



Bridging Compliance and Commitment: Deforestation and Climate Resilience in Malaysia

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Abstract

Malaysia's tropical forests are critical to global biodiversity and climate regulation, yet they face escalating threats from deforestation driven by urban expansion, monoculture plantations, and industrial development. This paper investigates the systemic challenges underlying forest degradation and climate vulnerability in Malaysia, emphasizing the disconnect between regulatory compliance and genuine environmental commitment. Drawing on interdisciplinary insights, the study outlines strategic pathways for climate-aligned transformation, including forest genomics research, mixed-species reforestation, circular economy models, and climate-integrated governance frameworks. The analysis highlights the need for cohesive national strategies that align ecological preservation with industrial innovation and policy reform. By integrating scientific evidence, sustainability practices, and governance mechanisms, the paper offers actionable recommendations to enhance Malaysia's environmental resilience and long-term sustainability.

Keywords: Deforestation, Climate Resilience, Environmental Sustainability, Biodiversity Conservation, Climate Policy, Malaysia, Ecological Restoration.

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INTRODUCTION

Climate change represents one of the most complex and urgent challenges of the 21st century, with far-reaching implications for ecosystems, economies, and societies. It is characterized by global warming, altered precipitation patterns, and an increased frequency of extreme weather events, all of which have profound impacts on both natural and human systems (Grimm et al., 2013). One of the most vulnerable systems to these changes is forest ecosystems, which are likely to be strongly affected through shifts in tree growth, mortality, and reproduction. Ecosystem services (supporting, regulating, provisioning, and cultural services) are the benefits people derive from the natural processes that sustain ecosystems.

Malaysia is well known for its expansive tropical forests, which play an important role in global climate change policy and the ecosystem. However, in recent decades, the country

has faced significant pressures from deforestation driven by agricultural expansion, particularly for oil palm and timber plantations. According to Global Forest Watch (2024), Malaysia recorded a loss of 101 thousand hectares (kha) of natural forest in 2024, resulting in an estimated 70.9 million metric tons (Mt) of carbon dioxide (CO₂) emissions. This figure represents a 0.56% reduction from the 18.1 million hectares (Mha) of natural forest cover recorded in 2020.

Although deforestation in 2024 was slightly lower than in previous years, it is still a major concern because of its harmful effects on the environment and climate. The primary drivers of forest loss include the conversion of natural forests within forest reserves into monoculture plantations, particularly for timber and oil palms. Palm oil is a major part of Malaysia's economy and is important for the global food supply. It is used in many products, including food, cosmetics, and biofuels. Malaysia is the second-largest producer and exporter of palm

oil after Indonesia, with large plantations found across the country (Bilu et al., 2025).

From 2002 to 2024, Malaysia lost 2.99 Mha of humid primary forest, making up 33% of its total tree cover loss in the same time. Total area of humid primary forest in Malaysia decreased by 19% in this time (Figure 1). Forest loss remains a significant issue in Malaysia, weakening the country's policies aimed at forest conservation. This ongoing deforestation poses a serious threat to biodiversity, endangers the well-being of indigenous communities, and jeopardizes Malaysia's ability to meet its climate commitments under international agreements like the Paris Agreement (Bilu et al., 2025). Even though there is more awareness now, deforestation is still serious. The negative effects of the palm oil industry have pushed many companies to adopt corporate environmental responsibility (CER). According to Bisschop (2010), CER means that businesses should consider how their actions affect the environment now and in the future.

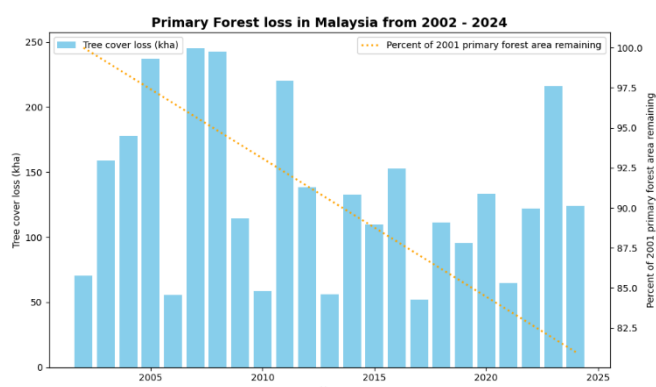


Figure 1: Primary Forest loss in Malaysia Global Forest Watch (2024).

