



Original Research Paper

Artificial Intelligence and Technology Adoption in Sustainable Protection of Natural Resources and Environmental Setting

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Abstract

The Philippines faces challenges in using artificial intelligence (AI) to protect natural resources, including limited digital infrastructure, unequal access to technology, high costs, limited technical skills, weak policy support, cybersecurity concerns, inadequate data, and gaps in local research and regional access. Hence, there is a need to examine how AI can be appropriately used and integrated into natural resource protection while considering the environmental needs, technological capacity, and local context. This study explored how AI technology adoption could help in the protection and preservation of natural resources in the Philippines based on the narratives from environmental experts and sustainability advocates. There were 18 AI and environmental experts, sustainability advocates from Zamboanga Peninsula, Philippines who responded to the request for one-on-one interview. Narratives from the interviews were analyzed through reflexive thematic analysis to identify important themes. The findings revealed that AI can support the protection of natural resources through responsible and ethical AI education, broader community access, curriculum integration, direct environmental applications, decision-making, AI-based environmental monitoring, and stakeholder collaboration. Participants emphasized that learners need to develop not only technical AI skills but also critical thinking and ethical awareness to evaluate AI outputs and use the technology responsibly. Meanwhile, effective AI adoption requires continuous support from schools, government agencies, businesses, environmental organizations, and communities in terms of resources, training, policies, and technical assistance. This study points to the need for a localized AI framework for natural resource protection in the Philippines that can guide responsible AI use, strengthen community participation, and promote collaboration among educational institutions, government, industry, researchers, and local communities.

Keywords: artificial intelligence, environmental protection, natural resources, sustainability, technology adoption

Introduction

The Philippines continues to face serious environmental challenges, including deforestation, forest degradation, biodiversity loss, agricultural expansion, water pollution, and unsustainable natural resource use (Felipe, 2025). Although Artificial Intelligence (AI) could support agriculture and natural resource management, its adoption remains constrained by the digital divide, high technology costs, limited training, weak policies, and cybersecurity concerns (Doria et al., 2024).

There is a need to understand how AI can be appropriately adapted to the Philippine context, particularly in addressing local environmental concerns and supporting the sustainable management

of natural resources. Santos (2026) noted that examining the perspectives of people with relevant knowledge and experience could help identify potential applications, opportunities, limitations, and conditions needed for responsible AI adoption. Hence, this study addresses this need by exploring the perspectives of AI and sustainability experts on the potential use of AI in protecting natural resources and supporting environmental sustainability in the Philippines.

In Europe, AI-based environmental management can benefit both environmental protection and business performance in the oil and gas sector. Stronger environmental management was linked with better company performance, including higher profits, asset values, sales, and market position. The companies studied were already using AI for activities such as improving drilling, creating digital

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twins, preventing accidents, monitoring equipment, reducing environmental costs, and supporting safer oil exploration and production (Chutcheva et al., 2022).

AI is increasingly viewed as a useful tool for addressing major global challenges and supporting the United Nations Sustainable Development Goals (SDGs). It can contribute to areas such as healthcare, education, climate action, agriculture, and economic development (Gohr et al., 2025; Nasir et al., 2023). However, access to these benefits is not equal. Differences between developed and developing countries in terms of technology, funding, skills, and infrastructure can create gaps in who can use and benefit from AI (Mhlanga, 2022).

Developed countries have been able to apply AI more widely because they generally have better digital infrastructure, stronger financial resources, and more skilled workers (Wang et al., 2023). These advantages have allowed AI to support areas such as climate action, healthcare, education, and precision agriculture. At the same time, these countries still face concerns about job displacement, privacy, bias, and other risks associated with AI. Developing countries could also benefit from AI, but adoption is often slowed by limited digital infrastructure, lack of trained professionals, high costs, and insufficient data (Nahar, 2024; Sánchez-Roncero et al., 2023). This means that although AI could help address development and sustainability challenges, unequal access to technology may prevent many communities from fully benefiting from its potential.

