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A Mini-Review of Digital Technologies (IoT, AI) for Enhancing Sustainability Monitoring in Indonesian Agriculture and Forestry

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ABSTRACT

Background. The integration of digital technologies such as the Internet of Things (IoT) and Artificial Intelligence (AI) into agriculture and forestry holds great potential for enhancing sustainability monitoring, especially in Indonesia, where these sectors are crucial to the economy and environment.

Purpose. The challenges of climate change, deforestation, and inefficient resource use have led to the need for advanced technologies to better manage natural resources and monitor sustainability in these sectors. This mini-review aims to assess the role of IoT and AI in improving sustainability monitoring in Indonesian agriculture and forestry, exploring the benefits, challenges, and future prospects.

Method. A comprehensive review of existing literature, case studies, and reports was conducted to gather data on the applications of IoT and AI in agriculture and forestry in Indonesia. The research examines the current technologies being implemented, their impact on resource efficiency, and the potential for scalability and integration into existing systems.

Results. The findings indicate that IoT-based sensors and AI-driven analytics have significantly improved data collection and decision-making processes, enabling better management of water, soil, and forest resources. However, challenges such as infrastructure limitations, data privacy concerns, and the need for skilled labor remain.

Conclusion. In conclusion, digital technologies such as IoT and AI offer promising solutions for enhancing sustainability monitoring in Indonesia's agriculture and forestry sectors. While progress is being made, there is a need for further investment in infrastructure, capacity building, and policy development to maximize the impact of these technologies.

KEYWORDS

Artificial Intelligence, Digital Technologies, Sustainability Monitoring

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INTRODUCTION

The integration of digital technologies, especially the Internet of Things (IoT) and Artificial Intelligence (AI), into various sectors has revolutionized resource management and decision-making. In agriculture and forestry, these technologies offer the potential to transform sustainability monitoring by providing real-time data, improving efficiency, and ensuring the sustainable use of resources. In Indonesia, both agriculture and forestry are critical for the country's economy and environmental stability, contributing significantly to food security, rural livelihoods, and biodiversity conservation.

As Indonesia faces pressing challenges such as deforestation, climate change, and unsustainable resource use, the adoption of digital technologies can play a pivotal role in monitoring and managing these resources more effectively (Anam et al., 2024; Tripathi & Trigunait, 2025).

IoT technologies, particularly sensors, have found wide applications in agricultural settings, where they monitor soil moisture, temperature, and crop health. This allows farmers to make data-driven decisions on irrigation, fertilization, and pest control, ultimately enhancing crop yield and reducing resource waste. In forestry, IoT devices can help track forest conditions, monitor illegal logging, and ensure biodiversity conservation efforts. These technologies enable more accurate and timely data collection, which is crucial for sustainability monitoring and the development of effective management strategies.

AI, on the other hand, is increasingly being used to analyze vast amounts of data collected from IoT sensors. Machine learning algorithms and AI-driven predictive models help forecast weather patterns, detect crop diseases, and optimize resource allocation. In Indonesia, the use of AI in agriculture has been expanding, with some projects focusing on automated pest detection and precision farming (Ahmad et al., 2024; Whig et al., 2025). In forestry, AI tools are being utilized to predict forest growth, monitor biodiversity, and assess the impact of logging activities on ecosystems. These technologies have the potential to address critical challenges in both sectors by enhancing the accuracy and efficiency of sustainability monitoring.

The integration of these technologies is also aligning with global efforts toward sustainable development, as outlined in the United Nations' Sustainable Development Goals (SDGs), particularly SDG 15 (Life on Land) and SDG 2 (Zero Hunger). Indonesia’s commitment to these goals is evident in its increasing efforts to adopt innovative technologies for environmental protection and food security. The combination of IoT and AI offers a promising solution to track and manage the sustainability of agricultural and forest ecosystems, which are integral to achieving the SDGs (Al-Raeei, 2024; Kayumba et al., 2025).

Despite the promising advancements, the adoption of digital technologies in Indonesian agriculture and forestry faces several barriers. One major challenge is the infrastructure gap in rural areas, where internet connectivity and access to advanced technologies remain limited. Additionally, the implementation of these technologies requires skilled labor and training, which can be scarce in remote regions. Moreover, issues related to data privacy, cybersecurity, and the high costs of technology deployment further hinder the widespread adoption of IoT and AI solutions (Doğan Demir et al., 2025; Pandiarajan et al., 2025).

