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AI for Sustainable Development in ASEAN:

Advancing Safe, Trustworthy and Ethical AI for Climate Action

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Arup is a global collective of designers, consultants and experts dedicated to sustainable development, and to using imagination, technology and rigour to shape a better world. Authors of this report include Kristian Steele, Arina Koul, Jill Leung, Ying Hong and Chester Ling.

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Executive Summary

This report explores the transformative potential of AI in addressing climate challenges across Southeast Asia, emphasising the need for targeted interventions to harness AI effectively while mitigating emerging risks. The analysis covers nine countries in the region, focusing on pressing climate-related risks and key actions to consider across seven pillars: Data, Computing, Talent & Skills, Responsible Governance, Innovation, Scaling, and GEDSI (Gender Equality, Diversity, and Social Inclusion). Some key insights include:

Addressing climate data gaps is critical for combating climate risks. The lack of access to and quality of climate data can be mitigated through establishing robust data governance and strengthening local data collection. Integrating Traditional Ecological Knowledge into AI systems is a novel approach that could be explored, tapping into indigenous understanding of the local environment to create inclusive and impactful AI-driven climate strategies.

AI's expanding environmental footprint demands urgent attention. The region's fast-growing data centre market strains energy and water resources. Strengthening governance for sustainable data centres and improving energy efficiency through advanced algorithms are crucial to mitigating these impacts – further solidifying Southeast Asia's position as an emerging green data centre hub.

Building an inclusive, AI-ready workforce is essential to accelerate progress in key climate sectors. In agriculture, for instance, farmers must be equipped with foundational AI skills to effectively access and apply emerging technologies. Special attention should be given to supporting female farmers, who often face higher barriers to digital inclusion. Beyond this, it is critical to nurture cross-domain knowledge at the intersection of AI and climate change. Upskilling tertiary students and professionals with this hybrid expertise will enhance the relevance and impact of AI solutions for climate change efforts.

The gender gap in AI-driven climate tech funding in Southeast Asia needs to be addressed to foster innovation and scaling. Women-led startups often face structural barriers, such as reduced access to investor networks and limited visibility in tech ecosystems. As a result, promising AI-for-climate solutions led by women may be overlooked or underfunded. Tackling this requires targeted action, including more inclusive funding processes and support systems that recognise the value of diverse leadership in climate and AI innovation.

Overall, this report presents numerous key findings which collectively aim to inform the critical actions required and identify key actors responsible to advance the development and deployment of safe, trustworthy, and ethical AI for climate action across Southeast Asia.

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Project Aims

Context

Artificial intelligence (AI) holds immense potential to accelerate progress on Sustainable Development Goals (SDGs). This potential can only be realised if AI is developed, adopted, and regulated responsibly, inclusively, and with safety at its core. Recent UK initiatives, including the Digital Development Strategy, emphasize the importance of careful policy efforts to prevent AI from worsening existing inequalities. The UK's International Development White Paper highlights the need to ensure that low and middle-income countries, where the risks and opportunities of AI are amplified, are not left behind. In this context, the UK hosted the first global AI Safety Summit and announced the AI for Development (AI4D) initiative, which has now expanded into Asia.

The Association of Southeast Asian Nations (ASEAN) is proactively utilising AI to boost economic growth and foster innovation. The ASEAN Digital Masterplan 2025 aims to position the region as a premier digital and economic hub. Despite this, AI development in ASEAN has been fragmented, with countries demonstrating varying levels of AI readiness and capability. To bridge the regional gap in intergovernmental AI governance standards, ASEAN has introduced the ASEAN Guide on AI Governance and Ethics, offering practical guidance for organisations in the region to responsibly design, develop, and implement AI technologies.