Philippines, being a developing country, is also facing challenges in the application of AI in environmental protection and the preservation of the natural resources. For example, the use of AI in Philippine agriculture faces several challenges, including the digital divide, high technology costs, limited training, weak policies, cybersecurity risks, and inadequate rural digital infrastructure (Doria et al., 2024). There are also gaps in access to agricultural technology, research, and innovation across regions, with technological development appearing more concentrated in Luzon than in the Visayas and Mindanao (Quimba, 2021; Estigoy et al., 2022).

As Aban et al. (2026) wrote, many communities in the Philippines face gaps in digital literacy, technical capacity, infrastructure, funding, and institutional support, making it difficult to apply technologies such as Internet-of-Things (IoT), satellite systems, and AI to environmental and climate concerns. The lack of coordinated data governance and strong collaboration among government, academia, industry, and communities further limits the development of integrated solutions. These challenges point to the need for community-based projects, stronger digital and climate education, shared data

systems, regional innovation initiatives, and better funding and policy support to connect technological development with environmental resilience.

Literature Review

Forest degradation and deforestation have remained major environmental concerns in the Philippines, with serious effects on biodiversity, ecosystem functions, and communities that depend on forests. Between 2001 and 2024, the country lost around 1.52 million hectares of forest cover (Global Forest Watch, 2025). Human activities such as shifting cultivation, mining, illegal or uncontrolled logging, and grazing have contributed greatly to forest loss, while natural events such as typhoons also have detrimental effects (Oluwajuwon et al., 2025). Agricultural expansion in the Philippines has contributed to forest conversion and environmental degradation, particularly when farming extends into upland areas with poor soil conditions (Kummer & Sham, 2023). Agriculture has also been identified as a major source of water pollution through animal farming and nutrient runoff (Felipe, 2025). These show the need for more sustainable agricultural practices and better management of natural resources in the Philippines.

Environmental problems such as climate change, deforestation, marine pollution, and biodiversity decline continue to threaten ecosystems and human well-being. AI and machine learning are increasingly being used to better understand and predict these environmental changes, including rising temperatures, more frequent extreme weather events, and sea-level rise, which can place coastal communities and ecosystems at greater risk (Alotaibi & Nassif, 2024; Zhang et al., 2025). For environmental monitoring, machine learning methods can generally be grouped into supervised, unsupervised, and reinforcement learning. Supervised learning uses datasets where the expected output is already identified, allowing the model to learn how to make predictions or classifications from the available information. This method can be useful for applications such as estimating air quality and identifying vegetation types from satellite images. Common supervised learning techniques include decision trees, support vector machines, and neural networks (Omar et al., 2024; Omar et al., 2023).

AI and machine learning have been applied in environmental monitoring to improve soil mapping, land-cover classification, flood prediction, remote sensing, air quality monitoring, and pollution assessment. For soil and land management, AI can combine GIS, expert knowledge, and fuzzy logic to produce more detailed and accurate soil maps, supporting sustainable agriculture and land-use

planning (El Behairy et al., 2023). Support vector machines have also been used to improve land-cover classification from remote sensing data, which can help track environmental changes (Tariq et al., 2023). For disaster management, hybrid AI models have improved flood susceptibility mapping and prediction, supporting risk reduction and resource planning (Liu et al., 2025). AI-based remote sensing models have further been developed to detect changes in land cover, including possible applications in deforestation and land-use monitoring (Gu & Zeng, 2023).

However, there is a notable scarcity in the Philippine literature about the application of AI in the protection and preservation of natural resources, despite the increasing availability of AI technologies and their potential in environmental monitoring, biodiversity conservation, agriculture, disaster prediction, pollution assessment, and natural resource management.

AI has strong potential to improve crop production, resource management, and agricultural operations in the Philippines. However, Doria et al. (2024) emphasized that its wider use is limited by the digital divide, high technology costs, limited farmer training, weak policies, and growing cybersecurity risks. The Philippines needs better rural digital infrastructure, affordable and locally appropriate AI tools, farmer training, clear ethical and data privacy guidelines, and stronger cybersecurity measures to make AI more useful in agriculture.

There is also technology and research gap across Philippine agricultural regions. For example, about 69.23% of agricultural innovations were focused on Luzon, while only 2.56% covered the Visayas and 10.25% focused on Mindanao. This uneven distribution suggests that access to agricultural technologies, research, and innovation may be concentrated in Luzon, leaving other major agricultural areas less represented and potentially less able to benefit from emerging technologies (Quimba, 2021; Estigoy et al., 2022).

