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IMPLICATIONS OF ARTIFICIAL INTELLIGENCE (AI) IN LAND MANAGEMENT

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Abstract
This study sought to find out the implications of Artificial Intelligence (AI) in land management. The rapid development of AI, especially in the 21st century, and its applications in land management notably have led to a significant literature gap in the technological sphere, which needs to be addressed. AI has become a significant 7 element in land development, efficiency, optimisation, and decision-making. The research involved engagement and collaboration with various stakeholders, such as researchers, policymakers, communities, and developers, in the construction of a future where AI attributes its value to sustainability within the ethical frameworks established. By questioning the ethical concerns that arise from crucial matters such as data privacy, transparency, environmental impact, social displacement, and algorithmic bias, it was possible to address the negative implications of AI in land management. Results from the research show that there is a likelihood of socioeconomic effects such as job losses, unequal access to technology, and potential exacerbation of rural-urban divides. This study concludes that actively integrating ethical principles into AI development can ensure that AI contributes to sustainable, equitable, and responsible land management practices for the future. The study recommends algorithmic transparency within the research ethics of AI implications on land management.

Key terms: AI, ethical AI framework, land management, research ethics, responsible research practices.

1.0 INTRODUCTION

The rise of AI has taken root in land management, building thriving systems that serve humans in making extraordinary progress at an unprecedented rate, such as in land management, where AI has promoted the sophistication of models based on large data sets using algorithms to make land decisions. One will agree that land management is undergoing a revolution that is marked by the advancement of technology, especially through artificial intelligence (AI) (Wu & Silva, 2010). The emergence of satellite imagery has enabled real-time soil monitoring using AI tools, revolutionising the understanding of land terrains. In the recent past, growing reliance on AI in decision-making has portrayed some exponential abilities. For instance, machine learning algorithms analyse vast datasets, identifying patterns and predicting outcomes invisible to human eyes (Kaplan & Haenlein, 2019). Besides, AI has ensured that crop yields are optimised, water conservation is conserved, and soil erosion mitigation is achieved, which are strides towards precision by land managers. In addition, AI researchers depict that the influence of AI within agriculture is susceptible to desertification, allowing proactive intervention to protect vulnerable ecosystems (Coeckelbergh, 2020). Nevertheless, research ethics within this critical field advocates for transparency and fairness within the model's algorithms that deal with sensitive information that touches on land ownership and access. In addition, concerns arise from data privacy, as land management is involved in sensitive information of individuals and communities, thus encouraging ethical frameworks to safeguard privacy and ensure AI solutions respect local knowledge and traditions. This study shall also show why ethical frontiers are critical in the realisation of the full potential of AI in land management through responsible development and implementation, as it unlocks the future where land thrives nurtured by the power of AI and guided principles of sustainability and equity (Dharmaraj & Vijayanand, 2018). Therefore, this paper shall discuss the ethical implications of AI in land management, the importance of research ethics in mitigating these implications, and proposed recommendations for ethical AI development and application in land management.

2.0 LITERATURE REVIEW

Ethical Implications of AI in Land Management

The whole discussion of ethics is derived from the data bias, which calls for algorithmic fairness in AI-driven land management. Issues arise with the insidious algorithm, which holds immense promise in increased agricultural production, acceleration of biodiversity conservation, and streamlining land-usage planning. Algorithms are criticised because they are data-biased and can perpetuate and amplify existing inequalities, leading to unfair and unjust outcomes in land management decisions (Prunkl et al., 2021). Furthermore, concerns about bias bitebacks are also valid, with precision agriculture AI algorithms analysing data to recommend the required crop varieties, fertiliser application, and irrigation schedules. However, trained models of AI that are based on historical data may reflect unequal land ownership and access to resources, unfairly favouring large-scale plantations with established data collection infrastructure while marginalising small-scale farmers who lack such data, thus widening land access disparities and agricultural productivity gaps (Dharmaraj & Vijayanand, 2018). Besides, the conservation conundrum derived from AI is often skewed by biased data, where the algorithm might prioritise areas for wildlife protection based on habitat suitability models. The data could be trained to neglect the traditional land management practices where indigenous communities make decisions, as the models might overlook culturally significant conservation areas, which might disrupt the local livelihoods, cause environmental injustice and erode trust in conservation initiatives (Dharmaraj & Vijayanand, 2018). Many ethical issues are raised regarding AI management, for instance, the concerns of loan disbursement algorithms used for

agricultural financing, zoning models influencing urban development, and even wildfire prediction systems, which are all susceptible to perpetuating inequalities if the models are trained on a biased set of data (Morley et al., 2020).