This study examines the factors contributing to deforestation in Malaysia, including industrial development and the challenge of balancing economic progress with environmental protection. It further examines the integration of scientific insights and policy mechanisms to advance Malaysia's progress toward sustainable development. By analyzing case studies and existing research, the paper outlines the major challenges and recommends practical solutions to address climate change in the Malaysian context. It emphasizes the importance of a comprehensive strategy that involves sustainable urban planning, forest conservation, and environmentally responsible business practices to reduce climate impacts and ensure long-term resilience.

DEFORESTATION LANDSCAPE IN MALAYSIA

Deforestation in Malaysia is driven by a combination of urban expansion, agricultural intensification, and infrastructure development (Abdullah & Hezri, 2008; Masum et al., 2017). These activities have led to the fragmentation of forest landscapes, increasing their vulnerability to pests, diseases, and invasive species (Burkett-Cadena & Vittor, 2017; Prezoto et al., 2019). The conversion of forested land into monoculture plantations—particularly for palm oil and timber—has significantly reduced biodiversity and disrupted ecological balance (Fitzherbert et al., 2008).

Role of Forest in Supporting Ecosystem

Forests in Malaysia serve as critical ecological infrastructure. They regulate hydrological cycles, stabilize soil, and act as carbon sinks, mitigating the effects of climate change (Khormali & Ajami, 2011; Sedjo & Sohngen, 2010). Tropical rainforests also support a high level of biodiversity, including endemic and endangered species (Fitzherbert et al., 2008). The degradation of these forests' compromises

ecosystem services, reduces habitat connectivity, and increases the risk of ecological collapse. The loss of forest cover not only affects wildlife but also undermines the livelihoods of indigenous and rural communities who depend on forest resources (Lima et al., 2016).

Forests As Climate Infrastructure

Forests are not merely repositories of biodiversity; they serve as critical natural infrastructure that supports climate regulation, ecological balance, and human well-being. In the context of Malaysia, tropical rainforests play a pivotal role in modulating local and regional climates by acting as carbon sinks, stabilizing hydrological cycles, regulating temperatures, and preventing soil erosion (Bonan, 2008; Muller et al., 2018). These ecosystem services are fundamental in buffering the impacts of climate change, especially for countries like Malaysia that are highly biodiverse yet vulnerable to extreme weather events.

Despite their ecological significance, Malaysian land-use policies have historically undervalued the multifunctional roles of forests. Instead, emphasis has often been placed on short-term economic benefits, such as timber extraction and conversion of forests into agricultural plantations, particularly for palm oil (Miettinen et al., 2011). This undervaluation has led to habitat fragmentation, loss of ecological connectivity, and degradation of natural resilience to climate shocks (Bryan et al., 2013).

Integrating Forest Metrics into Climate Policy

For Malaysia to enhance the effectiveness of its climate strategies, forest-related ecological metrics must be systematically embedded into national climate accounting systems. Indicators such as species richness, canopy cover, biomass density, and soil organic carbon levels provide crucial data to assess the health and climate mitigation potential of forest ecosystems (Pörtner et al., 2022). The incorporation of these metrics into frameworks like Malaysia's Nationally Determined Contributions (NDCs) or carbon trading schemes under REDD+ (Reducing Emissions from Deforestation and forest Degradation) would ensure that forest ecosystems are recognized not only for their carbon storage but also for their biodiversity co-benefits and social functions (Angelsen et al., 2012).