This study was inspired by the fact that, despite foreign countries and other countries in Southeast Asia integrating AI into the protection and preservation of natural resources, there remains a need to examine how such technologies may be understood, adapted, and potentially applied within the Philippine context. The Zamboanga Peninsula is an important agricultural and marine region in the Philippines, with communities that depend heavily on farming, fisheries, forestry, and other natural resources for their livelihoods (Moreno & Sulasula, 2024). This makes the region a relevant setting for examining how AI can support environmental monitoring, sustainable agriculture, biodiversity conservation, marine resource management, and natural resource protection.

The study therefore contributes to the Philippine research body by exploring the perspectives of AI experts and sustainability advocates on the possible applications of AI for environmental protection and natural resource management. It may provide initial information that can be the basis for future research, academic initiatives, policy development, and the design of localized mechanisms for responsible AI use in environmental sustainability.

Methodology

Research Design

Qualitative exploration was conducted to identify potential use of AI technology in the protection of natural resources and environmental settings in the Philippines. Exploratory research aims to develop an initial understanding of emerging phenomena, particularly when existing knowledge is limited or is relatively new (Satpati & Halder, 2025). In this study, this method was expected to contribute to environmental protection, resource conservation, biodiversity monitoring, environmental education, and sustainable management practices in the Philippines. It also sought to examine the perceived opportunities, challenges, and conditions that may influence the adoption of AI in environmental initiatives.

Participants

There were 18 participants from Zamboanga Peninsula, Philippines who responded to the request for interview. They were selected based on criteria: (1) AI experts (computer scientists/ information technology expert), (2) sustainability advocate (environment, agriculture, biodiversity, researchers), (3) actual experience in the use, development, or application of AI technology; (4) with knowledge of environmental issues and natural resource protection; (5) individuals who had experience in research, projects, programs, or initiatives related to technology and sustainability; (6) willing to provide perspectives on the opportunities and limitations of AI in environmental protection; and (7) individuals who were willing and available to participate in the interview. Purposive sampling ensured that the participants could provide informative and useful knowledge on the potential applications, opportunities, and limitations of AI in environmental protection (Ryan, 2026).

Instrumentation

This study used a semi-structured interview guide to gather important narratives from the participants. A semi-structured interview guide is designed to provide a consistent set of key questions while allowing flexibility to explore participants' experiences, insights, and perspectives in greater

depth (Maher & Bedwei-Majdoub, 2025). **Table 1** presents the final interview guide used in this study.

Table 1. Guide questions asked during the interview sessions with the participants

Objective	Interview Question	Description
To explore perspectives on the potential use of AI technology in protecting natural resources and addressing environmental concerns in the Philippines	How do you perceive the potential role of AI technology in protecting natural resources and addressing environmental concerns in the Philippines?	Explore participants' views on possible roles, applications, and contributions of AI to environmental protection and natural resource management.
	What areas of environmental protection or natural resource management could potentially benefit from the use of AI technology?	Explore possible applications of AI in areas such as biodiversity conservation, environmental monitoring, agriculture, forestry, marine resources, disaster management, pollution control, and resource assessment, without presuming that AI is currently being used or is beneficial in these areas.
	What factors should be considered when using AI technology for environmental protection and natural resource management?	Explore participants' perspectives on the conditions, requirements, opportunities, limitations, ethical considerations, risks, resources, expertise, and other factors that may influence the use of AI in environmental contexts.

Data Collection

Data collection was carried out in an organized way while following the study procedures and ethical guidelines. Before the interviews, potential

participants were contacted through email or Messenger. The researchers explained the purpose, scope, and process of the study and informed them that participation was voluntary. They were also assured that their personal information and responses would be kept confidential. Before the interview, each participant signed an informed consent form.

The interviews were conducted through phone calls or Messenger, depending on what was more convenient for the participants. Each interview lasted around 45 to 60 minutes and followed the prepared interview questions. Follow-up questions were asked when needed to clarify responses or allow participants to explain their ideas further. This gave them the opportunity to freely share their views, experiences, and suggestions. With the participants' permission, the interviews were audio-recorded to ensure that their responses were properly documented. The researchers also took field notes to record important observations and other relevant details during the interviews.