Transparency and Accountability

Limited transparency might lead to a failure to understand the rationale behind decisions that are AI-driven land management. It will cause a lack of clarity that has the potential to breed distrust and raise concerns that revolve around potential biases, errors, or even manipulation within the algorithms by land-dependent communities. Thus, achieving transparency is key to ensuring those persons are not affected by AI-driven decisions as they will cause erosion of trust. Additionally, the implication of opaque models is dire because communities might feel alienated, unheard, and vulnerable to unfair outcomes generated by AI models. This could accelerate a lack of trust and can impede collaboration, hinder effective land management practices, and undermine the very goals that AI objects to attain (Vakkuri et al., 2019). Thus, there should be imperative transparency that bridges the gaps and fosters responsible AI development for land management through explainable AI (XAI) techniques, community engagement, and open-source algorithms and data that harness the power of AI.

3.0 RESULTS AND FINDINGS

Environmental and Social Impacts

Research shows AI is the future, and it will be depended on even more in the future based on its increased efficiency, optimised resource use, and improved decision-making. However, the advancement of this technology raises eyebrows on the potential challenges within the environment and social risks that are vital to the well-being of humans. AI impacts the environment significantly, raising concerns about the automation paradox that could be positive in terms of boosting productivity within the agricultural sphere. But it again brings forth the issue of overexploitation of land and water resources, which are negative. Besides, it could encourage monoculture farming practices that are favoured by AI-driven optimisation algorithms that can deplete soil fertility and biodiversity, influencing long-term sustainability (Walton & Nayak, 2021). Moreover, the concern of resource extraction is paramount; for instance, systems and models have been established in mineral exploration and extraction. This streamlining resource discovery enhances environmental degradation through deforestation, pollution, and disruption of natural ecosystems. In addition, AI-driven decisions affect climate change, with energy demands of large-scale infrastructure and data processing that can impact hugely increased greenhouse gas emissions (Morley et al., 2020). The emissions of the greenhouse gas have the potential to affect the environment negatively by affecting land management practices ((Dharmaraj & Vijayanand, 2018). Secondly, the social impacts caused by AI-driven decisions include job displacement, where automation has led to work losses in land-based sectors like agriculture, forestry, and land management, portraying existing inequalities and creating social unrest in communities reliant on these occupations. Similarly, AI has led to community displacement where large-scale land-use projects that optimise the models have forced individuals from native lands and communities to find another region as they can no longer be traditional land users, disrupting their cultural practices and livelihoods. This has implicated the erosion of traditional knowledge, with the overreliance on AI-driven decisions within land management, thus affecting cultural heritage (Martin & Freeland, 2021). Thus, AI requires ethical considerations that will help prioritise sustainability, assess social impacts, and foster respect for traditional knowledge.

Privacy and Security

AI is the best decision that has ever existed with the land management system. However, issues of data privacy and security pose significant challenges. AI relies on data collection, which tracks land and resource usage and has promoted the issue of individual data protection and privacy. The model collects the farmer's personal information, property boundaries, and even crop variety choices, which researchers fear could be compromised if not adequately anonymised and secured. Additionally, the issue raised from surveillance creep, where there is constant land-use monitoring through AI-powered drones or satellite imagery, is viewed as a challenge within communities as it hinders traditional land management practices (Hagendorff, 2020). The issue of conflicts of interest arises from the target marketing as AI uses personal land-use information that it analysed scientifically, which could be used for targeted marketing of agricultural products or services, which compromises the independence of land management decisions. The breaches and misuse of information kept by the AI models could lead to data breaches of sensitive land-use information, algorithms with bias and inaccuracies that perpetuate inequalities and injustices in land, and misinformation warfare with malicious actors potentially manipulating land use-data or AI algorithms to spread misinformation, impacting agricultural markets, land-use policies, and trust in land management institutions (Banerjee et al., 2018). Therefore, there should be an ethical consideration that is trustable and transparent, which is informed by strong data protection laws, community ownership and control, algorithmic transparency and accountability, and international cooperation in ensuring data governance and ethical AI development for land management to prevent the misuse of data.