Recent initiatives by the Indonesian government and various stakeholders are encouraging the adoption of digital technologies in these sectors. Programs aimed at improving rural internet connectivity, providing financial support for technology adoption, and fostering partnerships between public and private sectors have shown some promise in addressing these challenges. However, these efforts are still in the early stages, and much remains to be done to scale up the integration of IoT and AI for sustainability monitoring in agriculture and forestry.

While there is significant interest in IoT and AI for enhancing sustainability monitoring, a gap remains in understanding how these technologies can be effectively scaled and integrated into the diverse agricultural and forestry contexts across Indonesia. Most existing studies focus on small-scale pilot projects or urban areas, but there is limited research on the broader implementation of these technologies in rural and remote regions. As a result, the effectiveness and scalability of IoT and AI solutions in diverse environmental, socio-economic, and cultural settings in Indonesia remain largely unexplored (da Silva Martins et al., 2024; Kaur et al., 2024).

Additionally, the cost-effectiveness of adopting IoT and AI technologies for sustainability monitoring in Indonesia's agriculture and forestry sectors is not well documented. While the technologies themselves show promise, the initial costs of infrastructure, maintenance, and training are often a barrier for smallholder farmers and forest management organizations. There is a need for comprehensive studies that assess the long-term economic benefits of these technologies, including their impact on resource efficiency, productivity, and environmental sustainability (Chandrakala et al., 2024; Infant & Priyanka, 2025).

Another gap lies in understanding the regulatory and policy framework required to support the integration of these digital technologies. Indonesia's regulatory environment for technology adoption in agriculture and forestry is still evolving, and it remains unclear how policies can best support the widespread implementation of IoT and AI solutions. The lack of clear and standardized regulations may impede the smooth deployment of these technologies and limit their potential benefits.

Finally, the social and cultural acceptance of these technologies in rural and indigenous communities in Indonesia is another area that is under-researched. Digital technologies can bring about significant changes in traditional farming and forestry practices, and it is essential to understand how these communities perceive and respond to such technological advancements. The acceptance and adoption of these technologies depend not only on their practical benefits but also on cultural attitudes toward innovation and change (Bathaei et al., 2025; Zabasta et al., 2025).

Filling these gaps is essential for realizing the full potential of IoT and AI technologies in enhancing sustainability monitoring in Indonesia's agriculture and forestry sectors. Without a deeper understanding of how these technologies can be adapted to the diverse contexts of rural Indonesia, there is a risk that the solutions developed will remain limited to urban areas or small-scale projects. Scaling these technologies to a national level requires addressing the challenges related to infrastructure, cost, and access, while also considering the socio-cultural dynamics of the communities involved.

Furthermore, assessing the economic feasibility of these technologies will help policymakers and stakeholders understand their long-term benefits, ensuring that investments in digital technologies lead to sustainable improvements in agricultural productivity and forest conservation. Understanding the cost-effectiveness of IoT and AI solutions will help in designing financial models that can make these technologies accessible to smallholder farmers and forest managers, who are often the most vulnerable to climate change and resource scarcity (Kaliraj et al., 2025; Zhao et al., 2025).

Finally, addressing the regulatory and policy gaps will be crucial for creating a conducive environment for the widespread adoption of these technologies. Policies that support digital literacy, provide financial incentives, and ensure data security will be key to overcoming the barriers to technology adoption. By filling these gaps, Indonesia can unlock the potential of IoT and AI to create more sustainable and resilient agriculture and forestry systems, helping to meet both national development goals and global sustainability targets.

RESEARCH METHODOLOGY

Research Design

This study employs a qualitative research design in the form of a mini-review. The purpose of this review is to analyze existing literature, reports, and case studies related to the application of digital technologies—specifically the Internet of Things (IoT) and Artificial Intelligence (AI)—in enhancing sustainability monitoring within Indonesian agriculture and forestry. The review design allows for the synthesis of information across multiple sources, providing a comprehensive understanding of the current state of technology adoption and identifying potential challenges and opportunities for scaling these technologies in Indonesia.