Malaysia must continuously institutionalize these forest health indicators within its REDD+ implementation and Measurement, Reporting and Verification (MRV) framework systems to ensure that climate policies are not only technically robust but also ecologically and socially inclusive, refer Figure 2. REDD+ mechanisms, when designed with local participation and benefit-sharing models, can provide both climate and socioeconomic dividends. For instance, involving indigenous and rural communities in monitoring forest conditions and managing reforestation efforts can simultaneously uphold traditional knowledge systems and foster environmental stewardship (Sills et al., 2014).

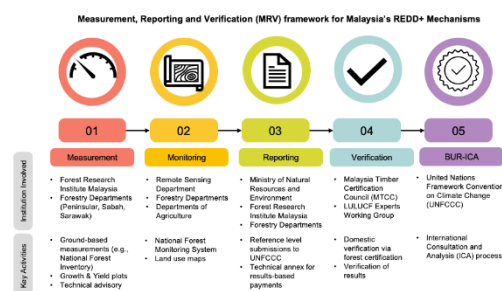


Figure 2: Measurement, Reporting and Verification (MRV) framework for Malaysia's REDD+ Mechanisms.

COMPLIANCE VS COMMITMENT; INDUSTRY VS GOVERNANCE

The relationship between industry and governance in Malaysia reflects a broader global tension: the difference between regulatory compliance and genuine environmental commitment. While industries often respond to legal mandates, long-term sustainability requires proactive engagement and innovation.

Industry Practices and Compliance

Many Malaysian industries, particularly in the energy and forestry sectors, have adopted sustainability frameworks to meet ISO standards and ESG benchmarks (Wong, 2024). Examples include the use of digital tools for operational efficiency, solar installations in community spaces, and energy-saving architectural designs. However, these efforts are often driven by cost-saving motives or external pressure rather than intrinsic commitment to environmental stewardship (Hennig et al., 2023). The inconsistency in sustainability adoption across sectors highlights the need for stronger incentives and clearer accountability mechanisms.

Governance and Environmental Commitment

Malaysia's environmental governance has undergone transformation through frameworks like the Environmental Quality Act 1974 and the National Policy on Industry 4.0, which aim to integrate technology and stricter enforcement. These frameworks aim to balance economic development with ecological preservation. However, enforcement remains uneven, and coordination among agencies is often fragmented (Halmi & Rahman, 2021). There is a pressing need for integrated governance that aligns national climate goals with local implementation. This includes empowering local authorities, enhancing transparency, and fostering public-private partnerships to ensure that commitments translate into measurable outcomes.

STRATEGIC PATHWAYS FOR CLIMATE-ALIGNED TRANSFORMATION

To address the systemic challenges identified in Malaysia's climate and sustainability landscape, this section proposes a multipart strategy that integrates ecological science, industrial innovation, and governance reform. The recommendations presented are insights gathered from the academic, industrial, and private sector perspectives. The goal is to move beyond fragmented efforts and toward a cohesive national framework that supports both environmental resilience and economic progress.

Strengthening Forest Intelligence and Ecological Restoration

Expand Forest Genomics Research

Establish national research hubs focused on native species resilience, pest resistance, and carbon sequestration potential. As it stands, Malaysia is still lacking behind having a competent forest focused genomics program. The Shorea series, known as dipterocarps, are the common timber trees used extensively in the country. Unfortunately, there is still a limited genomic information on many species in this genus (Mohammad et al., 2025). This can hinder potential advancements in tree breeding programs which can help the forest to recover.

Integrate Forest Health Metrics into Reducing Emissions from Deforestation and Forest Degradation (REDD+) and ESG Reporting

Leveraging Malaysia's National REDD+ Strategy, Forest Health Metrics such as biodiversity indicators, soil health

assessments, and canopy recovery rate can be systematically integrated into REDD+ and ESG reporting frameworks. This strategy provides a robust institutional foundation through its emphasis on policy coherence across governance levels, the establishment of a comprehensive Measurement, Reporting, and Verification (MRV) system, and the development of sustainable financing mechanisms (Ministry of Natural Resources and Environment Malaysia, 2017). Incorporating indicators into these frameworks enhances the capacity to monitor ecological integrity and climate mitigation outcomes. Adding tools that track both nature and communities helps forest protection adapt to change and include local voices, while meeting global standards for fairness and sustainability.