Importance of Research Ethics in AI Development

AI is taking by force the land management systems, and it's critical to navigate its ethical terrain through the analysis of the existing frameworks to gain insight into what the future holds. First, the study looks into the Asilomar AI Principles, which are guidelines that inform the responsible usage of artificial intelligence throughout its development. It ensures the paramount observation of the principles that accelerate the safety, security, and rights of individuals and society in a way that covers aspects of AI such as research ethics, transparency, and accountability. This global initiative takes pride in its 23 principles that outline developmental issues, ethics, and guidelines for the development of AI in a positive and beneficial way to humanity (Eli-Chukwu, 2019). The Asilomar AI principles are a widely acknowledged framework that was endorsed within the science policy to aid the technical functionalities of AI systems with their goals and behaviours. Among the principles, it ensures liberty and privacy, non-subversion, dwells on the importance of the advancement of the world, and advocates the risks that are posed by AI systems. Therefore, within the land management system, the principles dictate that there should be fairness, non-maleficence, and essential accountability in responsible AI development. Within land management, the Asilomar AI Principles aim to prevent bias against marginalised communities, prioritise environmental well-being, and establish accountability mechanisms for unintended consequences. Besides, the European Commission's Ethics Guidelines for Trustworthy AI provide a framework that encourages technical robustness and safety (Eli-Chukwu, 2019). It ensures that AI systems are resilient and secure and that they should be guided on the principles of lawfulness and ethics concerning all applicable laws and regulations and respect for ethical principles and values, both from a technical perspective while taking into account its social environment. Its seven requirements, when applied to land management, these guidelines would necessitate transparent decision-making algorithms, robust data privacy safeguards for farmers and landowners, and human oversight to ensure AI aligns with community values and environmental sustainability goals. Ethics guidelines for trustworthy AI ensure human agency and oversight in making informed decisions that foster fundamental rights, have technical robustness and safety mechanisms that

are accurate, reliable, and reproducible, with unintentional harm which leads to privacy and data governance, non-discrimination and fairness, transparency, diversity, societal and environmental well-being, and accountability with the land management systems (Murase, 2000).

Responsible Research Practices

AI application within land management should be used in an ethical manner. Thus, research practices should be responsible for mitigating inherent risks and ensuring equitable outcomes. For example, collaboration should be ensured through the following: Interdisciplinary teams, which help handle the complexities that arise with the evolution of AI in land management from diverse perspectives (Samuel et al., 2021). These teams could be from all spheres of professions, which include computer and environmental scientists, sociologists, legal experts, and local communities in fostering holistic understanding and collaboration that will address issues ethically (Canadian Society for Computational Studies of Intelligence, 2004). Similarly, stakeholder engagements with farmers, environmental activists, policymakers, and local communities in the creation of policies will yield trust, identify pitfalls, and promote inclusivity of the intended AI usage. Besides, advocating for community-based research will empower the indigenous communities with research resources and agencies that lead to context-specific solutions that respect traditional knowledge and address local needs throughout AI development (Zha, 2020). This will help mitigate bias, shared benefits and burdens, and respect for the diverse knowledge systems throughout technological advancement.

Education and Awareness

In the cultivation of ethical considerations within research, education and awareness of responsible AI in land management are paramount. There should be an essence in equipping researchers, policymakers, and the public with ethical literacy that will nurture their responsible application of AI technology. This could be done in various ways that increase research training, where ethics modules that dwell on AI research curricula will be introduced (Saleem et al., 2021). It will help individuals understand and discuss the potential biases and effects of AI and also prepare developers to reason critically and logically in the prioritisation of ethical considerations (Sharma, 2021). Besides, policymaker workshops should be established to educate them on the ethical implications of AI in land management so as to draft laws that are informed to regulate, promote transparency, and hold developers accountable. Consequently, they can make public awareness campaigns which will engage them in an informative manner through interactive workshops, where they will access resources that can foster responsible usage of AI-powered land management tools and cultivate trust in technological advancements (Ruiz-Real et al., 2020). Such shared knowledge and building of capacity will ensure AI is beneficial and serves all stakeholders effectively and in an inclusive way.