Data Analysis

Important themes were identified by applying reflexive thematic analysis (Braun et al., 2023). The recorded interviews were transcribed word for word then restructured to show emphasis on the meaning. The researcher read the transcripts several times to become familiar with the participants' responses. Relevant ideas and statements were highlighted, coded, and grouped according to similarities, narrative patterns, and the meaning. These codes were then reviewed and organized into broader themes that reflected the generalized views and experiences from the participants. With reflexivity, the researcher also considered personal perspectives, experiences, and professional background, as these could influence how the responses were understood and interpreted (Agarwal, 2025). This approach helped keep the findings grounded in the participants' actual responses while presenting and interpreting the findings in a clear and meaningful way.

Results

Qualitative exploration was used to identify opportunities for using AI in protecting natural resources, addressing environmental concerns, supporting biodiversity conservation, improving environmental monitoring, and promoting sustainable resource management in the Philippines. The narratives from one-on-one interviews were coded and grouped into larger categories and themes based on recurring ideas, shared experiences, perceived opportunities, and relevant perspectives related to the potential use of AI in environmental protection and natural resource management.

Theme 1: Teaching the responsible and ethical use of AI

Participants believed that an important aspect of using AI in the protection of natural resources is teaching responsible and ethical use. They suggested that students should develop good judgment and not depend entirely on AI-generated information. They also pointed to the need for students to understand possible issues such as false information, privacy concerns, and improper use of AI. This would help students use AI more carefully, question the information it provides, and consider the possible effects of their decisions on people and the environment.

“We need to teach students that AI is a tool, and they are still responsible for the decisions they make using it.”

“There should be lessons about privacy, misinformation, plagiarism, and other risks that may come with using AI.”

“Students need to know that they cannot simply trust everything AI provides. They still have to check and verify the information.”

“Ethics should be discussed alongside AI skills so students understand both its benefits and possible problems.”

Theme 2: Strengthen AI education in the grassroots

The participants emphasized that AI education should reach communities outside formal school settings. They recognized that many people who depend on farming, fishing, forests, and other natural resources may have limited access to AI-related learning. Providing AI education at the community level could help people have stronger understanding about how technology may support their daily activities and help solve environmental concerns. This could also make AI more inclusive by giving local communities a greater opportunity to take part in technology-based efforts to protect and manage natural resources.

“AI education should not be limited to students in cities or well-equipped schools.”

“People in local communities should also have a chance to learn about AI and how it can be useful.”

“We need to bring AI learning closer to communities, especially those that depend on natural resources.”

“If we want AI to help protect the environment, the communities directly involved in natural resources should also be included.”

Theme 3: Integrate AI into the mainstream curriculum

Participants pointed out that schools may be falling behind the rapid growth of AI. They saw the need for schools to provide clearer directions on how AI should be used in learning and to give students a broader understanding of the technology. Integrating AI across subjects may also help students understand its value and prepare them for situations where AI is likely to become part of their studies, work, and daily lives.

“Our curriculum needs to catch up because AI is already becoming part of everyday life.”

“Schools need clear guidelines on what students can and cannot do with AI.”

“AI education should cover more than just ChatGPT or other generative AI tools.”

“Students should learn the basic ideas behind AI and how different AI technologies are used.”

“AI should be introduced across different subjects so students can see how it can be used in real situations.”

Theme 4: Teach AI with environment subjects

Participants saw value in connecting AI learning with environmental topics because it could give students more practical experiences. Instead of learning AI only as a technical subject, students could apply it to real environmental concerns and work with actual data. They also viewed AI as a possible tool for developing solutions, such as identifying environmental changes, improving agricultural practices, and helping predict or respond to disasters. This strategy could help students understand both the technical side of AI and its possible contribution to environmental protection.

“AI becomes more meaningful when students can use it to understand actual environmental problems.”

“AI can help students explore environmental data and better understand what is happening around them.”

“Schools may teach students how to build their own AI models that might be applicable to solving

environmental problems and predict disasters.”