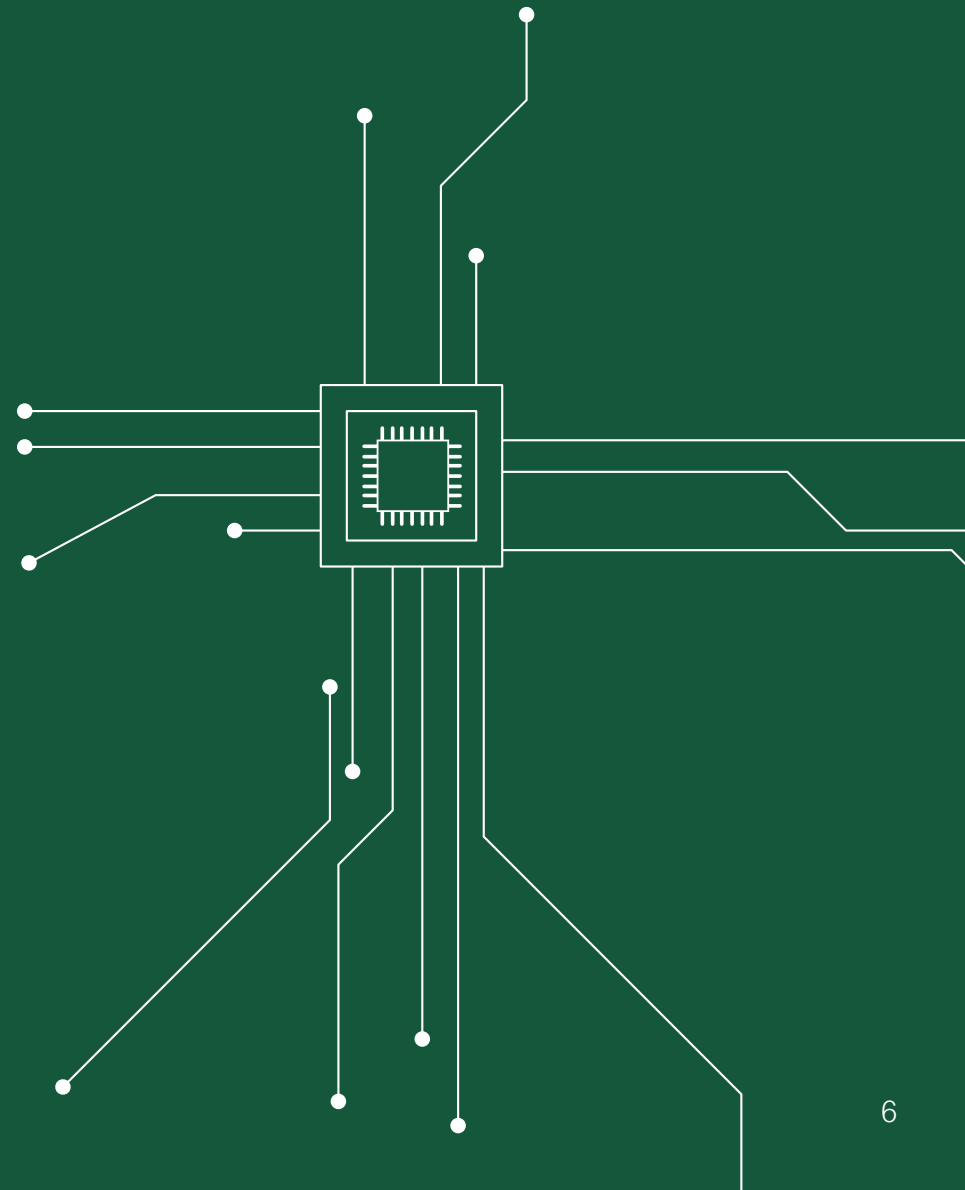
Objectives

This study aims to develop a shared understanding of answers to the following questions:

- What do we mean by responsible, safe and inclusive AI in climate action?
- What is the current landscape of responsible, safe and inclusive AI in climate action across ASEAN countries?
- What are the key areas where responsible, safe and inclusive AI can be harnessed for development, with gender, disability and inclusion at the core?
- What AI-based research and development (R&D) investment opportunities are actionable, innovative, and scalable to support ASEAN countries in achieving their SDGs?
- What are the critical enablers needed to build capacities for harnessing inclusive, accountable, and safe AI for development in Southeast Asia?
- How can the pillars of responsible governance, talent and skills, data, computing, and innovation be strengthened to support the development and deployment of inclusive and safe AI in ASEAN countries?