4.0 CONCLUSIONS AND RECOMMENDATIONS

The future of land management heavily relies on technological advancement, especially AI, which is cultivated on ethical considerations. This research paper has shown why research ethics is important as AI burrows deeper into land management. It gives the plethora of ethical concerns that arise and how to mitigate them and ensure AI serves as a tool for a sustainable and equitable future. The research has established that there should be a prioritised ethical development and implementation of AI within different spheres of land management; thus, actionable recommendations are required (Parasuraman et al., 2021).

Firstly, data governance is critical in the analysis of AI in land management. Data governance is a creative process that creates and enforces policies and procedures for managing data through the usage of legal framework and machine learning in technologies and researched responsibly and ethically AI systems. It showcases the data ownership and control from the frameworks established within the land-use data, which prevents exploitation and fosters responsible data-sharing practices (Cosmin, 2011). Data governance enables the development of responsible, fit-for-purpose AI systems through data anonymisation and aggregation, which protects individual privacy while still enabling valuable insights from land-use data. In addition, it offers independent data oversight bodies that establish an audit on data collection, storage, and usage practices, which ensures compliance with ethical principles and data protection regulations.

Additionally, the paper recommends algorithmic transparency within the research ethics of AI implications on land management. Algorithmic transparency is an ideology derived from factors that influence the system algorithms' decisions, which are visible to the people who use, regulate or are affected. It should be ethically guided with openness about the goal, structure and underlying activities of the algorithms used to search for, process and deliver information. Research shows that data-driven tools, such as AI algorithms, which are used to help make important decisions such as land management, should depend on quality data used to train the AI model (Talaviya et al., 2020). Therefore, they can limit biasness or become subject matter to prejudice, which can become an inherent risk factor associated with their usage. Thus, transparency is essential to securing trust from users, influencers, or those influenced by the decisions driven by AI. For instance, explainable AI (XAI) tools should promote and incentivise the development and usage of XAI tools that demystify AI algorithms, making their decision-making processes understandable and transparent to stakeholders (Sharma, 2021). Independent algorithm audits also play a role in ensuring that land management systems are up to date and reduce or identify biases and errors, thus ensuring fairness and accountability. Similarly, the issue of public accessibility and data algorithms should be encouraged as it promotes open-source access to land-use data and algorithms, aiding collaboration, trust, and community-driven solutions.

Besides, the environmental and social impact assessment should be conducted to ensure the proper application of AI within land management (Talaviya et al., 2020). For instance, it should have a mandatory impact assessment that examines its environmental and societal impact throughout its development and deployment within AI-driven land management projects. This will enable the researchers to prioritise sustainability and minimise negative impacts on communities. Nevertheless, the community-based risk assessment should also be conducted in a manner that engages local communities in identifying and mitigating possible risks associated with AI-driven land management practices (Jha et al., 2019). This promotes addressing the concerns, which accelerates the long-term monitoring and evaluation systems to track the environmental and social impacts of AI, allowing for course correction and continuous improvement.

In addressing the ethical challenges, there should be ethical integration between research and practice of usage of AI. Firstly, ethical integration within AI systems is the major principle that should be considered in land management. It advocates for fairness in AI design, with an equal algorithm with data anonymisation for the protection of privacy and leading in transparency and accountability to all diverse contexts presented within the land to avoid historical biases witnessed as it fosters trust. Additionally, the aspect of community engagement is vital, where AI works alongside local stakeholders as participatory research will