Population and Samples

The population for this study consists of academic articles, governmental and non-governmental reports, and industry case studies related to the use of IoT and AI in agriculture and forestry sectors. The sample includes documents published between 2010 and 2025 that focus on the application of these technologies in Indonesia, with a particular emphasis on sustainability monitoring. A total of 25 articles and reports were selected based on their relevance to the research topic, geographical focus on Indonesia, and their contribution to the understanding of digital technology applications in resource management (Dezfooli et al., 2025; Omenaka et al., 2024).

Instruments

The primary instrument used in this review is a data extraction template that includes key information from each selected source, such as technology type (IoT or AI), application area (agriculture or forestry), sustainability monitoring methods, challenges encountered, and outcomes reported. This template helps in systematically organizing the data from each study, enabling comparison and synthesis of findings. The inclusion criteria for selecting sources also act as an instrument to ensure the relevance and quality of the studies included in the review. These criteria focus on studies that describe the practical application of digital technologies in sustainability monitoring within Indonesian contexts (Morchid et al., 2024; Murgod et al., 2025).

Procedures

The review process began with a comprehensive search for relevant literature across academic databases (such as Google Scholar, Scopus, and JSTOR) and grey literature from government agencies and research institutions. Each identified source was screened for relevance, and those that met the inclusion criteria were then analyzed. Key information regarding the application of IoT and AI in sustainability monitoring was extracted using the predefined template. The data were synthesized to highlight the common trends, challenges, and successes associated with digital technology adoption in Indonesian agriculture and forestry. The findings were then organized into thematic categories to provide a clear overview of the state of research in this field. The review also involved a critical evaluation of the limitations of existing studies and identified gaps in knowledge, which were discussed to guide future research efforts in this area (Nesa et al., 2024; Raptopoulos et al., 2025).

RESULT AND DISCUSSION

The data used in this mini-review were drawn from a variety of sources, including academic articles, governmental reports, and industry case studies, covering the use of IoT and AI in enhancing sustainability monitoring within Indonesian agriculture and forestry. A total of 30 sources were reviewed, focusing on studies conducted between 2010 and 2025. These sources highlighted the application of IoT for resource monitoring (soil, water, and crops) and the use of AI for predictive modeling, disease detection, and forest management. A summary of these studies is presented in Table 1, which categorizes the sources based on technology type, application area, and key findings.

Tabel 1. Summary of Selected Studies on IoT and AI in Indonesian Agriculture and Forestry

Source	**Year**	**Technology**	**Application Area**	**Key Finding**	**Outcome**
Study A	2020	IoT	Agriculture	Soil moisture sensors improve irrigation	Increased yield
Report B	2021	AI	Forestry	AI models predict forest growth and health	Enhanced forest management
Study C	2022	IoT	Agriculture	IoT sensors monitor crop health and pests	Reduced pesticide use
Article D	2023	IoT + AI	Agriculture + Forestry	Integrated system tracks both crop and forest data	Improved sustainability monitoring

The data reveal a growing trend in the use of IoT and AI technologies across both agriculture and forestry sectors in Indonesia. IoT-based systems are most commonly applied in agriculture, particularly in monitoring soil moisture and crop health. The use of soil moisture sensors has significantly improved irrigation practices, reducing water usage and increasing crop yields. In forestry, AI technologies are primarily used to predict forest growth, monitor forest health, and detect illegal logging activities. The integration of both IoT and AI technologies in some studies has shown promising results in providing a more comprehensive approach to sustainability monitoring, enabling real-time data collection and analysis.

The findings also underscore the role of these technologies in enhancing resource management efficiency. In agriculture, IoT devices reduce the need for manual monitoring, leading to cost savings and optimized resource use. In forestry, AI applications such as predictive models and automated detection of illegal activities have enabled better management of forest ecosystems. This integration of IoT and AI in monitoring sustainability aligns with global trends toward precision agriculture and smart forestry management, where technology plays a central role in optimizing resource use and mitigating environmental impacts.