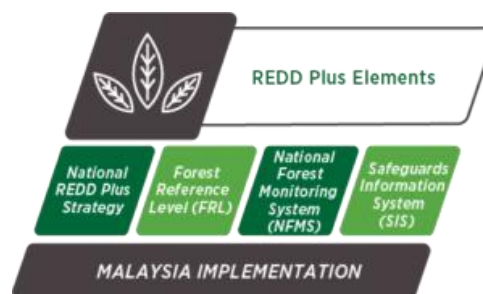


Figure 3: Malaysia's REDD Plus Elements (Ministry of Natural Resources and Environment Malaysia, 2017).

Replace monoculture plantations with ecologically diverse forest corridors to restore habitat connectivity and improve long-term carbon storage. Nowadays, planting strategies are still relying on monoculture plantations such as the case of acacia and rubber plants. This is detrimental to future reforestation plans as continuing with this method of planting can cause soil degradation and ecological imbalance, which is bad for soil recovery and leads to limited biodiversity (Belete & Yadete, 2023). Through mixed-species plantations, it provides multiple benefits. Qian et al. (2025) highlighted in a study that mixed plantation has diversity enhancements in the ecosystem through the BEF (Biodiversity-Ecosystem Functioning) theory. The study also mentions that artificial mixed plantations are vital in facing global warming and other extreme weather events.

Industry-Led Sustainability Innovation

Incentivize Circular Economy Models

To encourage Malaysia into providing sustainable production in its economy, the country must provide tax and policy incentives for companies that reduce waste, recycle materials, and design for resource efficiency. Studies shown that countries like Malaysia, Pakistan, and China have proved that circular economy innovation and business model innovation (BMI) can improve the economic and social situation of Small and Medium-sized Enterprises (SMEs) (Rehman et al., 2022). Hence, integrating this circular economy can help local businesses transition to become more sustainability-driven in the future.

Digitalize Environmental Compliance

Encourage the use of mobile apps, IoT sensors, and AI dashboards for real-time monitoring of emissions, energy use, and biodiversity impact. These days, technology has advanced to a point where every device is now connected to the internet and constantly updated. This proves useful in various industries, more so for environmental monitoring. Baranwal (2025) pointed out that IoT-based environmental sensing systems show that real-time monitoring can enhance any decision making and emergency response through feeding in environmental data across parameters like air, water, and noise.

Scale Community Solar Projects

Solar projects are still in its infancy, despite there being solar farms already in Malaysia. However, there is still a need for projects that are small scale enough to reasonably provide for rural communities. A discussion brought about the installation of a solar panel at a surau has brought clean energy to a public religious space, which is a good first step, although there is always room for improvement. In rural settlements like FELDA communities, such technology would be welcome as it invited clean energy and at a fraction of the cost. A study highlighted this with the decentralized energy systems like solar energy can build up public trust and provide smooth transition to a lower carbon consumption lifestyle (Streimikiene et al., 2021).

Governance Reform and Policy Synchronization

Establish Climate-Integrated ISO Certification Pathways

Another method of ensuring environmental policy is always kept in check is through ISO certification. Despite that, Malaysia still deems environmental ISO certification not as important. Hence, it is important that ISO 14001 and 50001 must be implemented with national climate goals, embedding climate risk assessments into certification audits. Studies shown that 28 municipalities in Europe have displayed successful implementation of ISO 50001 in their energy management systems (Kaselofsky et al., 2021). Hence, Malaysia can adopt climate-related ISO standards to align with ESG requirements and prepare for future climate events. Figure 3 illustrates how ISO 14001:2015 links key clauses to climate change mitigation and adaptation, help users demonstrate climate action through their management systems (Climate Change and ISO 14001, 2024.).