ensure the address of their concerns and participation in decision-making processes. Similarly, the implementation of research ethics through strong regulatory frameworks and policy guidelines plays a significant role in the promotion of ethical AI in land management. This includes Data governance, algorithmic accountability, and risk mitigation strategies. The frameworks should dictate data collection, storage, and usage, ensuring ownership rights and reducing exploitation. Besides, continuous research and development of ethical guidelines that govern AI from a land management perspective is essential. This is because AI is constantly evolving, and it should be addressed in terms of emerging challenges, as unforeseen ethical issues will arise in a proactive manner. Also, iterative improvement of the ethical frameworks and regulations is key so that they can be adaptable to the technological issues arising to ensure continued relevance and effectiveness. Also, there should be a cross-disciplinary collaboration that brings on board researchers, land managers, policymakers, and communities in an essential manner that promotes informed and practical solutions to ethical challenges. Therefore, actively integrating ethical principles into AI development can ensure that AI contributes to sustainable, equitable, and responsible land management practices for the future.

5.0 REFERENCES

1. Banerjee, G., Sarkar, U., Das, S., & Ghosh, I. (2018). Artificial intelligence in agriculture: A literature survey. *International Journal of Scientific Research in Computer Science Applications and Management Studies, 7*(3), 1-6.
2. Bernstein, M. S., Levi, M., Magnus, D., Rajala, B., Satz, D., & Waeiss, C. (2021). *Esr: Ethics and society review of artificial intelligence research.* arXiv preprint arXiv:2106.11521.
3. Bouhouita-Guermech, S., Gogognon, P., & Bélisle-Pipon, J.-C. (2023). Specific challenges posed by artificial intelligence in research ethics. *Frontiers in Artificial Intelligence*, 6.
4. Canadian Society for Computational Studies of Intelligence. (2004). *Advances in artificial intelligence*: Proceedings of the Conference. Springer.
5. Coeckelbergh, M. (2020). AI ethics. MIT Press.
6. Cosmin, P. O. P. A. (2011). Adoption of artificial intelligence in agriculture. Bulletin of the University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca. *Agriculture, 68*(1).
7. Dharmaraj, V., & Vijayanand, C. (2018). Artificial intelligence (AI) in agriculture. *International Journal of Current Microbiology and Applied Sciences, 7*(12), 2122-2128.
8. Eli-Chukwu, N. C. (2019). Applications of artificial intelligence in agriculture: A review. *Engineering, Technology & Applied Science Research, 9*(4).
9. Garrett, N., Beard, N., & Fiesler, C. (2020). More than "If Time Allows", the role of ethics in AI education. In *Proceedings of the AAAI/ACM Conference on AI, Ethics, and Society* (pp. 272–278).
10. Hagendorff, T. (2020). The ethics of AI ethics: An evaluation of guidelines. *Minds and Machines, 30*(1), 99-120.
11. Heilinger, J.-C. (2022). The ethics of AI ethics. A constructive critique. *Philosophy & Technology, 35*(3), 61.
12. Holzinger, A., Keiblinger, K., Holub, P., Zatloukal, K., & Müller, H. (2023). AI for life: Trends in artificial intelligence for biotechnology. *New Biotechnology*, 74, 16-24.
13. Jha, K., Doshi, A., Patel, P., & Shah, M. (2019). A comprehensive review on automation in agriculture using artificial intelligence. *Artificial Intelligence in Agriculture*, pp. 2, 1–12.
14. Kaplan, A., & Haenlein, M. (2019). Siri, Siri, in my hand: Who's the fairest in the land? On the interpretations, illustrations, and implications of artificial intelligence. *Business Horizons, 62*(1), 15-25.

15. Kargl, M., Plass, M., & Müller, H. (2022). A literature review on ethics for AI in biomedical research and biobanking. *Yearbook of Medical Informatics, 31*(01), 152-160.

16. Martin, A.-S., & Freeland, S. (2021). The advent of artificial intelligence in space activities: New legal challenges. *Space Policy*, 55, 101408.

17. Morley, J., Floridi, L., Kinsey, L., & Elhalal, A. (2020). From what to how: An initial review of publicly available AI ethics tools, methods and research to translate principles into practices. *Science and Engineering Ethics, 26*(4), 2141–2168.

18. Morley, J., Machado, C. C., Burr, C., Cowls, J., Joshi, I., Taddeo, M., & Floridi, L. (2020). The ethics of AI in health care: A mapping review. *Social Science & Medicine*, 260, 113172.