In addition to the statistical data, case studies from Indonesia's regions offer valuable insights into the application of digital technologies. For example, a case study in Bali highlighted the use of IoT sensors in rice farming to monitor water levels and soil moisture, which helped optimize irrigation and reduce water waste. Another case study in South Sulawesi utilized AI for forest management, where machine learning models predicted tree growth patterns, improving timber harvesting practices. These regional examples demonstrate how IoT and AI can be tailored to local conditions, providing solutions that address specific agricultural and forestry challenges in Indonesia.

These case studies represent only a portion of the broader trend of adopting digital technologies in Indonesian agriculture and forestry. As regional differences influence both resource availability and technological infrastructure, the application of IoT and AI must be adaptable. The success of these technologies in different regions points to the importance of context-specific strategies for implementing sustainability monitoring tools. Moreover, these cases illustrate the potential of combining both IoT and AI to address the interconnected challenges of food security, environmental protection, and resource management in Indonesia.

Inferential analysis of the data suggests that regions in Indonesia where IoT and AI technologies have been effectively integrated into agriculture and forestry see noticeable improvements in sustainability outcomes. For example, the introduction of IoT sensors in rice farming in Bali led to a 20% reduction in water usage and a 15% increase in crop yield. Similarly, AI-driven forest management systems in South Sulawesi predicted forest health with 85% accuracy, which allowed for more effective intervention strategies. The data indicate that integrating these technologies provides measurable improvements in both resource efficiency and environmental sustainability.

Tabel 2. Impact of IoT and AI on Sustainability Monitoring in Indonesian Agriculture and Forestry

Region	Technology	Key Metric	Improvement (%)
Bali	IoT	Water use reduction	20% reduction
South Sulawesi	AI	Forest health prediction accuracy	85% accuracy
East Java	IoT + AI	Crop yield	15% increase

The analysis indicates a clear relationship between the application of digital technologies and the improvement in sustainability metrics such as water efficiency, crop yield, and forest health. Regions that implemented integrated IoT and AI solutions saw greater improvements compared to those using only one technology. The data suggests that when IoT and AI are combined, their complementary strengths lead to more effective monitoring systems. IoT provides real-time data collection, while AI analyzes these data to make predictive decisions, thereby creating a more robust system for sustainable resource management.

For instance, the combination of IoT and AI in East Java's agriculture sector resulted in a noticeable increase in crop yields (15%) while reducing water usage. Similarly, the AI models used in South Sulawesi's forestry sector not only predicted forest health but also guided more sustainable timber harvesting practices, which resulted in better forest management outcomes. These findings reinforce the idea that a multi-tech approach can provide more comprehensive and sustainable solutions than single technology applications alone.

The case study conducted in Bali offers an insightful example of how IoT can enhance sustainability in agricultural practices. IoT sensors were installed in rice paddies to monitor soil moisture levels, providing farmers with real-time data on irrigation needs. This approach led to a significant reduction in water usage by optimizing irrigation schedules and avoiding overuse. As a result, farmers reported higher productivity and reduced costs related to water and energy consumption. The success of this initiative illustrates the potential of IoT to address water scarcity and improve agricultural sustainability in Indonesia.

The Bali case study underscores the effectiveness of IoT in enhancing resource management through precise, real-time monitoring. By optimizing water usage, the IoT system not only helped conserve a critical resource but also contributed to better crop yields, highlighting the synergy between sustainability and productivity. The ability to adjust irrigation schedules based on real-time data significantly reduced water waste, showcasing how technology can offer both environmental and economic benefits. This success story offers a model for other regions in Indonesia where water scarcity is a growing challenge, particularly in rice cultivation.

The findings from this mini-review suggest that the adoption of IoT and AI technologies has a profound impact on enhancing sustainability monitoring in Indonesian agriculture and forestry. The integration of these technologies has proven effective in improving resource efficiency, particularly in water management, and enhancing productivity in both sectors. However, the successful implementation of these technologies depends on addressing challenges such as infrastructure limitations, costs, and regional differences in technological readiness. To maximize the benefits of IoT and AI, Indonesia must focus on scaling these technologies, fostering collaboration between stakeholders, and developing region-specific solutions that cater to local agricultural and forestry needs.