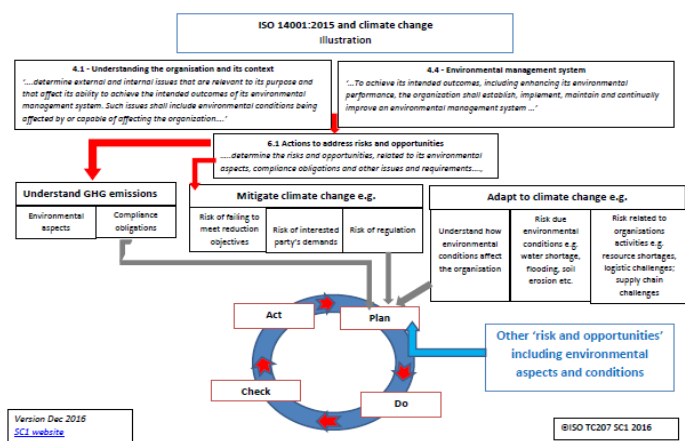


Figure 4: A schematic form shows how ISO 14001 supports climate change mitigation and adaptation (Climate Change and ISO 14001, 2024)

Create Multi-Stakeholder Climate Councils

Facilitate regular dialogue between government, industry, academia, and civil society to co-design climate policies and track implementation. Another factor lacking in Malaysia's governance on the climate is the consistent and meaningful discussion between various sectors. A common complaint amongst stakeholders is the late action taken by the policy makers, where environmental concerns are given little attention and barely make a difference in the general discussion. A study was conducted in the UK where a citizen's panel for low-carbon housing policy was made and found out that citizens were involved in policy making with analysts, which leads to more detailed and viable policy proposals for

housing areas over there (Tsouvalis et al., 2024). This inclusion underscores the necessity for ongoing communication and increased government transparency, thereby fostering more effective collaborative climate governance.

Mandate Climate Risk Disclosure

Require companies to report climate vulnerabilities and mitigation plans as part of their annual governance filings. Despite the rising awareness in the issues plaguing the world today, Malaysia's government remains limited in their consistency for discussions on such topics. Climate-related reports yet remain as a compliance and nothing more after the fact, which leads to weak enforcement of climate sustainability goals. To that, a study by Arian & Sands (2023) on various multinational companies from 2007 to 2021 showed that climate risk disclosures are still inadequate and only focus on the short-term financial gain instead of long-term environmental sustainability goals. To that end, Malaysia must enforce mandatory climate risk disclosure in their government filings to urgently set higher standards for practices and resilience in the private sector.

REFRAMING DEFORESTATION AS A SYSTEMIC RISK

Deforestation in Malaysia threatens biodiversity, national resilience, and socioeconomic stability. Major causes include land conversion for palm oil, urban growth, and infrastructure projects, which fragment forests and reduce their effectiveness against climate impacts (Miettinen et al., 2011; Esterman, 2017). This increases vulnerability, especially for rural and indigenous communities (Bryan et al., 2013). Addressing deforestation requires coordinated policy, cross-sector collaboration, and urgent investment in nature-based solutions.

Cross-Sectoral Implications

Addressing deforestation requires an integrated approach involving urban planning, agriculture, and conservation. For example, the incorporation of ecological buffers and green infrastructure in city planning can help mitigate flood risks and preserve habitat connectivity (Elmqvist et al., 2015). Furthermore, sustainable land-use practices in agriculture such as agroforestry and permaculture can enhance productivity while conserving biodiversity (Jose, 2009).

Enhancing Reforestation Strategies

Reforestation in Malaysia should transcend the conventional monoculture approach which focuses on fast-growing species for timber or commercial use and instead prioritize ecological restoration through mixed-species plantations and native flora. Mixed-species reforestation not only supports greater biodiversity but also improves ecosystem functionality, pest resilience, and long-term carbon sequestration (Chazdon, 2008; Lamb et al., 2005). Furthermore, reforested areas designed as wildlife corridors can restore habitat connectivity, allow species migration and reduce the risk of local extinctions.

