed literature focuses on governance frameworks and technological applications. It shows that AI-driven systems have been a key focus of research aimed at improving efficiency, decision-making, and policy implementation. The "AI technologies in resource management" theme reports on studies that demonstrate how AI has matured from simple decision-support systems to advanced systems capable of predictive analysis and real-time monitoring. Simultaneously, these studies raise several long-standing issues regarding data integration and technological complexity. The matrix analysis (Table 4) provides more in-depth reflections on the research gap and the methods used. This suggests that, in terms of approach, there are many conceptual and analytical studies compared with empirical or field-based research. While results consistently highlight the potential for AI to improve governance efficiency and sustainability outcomes, they also indicate a bias towards techno-centric viewpoints that prioritize performance gains over social and institutional implications.

Table 4: Analytical Matrix of Reviewed Studies on AI Governance in Natural Resource Management

Theme	Author (Year)	Methodology	Key Findings	Research Gap
AI Technologies in Resource Management	Coulson et al. (1987)	Conceptual	AI supports environmental decision-making	Limited practical application
AI Technologies in Resource Management	Stock & Rauscher (1996)	Analytical	AI enhances decision support systems	Limited scalability
AI Technologies in Resource Management	Chauhan et al. (2025).	Literature Review	AI improves efficiency in resource optimization	Lack of empirical validation
AI Technologies in Resource Management	Thapa et al. (2024).	Data-driven Analysis	AI detects inefficiencies in resource use	Data quality and privacy issues
AI Technologies in Resource Management	Wang et al. (2025).	Case Study	AI enhances river basin governance	Data integration challenges
AI Technologies in Resource Management	Takeda et al. (2021).	Case Study	AI improves water resource governance	Regulatory limitations
Governance Frameworks & Digital Governance	Moleka (2026).	Conceptual	AI strengthens ecosystem governance	Lack of practical frameworks
Governance Frameworks and Digital Governance	Tatar et al. (2024).	Quantitative (ML)	AI improves governance in resource-rich countries	Model bias and data dependency
Governance Frameworks and Digital Governance	Zhu et al. (2025).	Empirical	Digital governance enhances resource efficiency	Limited geographical scope
Governance Frameworks and Digital Governance	Zhang & Cao (2025).	Analytical	Governance frameworks improve resource utilization	Limited social perspective
Governance Frameworks and Digital Governance	Kumar et al. (2024).	Conceptual	AI enables smart governance systems	Over-reliance on technology
Governance Frameworks and Digital Governance	Salam et al. (2023).	Literature Review	AI improves public administration efficiency	Institutional readiness issues

Sustainability and Environmental Impact	Song & Deng (2025).	Quantitative	AI improves green economy efficiency	High energy consumption of AI
Sustainability and Environmental Impact	Li et al. (2024).	Empirical	Digital governance reduces the resource curse	Limited generalizability
Sustainability and Environmental Impact	Amir & Nasir (2025).	Conceptual	AI supports rural sustainability	Lack of practical evidence
Sustainability and Environmental Impact	Okoi (2025).	Analytical	AI influences environmental governance conflicts	Political and ethical risks
Sustainability and Environmental Impact	Maghsoudi et al. (2025).	Comparative	AI raises public sustainability concerns	Low public trust
Sustainability and Environmental Impact	Lozo & Onishchenko (2021).	Conceptual	AI supports climate change management	Legal and ethical challenges
Ethical and Legal Considerations	Camilleri (2024).	Conceptual	Need for ethical AI governance	Lack of implementation frameworks
Ethical and Legal Considerations	Rassolov & Chubukova (2022).	Legal Analysis	Importance of legal frameworks for AI	Regulatory gaps
Ethical and Legal Considerations	Korol & Korol (2025).	Conceptual	AI supports ethical governance in rural areas	Implementation challenges
Ethical and Legal Considerations	Hanushchyn et al. (2025).	Analytical	AI enhances transparency	Accountability issues
Ethical and Legal Considerations	Huang et al. (2025).	Tech-integrated	Blockchain + AI improves transparency	High implementation cost
Ethical and Legal Considerations	Thomas et al. (2025).	Policy Analysis	Community governance supports sustainability	Limited technological integration

These findings demonstrate the increasing prominence of sustainability in AI governance research. Research on sustainability suggests that AI has the potential to boost resource efficiency and drive green economic development. However, other aspects of the environmental costs of AI systems and energy use are not well covered. A third area of research, indeed a pertinent but still scarcely attended component, concerns ethical and legal issues. However, despite identified problems in transparency, accountability, and bias (Lerouge et al., 2021; Sullivan et al., 2018), a matrix analysis indicated that neither practical frameworks nor much empirical validation were available. It implies a disconnect between the theoretical and practical workspace. The analysis suggests that the field is highly interdisciplinary, with considerable overlap of technological, governance, and sustainability components. But it also exposes significant gaps, such as insufficient contextual studies, limited attention to developing countries, and inadequate consideration of societal consequences, such as fairness and public trust.