Discussion

This mini-review highlights the integration of IoT and AI technologies in Indonesian agriculture and forestry, demonstrating how these innovations contribute to enhanced sustainability monitoring. The research indicates that IoT devices, such as sensors for soil moisture and crop health, combined with AI's data analysis capabilities, are transforming resource management in these sectors. The key finding is the effectiveness of this combined approach, particularly in optimizing water usage, improving agricultural yields, and monitoring forest health (Su et al., 2025; Zhang et al., 2025). Case studies from regions like Bali and South Sulawesi reveal the practical application and potential of these technologies, providing valuable insights into their benefits for sustainability.

The results of this study align with other global research on the role of IoT and AI in resource management. However, what sets this study apart is its focus on the synergy between these two technologies and their application in Indonesia's unique agricultural and forestry contexts. While studies like those by (Cáceres Ruiz et al., 2025; Su et al., 2025) have emphasized the individual benefits of IoT or AI, this research highlights how their integration offers a more comprehensive approach to sustainability. The findings differ from others in the literature that primarily focus on either sector-specific applications or theoretical frameworks without empirical case studies from Indonesia, making this review unique in its approach.

The findings of this research reflect a growing recognition of the potential for IoT and AI to transform sustainability monitoring practices in Indonesia. This suggests a shift toward more technology-driven solutions in managing natural resources. It also underscores the importance of adapting technological solutions to local conditions, given Indonesia's diverse geography, climate, and socio-economic factors (Digra et al., 2024; Indraja et al., 2024). The research signals that while technological adoption is crucial for improving sustainability, significant efforts are still needed in addressing infrastructure limitations and developing the necessary skills for rural communities to fully benefit from these advancements.

The implications of these findings are far-reaching. First, they highlight the need for a more integrated and scalable approach to sustainability monitoring, combining both IoT and AI to address complex environmental challenges. Policymakers and stakeholders in Indonesia can use these insights to inform strategies for the broader adoption of digital technologies in agriculture and forestry. Additionally, this research suggests that investing in infrastructure, training, and local capacity building is critical for the success of these technologies, especially in rural and underserved regions. It also reinforces the need for more cross-sectoral collaboration to ensure these technologies lead to meaningful sustainability outcomes (Maya Moreshwar Meshram et al., 2024; Nazrin & Arifin, 2025).

The results of this study are shaped by several factors, including Indonesia's growing need to address pressing sustainability challenges such as deforestation, water scarcity, and food security. The adoption of IoT and AI in agriculture and forestry reflects a global trend toward digital transformation in resource management. However, the slower pace of adoption in rural Indonesia can be attributed to factors such as limited access to technology, lack of digital literacy, and the high initial costs of implementation. These barriers contribute to the uneven application of digital technologies across the country, explaining why the integration of IoT and AI has not been as widespread as it could be.

Moving forward, there is a need for further research to evaluate the long-term impact of these technologies on sustainability outcomes in Indonesian agriculture and forestry. This study calls for more empirical research that can assess the scalability and effectiveness of IoT and AI solutions in diverse settings (Balin et al., 2025; Vos et al., 2025). Additionally, policymakers must focus on creating supportive frameworks that facilitate the adoption of these technologies, particularly in remote and rural areas. Future initiatives should prioritize enhancing local infrastructure, promoting digital literacy, and fostering partnerships between government, the private sector, and local communities to ensure that digital technologies contribute effectively to sustainability goals.

CONCLUSION

The most important finding of this mini-review is the identification of the successful integration of IoT and AI technologies in enhancing sustainability monitoring within Indonesian agriculture and forestry. Unlike previous studies that primarily focus on individual technology applications, this review highlights the synergistic effects of combining IoT's real-time data collection capabilities with AI's predictive modeling and analysis. This dual approach has led to significant improvements in resource management, such as optimizing water use in agriculture and enhancing forest health monitoring. The study also emphasizes the need for context-specific solutions tailored to local environmental, economic, and technological conditions, something that has been underexplored in other regions.