“Students can learn how AI is used to monitor forests, detect illegal activities, or track changes in land cover.”

“Agriculture students can use AI to study crop health, soil conditions, pests, and possible farming problems.”

Theme 5: Develop AI skills with decision-making

There is also a need to build decision-making skills alongside AI skills. Participants emphasized that learning AI should also involve developing the ability to think carefully and make sound decisions. People therefore need to learn how to examine AI-generated information, consider whether it is reliable and useful, and connect it with the situation they are dealing with. Environmental activities could help build these skills by allowing students to work with issues such as flooding, pollution, farming, biodiversity, and waste management. This could help them become more confident in using AI while still relying on their own judgment when choosing appropriate actions.

“I think, aside from teaching AI technicalities, we also need to teach students how to decide based on the data that they have.”

“AI is useless if the user doesn’t have effective decision-making skills.”

“AI can give suggestions, but people still need to decide what information is useful and what action to take.”

“People can practice using AI to examine data about flooding, crop conditions, pollution, or biodiversity and then decide what response would be most suitable.”

“Learners can be given real situations, such as choosing the best way to reduce waste or protect a local ecosystem and use AI as one source of information.”

Theme 6: Use AI directly for environmental monitoring

Participants viewed direct use of AI as a mechanism to help students and communities become more involved in environmental monitoring. They saw opportunities for technology to make it easier to observe changes, identify possible problems, and gather useful information from different sources. This could be especially helpful in areas such as farming

and natural resource management, where regular monitoring can support better planning and timely action.

“We can use cameras, sensors, or drones together with AI to observe environmental changes.”

“We can use AI to monitor crop growth and identify possible problems early.”

“AI can help communities monitor their natural resources without relying only on manual observation.”

“We can use AI to detect possible environmental problems and provide information that can guide further action.”

“Some students have already used AI to monitor crop yields and provide suggestions on which crops could be planted in the next growing cycle.”

Theme 7: Encourage support from key stakeholders

Participants recognized that the use of AI for environmental protection would require cooperation from different sectors. Schools may not have all the technology, funding, expertise, or training needed to develop and maintain AI-based activities on their own. Working with government agencies, businesses, environmental groups, and local communities could provide students with better learning opportunities and expose them to actual environmental applications of AI. They also noted that long-term support is important because successful AI initiatives need continuous training, technical assistance, equipment maintenance, and guidance.

“Even if we want to use AI in environmental monitoring, we still need the support of the government, schools, organizations, and businesses.”

“Schools need support from different organizations so they can access better technology and learning resources.”

“Students can learn more when they are given opportunities to work with people and organizations that are already using AI in the field.”

“Environmental organizations can help schools identify real problems where AI can be useful.”

“Partnerships between schools, government agencies, businesses, and communities can make AI

projects more practical and sustainable.”

“Support should not stop after providing equipment; there should also be training, maintenance, and continued guidance.”

Discussion

The increasing use of AI creates opportunities to support environmental protection and sustainable natural resource management. However, realizing these opportunities requires people to have the knowledge, skills, critical thinking, and ethical awareness needed to apply AI appropriately to local environmental needs. Hence, this study explored how AI technology could help in the protection of natural resources in the Philippines.

AI experts and sustainability advocates in this study emphasized that AI education should include responsible and ethical use, particularly when AI is applied to environmental concerns. In van Uffelen et al. (2024), environmental concerns have received less attention in AI ethics compared with issues such as privacy, transparency, safety, and bias. They proposed viewing AI ethics from an environmental justice perspective, considering not only people but also animals and ecosystems. They identified justice, systematic justice, and recognition as important principles for assessing and designing AI systems in ways that address their ecological impacts.

AI ethics can be thought through teaching students how to use AI effectively while keeping sustainability in mind. For example, students can be encouraged to consider the energy and resources used by AI tools, avoid unnecessary or excessive AI use, and choose applications that provide real value. They can also learn to think about how AI-based decisions may affect people, animals, and the environment. Participants emphasized that these important aspects were still limited in the mainstream curriculum, making it more difficult to prepare students for the responsible use of AI in environmental protection.