5. Discussion

This study's findings offer useful implications regarding the changing landscape of governance of natural resource management with advanced technologies such as artificial intelligence (AI). The analysis shows a clear shift in the literature, where AI has outgrown its traditional role as a technical decision-support tool and has integrated into governance systems. Newer studies highlight its ability to improve policy effectiveness and transparency as well as resource efficiency, part of the general trend toward digital governance. But that evolution also begs the question of how prepared institutions are to adopt and deploy these complex technologies within existing governance structures. Simultaneously, the available literature

demonstrates a significant disconnect between AI's hypothetical capabilities and its actual use. While there is wide acclaim for AI Systems in improving resource efficiency and nuancing sustainability ambitions, deployment often hinges on the availability of high-quality data, along with pervasive digital infrastructure and people capabilities. These requirements are very demanding and are often not met, particularly in developing or resource-constrained contexts; thus, many proposed solutions have poor scalability, applicability, or deployment outside the lab. This is a key issue for AI governance, with ethical and legal considerations. Although we frequently talk about the necessity of transparency, accountability, and fairness in governance, the lack of common, functioning frameworks provides a weak foundation for implementation. Problems such as algorithmic bias, data privacy, and accountability for decisions continue to be under-addressed in practice, underscoring the need for stronger regulatory oversight and more precise ethical standards governing AI-directed decision-making. The confluence of AI with supplementary technologies such as Blockchain and smart governance systems has led to real complications and propositions. By integrating these approaches, transparency, traceability, and resource management efficiency can be drastically improved. At the same time, they also increase system complexity, implementation costs, and dependence on advanced technology infrastructures. This highlights that it is not simply a matter of innovate or die, but rather of achieving practical feasibility and sustainable technology adoption within existing institutional capacities. The study finds that the governance of AI for natural resource management is genuinely interdisciplinary, as achieving such alignment requires balancing technological innovation with environmental, institutional, and social realities. Although this gap has been narrowed in some recent studies, context-specific research is scarce, and, overall, the societal dimensions of future w∗ wrestling (including inclusiveness, equity, and public trust) have received little attention. Bridging these gaps will be crucial to ensuring that AI-powered governance systems deliver efficiency and sustainability, as well as fair, equitable, and socially responsible outcomes.

6. Conclusion

This study reviewed and synthesized existing literature on artificial intelligence (AI) to advance a comprehensive understanding of AI in natural resource management governance. With these findings, AI is rapidly developing as a key enabler within contemporary governance systems and has untapped transformative potential to improve the efficiency, transparency, and sustainability of resource management. The integration of AI into governance frameworks has led to better decision-making, more efficient resource use, and the emergence of more adaptive, data-driven policy approaches. However, the research identifies a range of barriers to the effective deployment of such AI-powered governance mechanisms. Major challenges include an inadequate digital infrastructure in some areas, data quality and availability issues, and increasingly difficult integration of AI with the existing institutional apparatus. Besides, ethical and legal implications—including the challenges of accountability, transparency, and algorithmic bias—are still only partially dealt with, leading to ambiguities in the practice of AI within governance settings. It also uncovers a chasm between the theoretical hype around AI and its ground-level deployment, especially at knowledge-collapsed into systems under development and limited means. Just as many papers highlight the positive aspects of AI implementation leading to better sustainability outcomes, there are fewer studies that provide empirical evidence or contextual frameworks that can be adequately applied across different governance settings. This highlights the importance of more evidence-based and pragmatic solutions tailored to national institutional capacities and socio-economic circumstances. Additionally, the study highlights the need for an integrated, multidisciplinary approach to AI governance. Innovative technologies can be effective for natural resource management only if they are supported by relevant governance structures, environmental priorities, and societal needs. Without this alignment, AI-driven systems may perpetuate existing inequalities or fail to meet their sustainability goals.

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