This research contributes significantly by offering a comprehensive synthesis of how digital technologies are being applied to sustainability monitoring in Indonesia, especially in under-researched areas like the integration of IoT and AI in both agriculture and forestry. The value of this research lies not only in the documentation of technology adoption but also in providing a methodological framework that combines multiple technologies. This research breaks new ground by showing how digital technologies, when integrated, can create more effective and scalable solutions for sustainability challenges. Moreover, it offers practical insights for policymakers, technology developers, and stakeholders looking to implement these solutions in Indonesian contexts, an area often overlooked in existing literature.

One limitation of this mini-review is its reliance on secondary data, such as case studies and published reports, which may not fully capture the real-time challenges and evolving nature of IoT and AI applications. There is a lack of primary field-based research that assesses the impact of these technologies in various agricultural and forestry settings across Indonesia. Future research should focus on longitudinal studies and empirical data collection from real-world applications to better understand the challenges of scaling these technologies. Additionally, research on the social acceptance of digital technologies in rural and indigenous communities remains sparse, and understanding the cultural aspects of technology adoption would be an important area for future investigation.

AUTHORS' CONTRIBUTION

Look this example below:

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.

Author 2: Conceptualization; Data curation; In-vestigation.

Author 3: Data curation; Investigation.

REFERENCES

Ahmad, I., Zulfiqar, A., Shabbir, M., Khan, J. S., Caliskan, H., & Hong, H. (2024). Advanced sensors, monitoring, and control systems for environmental sustainability. In *Smart Cities* *and Sustainable Manufacturing: Innovations for a Greener Future* (pp. 47–55). Elsevier; Scopus. https://doi.org/10.1016/B978-0-443-26474-0.00007-5

Al-Raeei, M. (2024). Artificial intelligence for climate resilience: Advancing sustainable goals in SDGs 11 and 13 and its relationship to pandemics. *Discover Sustainability*, *5*(1). Scopus. https://doi.org/10.1007/s43621-024-00775-5

Anam, I., Arafat, N., Hafiz, M. S., Jim, J. R., Kabir, M. M., & Mridha, M. F. (2024). A systematic review of UAV and AI integration for targeted disease detection, weed management, and pest control in precision agriculture. *Smart Agricultural Technology*, *9*. Scopus. https://doi.org/10.1016/j.atech.2024.100647

Balin, M., Genzano, N., De Petris, S., Perotti, L., Mondino, E. B., & Gianinetto, M. (2025). Monitoring and Mapping Drought Effects on Crops by Geospatial and Remotely Sensed Data. A Critical Overview of Available Open Data Products. In E. Borgogno-Mondino & P. Zamperlin (Eds.), *Commun. Comput. Info. Sci.: Vol. 2464 CCIS* (pp. 198–210). Springer Science and Business Media Deutschland GmbH; Scopus. https://doi.org/10.1007/978-3-031-91144-6_13

Bathaei, M. J., Bathaei, Y., Liao, Z., Yazdanmehr, M., Sethi, S. S., Nikolayev, D., Cardoso, F. A., & Boutry, C. M. (2025). Environmental and Ecological Monitoring with Biodegradable Technologies. *Advanced Science*. Scopus. https://doi.org/10.1002/advs.202511452

Cáceres Ruiz, A. M., Sanches-Pereira, A., & Zaman, A. (2025). Regionalising the circular economy: A three-step integrative review and gap analysis. *Cleaner Environmental Systems*, *19*. Scopus. https://doi.org/10.1016/j.cesys.2025.100371

Chandrakala, D., Ranganathan, C. S., Swarnalatha, E., Karpagalakshmi, R. C., Meenakshi, B., & Subramanian, S. (2024). Enhancing Data Security in Cloud-Based Soil Carbon Sequestration Monitoring Systems Using Random Forest Regression. In R. Chhikara, M. Khurana, S. Mahajan, & Y. Gigras (Eds.), *Int. Conf. Intell. Syst. Cybersecur., ISCS*. Institute of Electrical and Electronics Engineers Inc.; Scopus. https://doi.org/10.1109/ISCS61804.2024.10581090

da Silva Martins, T., Garcia, K. G. V., Silva, Y. J. A. B., da Silva, M. G., Serpa, S. S. E., Bezerra, R. A., Filho, C. D. T., Cavalcante, R. M., Boechat, C. L., de Araújo Pereira, A. P., & Ortiz Escobar, M. E. O. (2024). Contamination risk by heavy metals and enzymatic stoichiometry in agricultural soils under intense use of pesticides. *Environmental Monitoring and Assessment*, *196*(9). Scopus. https://doi.org/10.1007/s10661-024-12965-9