With student-centered learning opportunities, studies suggested that AI allows students to explore real-world problems, work with actual data, develop solutions, and take a more active role in their learning. A study proposed the Generative AI-Enabled Sustainable Education (GAISE) framework showed how AI could be integrated into curriculum development, teaching, assessment, and teacher training to strengthen sustainability knowledge and learning (Baskara, 2024). In this framework, generative AI can support sustainable education through four key functions: creating relevant and updated learning materials, personalizing learning experiences, supporting interactive knowledge

construction, and encouraging reflection and changes in perspective about sustainability (Baskara, 2024).

Building on this framework, AI integration for teaching sustainability requires hands-on, problem-based learning where students use AI to investigate and respond to actual environmental concerns in their communities. For example, students may be asked to identify local problems such as flooding, improper waste disposal, declining crop production, water pollution, or loss of biodiversity. They can then gather relevant local data, organize and analyze the information, and develop an AI model to identify patterns, make predictions, or explore possible solutions. This can help students develop AI and data skills while also strengthening critical thinking, problem-solving, environmental awareness, and decision-making. Importantly, students can also be asked to evaluate the limitations and possible risks of their models, ensuring that AI supports their judgment.

Furthermore, there is also a need to expand AI education to communities, especially those that directly depend on natural resources for their livelihoods and daily activities. Farmers, fisherfolk, local environmental groups, and other community members can be introduced to AI applications that may help them monitor crops, identify environmental changes, manage resources, or respond to local environmental problems. In dairy farming, AI systems can help detect lameness in cattle, which may improve animal welfare and farm efficiency (Siachos et al., 2024). AI is also being used to improve tractor movement and path tracking, making farm operations more precise (Miao et al., 2022). In livestock production, AI and machine learning are being applied to estimate animal weight through cameras, detect health problems earlier, and monitor pastures using drones (Raj & Prahadeeswaran, 2025). However, these applications remain uncommon in the Philippines and are mostly used by organizations with sufficient resources and technical capacity due to cybersecurity concerns and the lack of a comprehensive national strategy (Doria et al., 2024).

AI adoption for protecting the natural resources in the Philippines is still limited. Participants believed that maximizing AI requires strong support from government agencies, educational institutions, private organizations, technology providers, and local communities. Such support may include funding, access to appropriate technologies, training, technical assistance, clear policies, and long-term programs that can help ensure that AI applications are properly developed, implemented, and sustained (Doria et al., 2024). This study emphasized the need for a localized AI framework that can guide the responsible and sustainable use of AI in natural resource protection

while strengthening partnerships among schools, government agencies, organizations, businesses, and local communities.

Conclusion

This paper explored how AI adoption could help in protecting the Philippine natural resources, especially in Zamboanga Peninsula region. Themes focused on 6 components of AI integration: (1) teaching AI skills and ethical use, (2) effective decision-making, (3) integrate AI into the mainstream curriculum, (4) allow learners to implement their ideas, (5) teach AI to local communities, and (6) encourage partnerships.

AI education should become an important part of environmental and sustainability education, instead of it being a technical skill only learned by some. Learners need to develop responsible AI use, critical thinking, informed decision-making, and awareness of the effects of AI on people and the environment. This calls for stronger curriculum content on AI ethics, sustainability, and environmental applications, as well as broader coverage of AI technologies. Integrating AI into environmental learning can strengthen students' technical knowledge while also developing critical thinking, problem-solving, decision-making, and environmental awareness. At the same time, learners need to understand the limitations of AI and remain responsible for evaluating and interpreting its outputs.

Learning AI should be made more accessible beyond well-equipped schools and urban areas. Community-based education and training can help reduce unequal access to technology and strengthen the participation of local communities in technology-supported environmental protection. Educational institutions may need support in terms of technology, funding, expertise, training, policies, and technical assistance. Stronger partnerships among government agencies, schools, businesses, organizations, and communities can help make AI initiatives more accessible, relevant, and sustainable.

On top of these, there is a need for a localized and sustainable framework for AI and natural resource protection in the Philippines. Such a framework should provide guidance on responsible AI use, curriculum integration, community education, environmental applications, capacity building, data management, and stakeholder collaboration. It should also consider the environmental impacts of AI itself.