Successful case studies in Southeast Asia, such as assisted natural regeneration in the Philippines and forest corridor restoration in Sabah, Malaysia, demonstrate the viability of ecological restoration approaches that integrate community involvement, scientific input, and policy support (Shono et al., 2007).

BRIDGING COMPLIANCE AND COMMITMENT

Malaysian industries have made strides in adopting sustainability frameworks; however, many efforts remain

surface-level or driven by regulatory compliance rather than intrinsic environmental values (Salim & Padfield, 2017).

From Performative to Transformative Practices

Transformational change requires that sustainability be embedded into core business strategies through science-based targets, transparent governance, and climate-aligned investments (Lozano, 2015). Voluntary sustainability reporting under frameworks like the Global Reporting Initiative (GRI) and Task Force on Climate-related Financial Disclosures (TCFD) can help elevate these standards.

Incentivizing Deep Integration

Government incentives, such as tax rebates or fast-tracked permitting for green-certified projects, can encourage industries to pursue genuine environmental (Hashim & Ho, 2011). Case studies from Selangor show that regulatory flexibility coupled with fiscal incentives led to increased green building certifications.

GOVERNANCE AS AN ENABLER, NOT JUST A REGULATOR

While Malaysia has established progressive environmental frameworks such as the National Policy on Biological Diversity, the Malaysian Timber Certification Scheme, and the National Climate Change Policy, implementation challenges persist that particularly in the areas of enforcement, policy alignment, and inter-agency coordination (Abubakar et al., 2021; Hashim & Ho, 2011). These shortcomings often result in fragmented environmental action and a disconnection between national goals and local execution.

To move beyond a reactive, enforcement-only governance model, Malaysia should view environmental governance to encourage collaboration, creativity, and engagement from all parts of society. This shift requires strengthening institutional synergy and making sure that considerations about climate change and biodiversity are included in every stage of policy making and implementation.

Collaborative Governance Models

One of the most critical steps toward enabling environmental governance is the institutionalization of multi-stakeholder climate councils. These councils comprised of representatives from government ministries, industry bodies, civil society, academia, and indigenous communities which would serve as platforms for co-creating policies, resolving jurisdictional overlaps, and monitoring implementation in a transparent manner (Elmqvist et al., 2015; Ostrom, 2010). Such participatory mechanisms have proven effective in enhancing policy legitimacy and responsiveness in other decentralized governance contexts.

Collaborative models can also help bridge the rural-urban divide in environmental implementation. For instance, while urban authorities like Kuala Lumpur City Hall may have the capacity to implement green zoning or digital monitoring, rural districts often lack the financial and technical support to enforce sustainable land-use practices. A collaborative governance structure would allow for shared resources and knowledge transfer across regions.

Climate-Integrated Certification and Disclosure

To improve policy effectiveness, Malaysia can align its ISO certification systems (e.g., ISO 14001 for environmental management and ISO 50001 for energy management) with national climate goals. This alignment would require the integration of climate risk assessments and ecosystem metrics such as biodiversity indicators, carbon sequestration rates, and water risk in certification audits (Lozano, 2015). This not only raises the bar for corporate compliance but also ensures

that management systems actively support Malaysia's commitments under the Paris Agreement.

Additionally, mandatory climate risk disclosure should be incorporated into annual sustainability or governance reports for public and private companies. This would enhance accountability while giving investors and regulators better tools to evaluate long-term environmental and financial risks (Sullivan & Gouldson, 2017). Public disclosure of climate vulnerabilities, mitigation pathways, and adaptation progress would drive market-based incentives for companies to go beyond minimum compliance.

TOWARD A CLIMATE-ALIGNED INDUSTRIAL STRATEGY

The industrial sector plays a pivotal role in Malaysia's transition toward a low-carbon economy. As one of the largest contributors to greenhouse gas emissions and environmental degradation, the sector must evolve from resource-intensive practices to climate-aligned strategies. This transformation is not only critical for environmental sustainability but also necessary to future-proof Malaysia's economic competitiveness and social equity.