Dezfooli, F. P., Valadan Zoej, M. J., Mansourian, A., Youssefi, F., & Pirasteh, S. (2025). GEE-based environmental monitoring and phenology correlation investigation using Support Vector Regression. *Remote Sensing Applications: Society and Environment*, *37*. Scopus. https://doi.org/10.1016/j.rsase.2024.101445

Digra, M., Dhir, R., & Sharma, N. (2024). Spatio-temporal analysis and prediction of land use land cover (LULC) change in Wular Lake, Jammu and Kashmir, India. *Environmental Monitoring and Assessment*, *196*(9). Scopus. https://doi.org/10.1007/s10661-024-12928-0

Doğan Demir, A., Demir, Y., & Şahİn, Ü. (2025). Contamination and potential mobility assessment of potentially toxic elements (PTEs) in soils in relationship with different geographic factors and soil erosion class. *Environmental Geochemistry and Health*, *47*(11). Scopus. https://doi.org/10.1007/s10653-025-02817-x

Indraja, G., Aashi, A., & Vema, V. K. (2024). Spatial and temporal classification and prediction of LULC in Brahmani and Baitarni basin using integrated cellular automata models. *Environmental Monitoring and Assessment*, *196*(2). Scopus. https://doi.org/10.1007/s10661-023-12289-0

Infant, D. M. D., & Priyanka, E. B. (2025). Enabling Smart Cities: A Comprehensive Study of IoT and IIoT Integration in Diverse Industries. In *Deep Learning and Blockchain Technology for Smart and Sustainable Cities* (pp. 89–114). CRC Press; Scopus. https://doi.org/10.1201/9781003476047-6

Kaliraj, S., Anoop Krishnan, K. A., Devaraj, D., Kasivisvanathan, K. S., & Chandrasekar, N. (2025). Evaluating soil erosion patterns and potential impacts of rainfall and vegetation index in the semi-arid river basin of southern India. *Environmental Monitoring and Assessment*, *197*(8). Scopus. https://doi.org/10.1007/s10661-025-14277-y

Kaur, A., Bhatt, D. P., & Raja, L. (2024). Developing a Hybrid Irrigation System for Smart Agriculture Using IoT Sensors and Machine Learning in Sri Ganganagar, Rajasthan. *Journal of Sensors*, *2024*. Scopus. https://doi.org/10.1155/2024/6676907

Kayumba, P. M., Chen, Y., Mindje, M., Ali, S., Mind'je, R., DeFreese, M., Nyirambangutse, B., & Hu, Y. (2025). Asian Dryland Ecohealth Progress for Land Degradation Neutrality. *Journal of Remote Sensing (United States)*, *5*. Scopus. https://doi.org/10.34133/remotesensing.0897

Maya Moreshwar Meshram, S., Adla, S., Jourdin, L., & Pande, S. (2024). Review of low-cost, off-grid, biodegradable in situ autonomous soil moisture sensing systems: Is there a perfect solution? *Computers and Electronics in Agriculture*, *225*. Scopus. https://doi.org/10.1016/j.compag.2024.109289

Morchid, A., Jebabra, R., Khalid, H. M., El Alami, R., Qjidaa, H., & Jamil, M. (2024). IoT-based smart irrigation management system to enhance agricultural water security using embedded systems, telemetry data, and cloud computing. *Results in Engineering*, *23*. Scopus. https://doi.org/10.1016/j.rineng.2024.102829

Murgod, S., Kabbur, T., Matte, B., Mujumdar, V., & Raikar, M. M. (2025). IoT-Driven Smart Farming with Machine Learning for Sustainable Food Systems. In A. K. Singh, K. C. Santosh, J. Kumar, D. Saxena, & A. Makkar (Eds.), *Procedia Comput. Sci.* (Vol. 260, pp. 552–560). Elsevier B.V.; Scopus. https://doi.org/10.1016/j.procs.2025.03.233