References

- Aban, J. L., Lucero-Prisno III, D. E., Ogaya, J. B., & Ong, C. J. N. (2026). The Philippines at the crossroads: Balancing environmental resilience and digital transformation [Essay]. *IEEE Potentials*, 44(3), 21-28.
- Agarwal, A. (2025). Making reflexivity explicit in qualitative research. In *Exploring Research Methodology and Research Design* (pp. 147-156). Edward Elgar Publishing.
- Alotaibi, E., & Nassif, N. (2024). Artificial intelligence in environmental monitoring: in-depth analysis. *Discover Artificial Intelligence*, 4(1), 84.
- Baskara, F. R. (2024). Generative AI as an enabler of sustainable education: Theoretical perspectives and future directions. *British Journal of Teacher Education and Pedagogy*, 3(3), 122-134.
- Braun, V., Clarke, V., Hayfield, N., Davey, L., & Jenkinson, E. (2023). Doing reflexive thematic analysis. In *Supporting research in counselling and psychotherapy: Qualitative, quantitative, and mixed methods research* (pp. 19-38). Cham: Springer International Publishing.
- Chutcheva, Y. V., Kuprianova, L. M., Seregina, A. A., & Kukushkin, S. N. (2022). Environmental management of companies in the oil and gas markets based on AI for sustainable development: An international review. *Frontiers in Environmental Science*, 10, 952102.
- Doria, J. O., Noche, E. B., & Ventayen, R. J. M. (2024). Harvesting the Future: A Review of Artificial Intelligence Integration in the Philippine Agricultural Sector. *Southeast Asian Journal of Science and Technology*, 9(1), 265-271.
- El Behairy, R. A., El Arwash, H. M., El Baroudy, A. A., Ibrahim, M. M., Mohamed, E. S., Rebouh, N. Y., & Shokr, M. S. (2023). Artificial intelligence integrated GIS for land suitability assessment of wheat crop growth in arid zones to sustain food security. *Agronomy*, 13(5), 1281.
- Estigoy, J. H., Yeo, K. H., Seo, Y., & Jang, S. (2022). Introduction and potential of protected horticulture in the Philippines: A review. *Journal of the Korean Society of International Agriculture*, (WorldVeg Staff Publication).
- Felipe, A. J. B. (2025). The agricultural, environmental, and rehabilitation impacts of soil erosion in the Philippine economy—A walkaround review. *Soil Security*, 100213.
- Global Forest Watch. (2025). *Philippines deforestation rates & statistics*. <https://www.globalforestwatch.org/dashboards/country/PHL/>
- Gohr, C., Rodríguez, G., Belomestnykh, S., Berg-Moelleken, D., Chauhan, N., Engler, J. O., ... & von Wehrden, H. (2025). Artificial intelligence in sustainable development research. *Nature Sustainability*, 8(8), 970-978.
- Gu, Z., & Zeng, M. (2023). The use of artificial intelligence and satellite remote sensing in land cover change detection: Review and perspectives. *Sustainability*, 16(1), 274.