Industrial activities including manufacturing, construction, and resource extraction contribute significantly to carbon emissions, solid waste generation, and water and energy consumption (WWF-Malaysia, 2020). While many companies in Malaysia have adopted sustainability reporting frameworks aligned with ISO 14001, ESG indicators, or GRI standards, these efforts are often fragmented and compliance-driven rather than transformative. To bridge this gap, Malaysia must promote a holistic industrial strategy that emphasizes innovation, accountability, and inclusive development.

Scaling Circular Economy and Clean Energy

A circular economy model, which emphasizes waste minimization, resource efficiency, and product lifecycle extension, can serve as a cornerstone of industrial decarbonization (Geissdoerfer et al., 2017). In Malaysia, industries can be incentivized to adopt circular business models through fiscal measures such as tax breaks, green financing, or preferential procurement policies for companies that implement recycling, remanufacturing, or eco-design initiatives. Successful pilot programs such as closed-loop material use in the electronics and textile sectors offer a strong foundation for scale-up (UNESCAP, 2022).

Promoting circular economic initiatives such as waste valorization and eco-design can reduce raw material consumption and landfill use (Geng et al., 2012). For instance, solar microgrids in FELDA communities demonstrate how renewable energy can support rural electrification and socio-economic upliftment.

Renewable energy adoption, particularly solar energy, should be expanded through community-based and industrial-scale installations. Case examples such as solar panel integration at FELDA community suraus or within industrial parks in Selangor show that decentralized energy models can enhance energy security while empowering local economies (Seda Malaysia, 2023). Additionally, integrating clean energy into industrial parks could serve as a replicable model for low-carbon industrial zones, contributing to both emissions' reduction and job creation.

Leveraging Digital Tools for Sustainability

Digitalization offers transformative potential for tracking, managing, and reducing environmental impacts across industrial operations. The integration of IoT (Internet of Things)

sensors, AI-powered analytics, and mobile monitoring platforms can enable real-time data collection on emissions, resource usage, ecological impacts and facilitating faster decision-making and compliance (Upadhyay et al., 2021; Zaman et al., 2024). These tools can help industries anticipate risks, comply with environmental regulations, and continuously improve their sustainability performance.

For example, real-time monitoring dashboards can track carbon emissions and flag operational inefficiencies, enabling immediate corrective actions. Mobile apps can facilitate internal reporting of environmental non-compliance, while blockchain solutions could enhance supply chain transparency for ESG reporting (Neri et al., 2025). Importantly, these digital tools must be accessible to SMEs and local manufacturers through public-private partnerships or subsidized digital platforms.

CONCLUSION

Malaysia stands at a critical juncture in its climate journey, where ecological preservation, industrial transformation, and governance reform must converge to create a resilient and sustainable future. This paper has explored the multifaceted drivers of deforestation, the limitations of compliance-driven sustainability, and the untapped potential of forests as climate infrastructure. Through focused group discussions with experts from academia, industry, and regulatory systems, it is evident that fragmented efforts must give way to integrated strategies.

The findings underscore that deforestation is not merely a land-use issue but a systemic risk with cross-sectoral implications. Forests must be revalued not only for their biodiversity but for their role in regulating climate, water, and soil systems. Industry must evolve from reactive compliance to proactive commitment, embedding sustainability into core operations and innovation pipelines. Governance must shift from enforcement to enablement, fostering collaboration, transparency, and accountability across all levels.

To move forward, Malaysia must invest in forest intelligence, scale circular economy models, and institutionalize climate-integrated certification and disclosure. By aligning scientific research, industrial innovation, and policy frameworks, Malaysia can not only meet its climate commitments but also lead the region in ecological stewardship and green economic development.

This transformation is not optional, it is imperative. The path to climate resilience lies in bold, coordinated action that bridges science, systems, and society.

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