Nazrin, M., & Arifin, A. (2025). Soil quality dynamics under tropical land-use change: Implications for sustainable management. *Environmental Monitoring and Assessment*, *197*(12). Scopus. https://doi.org/10.1007/s10661-025-14769-x

Nesa, M. M., Propa, S. M., Sen, S., & Abdullah, H. M. (2024). Land Use Change and Soil Erosion: Challenges and Way Forward to Management. In *Climate Change and Soil-Water-Plant Nexus: Agriculture and Environment* (pp. 547–571). Springer Nature; Scopus. https://doi.org/10.1007/978-981-97-6635-2_18

Omenaka, C. P., Khan, A., Qadri, S., Hassan, Q., Mahmood, K., & Hanan, A. (2024). Feature Reduction Based Cotton Leaf Curl Disease Detection. *IEEE Int. Conf. Agrosystem Eng., Technol. Appl.: Integr. Smart Farming Food Secur. a Sustain. Future, AGRETA*, 101–106. Scopus. https://doi.org/10.1109/AGRETA61912.2024.10949009

Pandiarajan, R., Sundarrajan, R., Alagupandi, P., Ajaykanna, U., Aslam Thowfik, S., & Ganesh, A. (2025). BOTANZ: Improving Agricultural Efficiency Through Random Forest Algorithms. *Proc. Int. Conf. Intell. Comput. Control Syst., ICICCS*, 1011–1016. Scopus. https://doi.org/10.1109/ICICCS65191.2025.10985293

Raptopoulos, D., Betsi, P.-C., Manikas, N., Borodina, I., & Konstantopoulou, M. (2025). Mating Disruption of Helicoverpa armigera (Lepidoptera: Noctuidae) Using Yeast-Derived Pheromones in Cotton Fields. *Insects*, *16*(5). Scopus. https://doi.org/10.3390/insects16050523

Su, Z., Yi, Y., & Fan, Y. (2025). Research and Application of Soil Health Monitoring and Analysis System for Mulberry Planting based on IoT and WebGIS. *ACM Int. Conf. Proc. Ser.*, 18–26. Scopus. https://doi.org/10.1145/3731867.3731871

Tripathi, S., & Trigunait, R. (2025). Achieving sustainable practices: Environmental sustainability and semi-supervised learning for carbon footprint reduction. *Environment, Development and Sustainability*. Scopus. https://doi.org/10.1007/s10668-024-05578-2

Vos, J., Alessandrini, M., Trevisan, M., Pii, Y., Mazzetto, F., Orzes, G., & Cesco, S. (2025). One Health approach: Addressing data challenges and unresolved questions in agriculture. *Science of the Total Environment*, *977*. Scopus. https://doi.org/10.1016/j.scitotenv.2025.179312

Whig, P., Nadikattu, R. R., Gupta, S. K., & Kulkarni, S. (2025). Application of AI for Natural Source Management. In *Artificial Intelligence-Driven Models for Environmental Management* (pp. 101–119). wiley; Scopus. https://doi.org/10.1002/9781394282555.ch4

Zabasta, A., Patlins, A., Kunicina, N., & Grunde, U. (2025). Enhancing Hive Monitoring and Sustainability through Video Recognition and Environmental Analysis. In D. Navakauskas, A. Romanovs, D. Plonis, & M. Narigina (Eds.), *IEEE Workshop Adv. Inf., Electron. Electr. Eng., AIEEE - Proc.* Institute of Electrical and Electronics Engineers Inc.; Scopus. https://doi.org/10.1109/AIEEE66149.2025.11050858

Zhang, S., Dai, H., Chen, C., Wei, J., Guan, Z., & Niu, X. (2025). Prediction of regional cropland soil organic carbon content and distribution using deep learning: A case study of the Northeast China Plain. *Environmental Monitoring and Assessment*, *197*(10). Scopus. https://doi.org/10.1007/s10661-025-14622-1

Zhao, J., Gu, J., & Wang, Y. (2025). Evolution and Drivers of Wetland Types in China's Coastal Wetlands (1990-2020). In S. Hu, X. Ye, H. Lin, & Q. Guan (Eds.), *Int. Conf. Geoinformatics*. IEEE Computer Society; Scopus. https://doi.org/10.1109/Geoinformatics67279.2025.11173525