19. Murase, H. (2000). Artificial intelligence in agriculture. *Computers and Electronics in Agriculture, 29*(1/2).

20. Parasuraman, K., Anandan, U., & Anbarasan, A. (2021). IoT-based smart agriculture automation is in artificial intelligence. In 2021 *Third International Conference on Intelligent Communication Technologies and Virtual Mobile Networks (ICICV)*, pp. 420-427). IEEE.

21. Powers, T. M., & Ganascia, J.-G. (2020). The ethics of the ethics of AI. In *The Oxford Handbook of Ethics of AI*, pp. 25-51.

22. Prunkl, C. E. A., Ashurst, C., Anderljung, M., Webb, H., Leike, J., & Dafoe, A. (2021). *Institutionalising ethics in AI through broader impact requirements. Nature Machine Intelligence, 3*(2), 104-110.

23. Prunkl, C., & Whittlestone, J. (2020). Beyond near-and long-term: Towards a clearer account of research priorities in AI ethics and society. In *Proceedings of the AAAI/ACM Conference on AI, Ethics, and Society*, pp. 138–143.

24. Rességuier, A., & Rodrigues, R. (2020). AI ethics should not remain toothless! A call to bring back the teeth of ethics. *Big Data & Society, 7*(2), 2053951720942541.

25. Ruiz-Real, J. L., Uribe-Toril, J., Torres Arriaza, J. A., & de Pablo Valenciano, J. (2020). A look at the past, present and future research trends of artificial intelligence in agriculture. *Agronomy, 10*(11), 1839.

26. Saleem, M. H., Potgieter, J., & Arif, K. M. (2021). Automation in agriculture by machine and deep learning techniques: A review of recent developments. *Precision Agriculture, 22*, 2053-2091.

27. Samuel, G., Chubb, J., & Derrick, G. (2021). Boundaries between research ethics and ethical research use in artificial intelligence health research. *Journal of Empirical Research on Human Research Ethics, 16*(3), 325–337.

28. Sharma, R. (2021). Artificial intelligence in agriculture: A review. In *2021 5th International Conference on Intelligent Computing and Control Systems (ICICCS)*, pp. 937–942. IEEE.

29. Sharma, S., Verma, K., & Hardaha, P. (2023). Implementation of artificial intelligence in agriculture. *Journal of Computational and Cognitive Engineering, 2*(2), 155-162.

30. Smith, M. J. (2018). Getting value from artificial intelligence in agriculture. *Animal Production Science, 60*(1), 46–54.

31. Smith, M. J. (2018). Getting value from artificial intelligence in agriculture. *Animal Production Science, 60*(1), 46–54.

32. Talaviya, T., Shah, D., Patel, N., Yagnik, H., & Shah, M. (2020). Implementation of artificial intelligence in agriculture for optimisation of irrigation and application of pesticides and herbicides. *Artificial Intelligence in Agriculture, 4*, 58-73.

33. Vakkuri, V., Kemell, K.-K., & Abrahamsson, P. (2019). AI ethics in industry: A research framework. arXiv preprint arXiv:1910.12695.

34. Vijayakumar, V., & Balakrishnan, N. (2021). Artificial intelligence-based agriculture automated monitoring systems using WSN. *Journal of Ambient Intelligence and Humanized Computing, 12*, 8009-8016.

35. Walton, N., & Nayak, B. S. (2021). Rethinking of Marxist perspectives on big data, artificial intelligence (AI) and capitalist economic development. *Technological Forecasting and Social Change,* p. 166, 120576.

36. Wu, N., & Silva, E. A. (2010). Artificial intelligence solutions for urban land dynamics: A review. *Journal of Planning Literature, 24*(3), 246-265.

37. Zha, J. (2020). Artificial intelligence in agriculture. In *Journal of Physics: Conference Series 1693*(1), p. 012058). IOP Publishing.

38. Zhu, H., & Wu, Q. (2023). Artificial-Intelligence-Enhanced Study on the Optimisation of the Responsibility and Compensation Mechanism for Provincial Cultivated Land Retention from a Fairness Perspective. *Land, 12*(12), 2118.