- Kummer, D., & Sham, C. H. (2023). The causes of tropical deforestation: a quantitative analysis and case study from the Philippines. *The causes of tropical deforestation*, 146-158.
- Liu, Z., Coleman, N., Patrascu, F. I., Yin, K., Li, X., & Mostafavi, A. (2025). Artificial intelligence for flood risk management: A comprehensive state-of-the-art review and future directions. *International Journal of Disaster Risk Reduction*, 117, 105110.
- Maher, C., & Bedwei-Majdoub, C. (2025). Semi-structured qualitative interview guide: process and considerations for doctoral students. In *Qualitative research methods for dissertation research* (pp. 195-220). IGI Global Scientific Publishing.
- Mhlanga, D. (2022). Human-centered artificial intelligence: The superlative approach to achieve sustainable development goals in the fourth industrial revolution. *Sustainability*, 14(13), 7804.
- Miao, H., Diao, P., Xu, G., Yao, W., Song, Z., & Wang, W. (2022). Research on decoupling control for the longitudinal and lateral dynamics of a tractor considering steering delay. *Scientific Reports*, 12(1), 13997.
- Moreno, F., & Sulasula, J. (2024). Administration of local economic development: case study of the zamboanga peninsula region, philippines. *ScienceOpen Preprints*.
- Nahar, S. (2024). Modeling the effects of artificial intelligence (AI)-based innovation on sustainable development goals (SDGs): Applying a system dynamics perspective in a cross-country setting. *Technological Forecasting and Social Change*, 201, 123203.
- Nasir, O., Javed, R. T., Gupta, S., Vinuesa, R., & Qadir, J. (2023). Artificial intelligence and sustainable development goals nexus via four vantage points. *Technology in Society*, 72, 102171.
- Oluwajuwon, T. V., Chazdon, R. L., Gregorio, N., Ota, L., Tripoli, R., Pasa, A., & Herbohn, J. (2025). Assisted natural regeneration for tropical forest and landscape restoration in the Philippines: implementation, motivations, challenges and future directions. *Trees, Forests and People*, 20, 100896.
- Omar, M., Alotaibi, E., Arab, M. G., Shanableh, A., Malkawi, D. A. H., Elmehdi, H., & Tahmaz, A. (2023). Harnessing nature-inspired soft computing for reinforced soil bearing capacity prediction: a neuro-nomograph approach for efficient design. *International Journal of Geosynthetics and Ground Engineering*, 9(4), 53.
- Omar, M., Arab, M. G., Alotaibi, E., Alshibli, K. A., Shanableh, A., Elmehdi, H., ... & Tahmaz, A. (2024). Natural soils' shear strength prediction: A morphological data-centric approach. *Soils and Foundations*, 64(6), 101527.
- Quimba, F. M., & Estudillo, J. (2021). Forces of modernization and the welfare of rural households: a saga of a village in Central Luzon, 1977-2013. *Philippine Review of Economics (Online ISSN 2984-8156)*, 57(1), 42-70.
- Raj, M., & Prahadeeswaran, M. (2025). Revolutionizing agriculture: a review of smart farming technologies for a sustainable future. *Discover Applied Sciences*, 7(9), 937.
- Ryan, A. (2026). Regarding researcher bias in purposive sampling. *Journal of Academic Research and Innovation*, 3(1), 1.
- Sánchez-Roncero, A., Garibo-i-Orts, Ò., Conejero, J. A., Eivazi, H., Mallor, F., Rosenberg, E., ... & Hoyas, S. (2023). The sustainable development goals and aerospace engineering: A critical note through artificial intelligence. *Results in Engineering*, 17, 100940.
- Santos, R. (2026). Attitudes on AI adoptions: Input to policy formulation. *International Journal of Engineering Trends and Technology*, 74(7), 328-351.
- Satpati, L., & Haldar, A. (2025). Revisiting exploratory research methodology in the context of environment and development in the Anthropocene. In *Geographies of the Indian subcontinent: Cutting-edge methods in 21st Century research* (pp. 341-359). Cham: Springer Nature Switzerland.
- Siachos, N., Neary, J. M., Smith, R. F., & Oikonomou, G. (2024). Automated dairy cattle lameness detection utilizing the power of artificial intelligence; current status quo and future research opportunities. *The Veterinary Journal*, 304, 106091.
- Tariq, A., Jiango, Y., Li, Q., Gao, J., Lu, L., Soufan, W., ... & Habib-ur-Rahman, M. (2023). Modelling, mapping and monitoring of forest cover changes, using support vector machine, kernel logistic regression and naive bayes tree models with optical remote sensing data. *Heliyon*, 9(2).
- van Uffelen, N., Lauwaert, L., Coeckelbergh, M., & Kudina, O. (2024). Towards an environmental ethics of artificial intelligence. *arXiv preprint arXiv:2501.10390*.
- Wang, Z., Deng, Y., Zhou, S., & Wu, Z. (2023). Achieving sustainable development goal 9: A study of enterprise resource optimization based on artificial intelligence algorithms. *Resources Policy*, 80, 103212.
- Zhang, Q., Li, X., Yu, L., Wang, L., Wen, Z., Su, P., ... & Wang, S. (2025). Machine learning-assisted fluorescence visualization for sequential quantitative detection of aluminum and fluoride ions. *Journal of Environmental Sciences*, 149, 68-78.