01

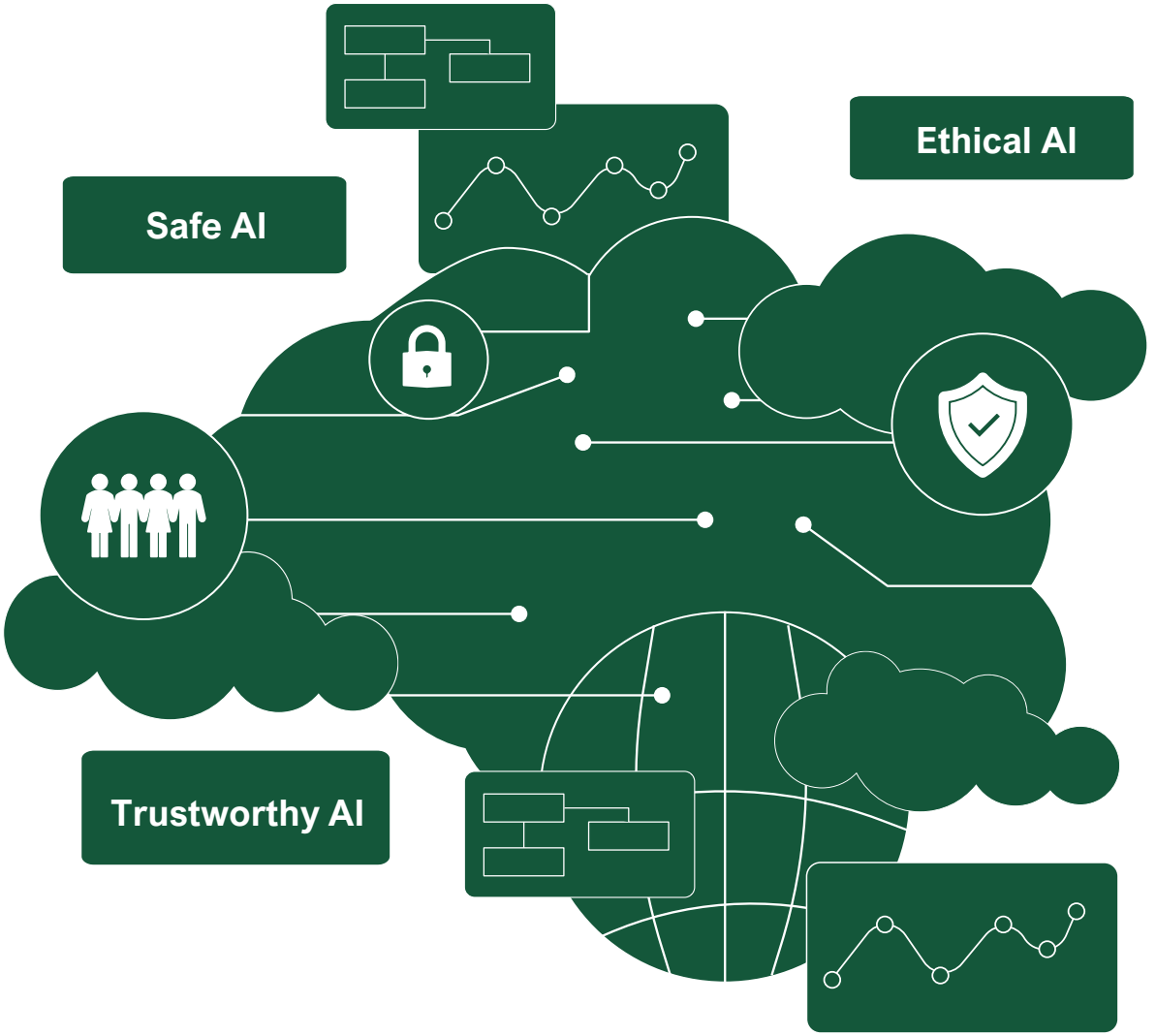
Introduction



Defining Safe, Trustworthy and Ethical AI

AI System Definition

Engineered or machine-based ‘products and services’ that are ‘adaptable’ and ‘autonomous’ and can generate outputs such as predictions, recommendations, or decisions influencing real or virtual environments. The adaptability of AI refers to AI systems, after being trained, often developing the ability to perform new ways of finding patterns and connections in data that are not directly envisioned by their human programmers. The autonomy of AI refers to some AI systems that can make decisions without the intent or ongoing control of a human.



Defining Safe, Trustworthy and Ethical AI

Safe AI

AI systems are governed by current legislation in data protection, ensuring they are secure, robust, and reliable. Risks of misuse, both current and future, are continuously assessed and managed across the AI system lifecycle to maintain compliance and accountability.

Criteria of Safe AI considered include:

- Focuses on the robustness and reliability of AI systems to prevent harm to climate resiliency, nature and society [1]
- Designed with accountability, laying out roles and responsibilities of personnel involved [1] [2]
- Undergoes rigorous testing and risk assessment to function appropriately and do not pose unreasonable safety and/or security risks [1] [2]
- Systems, input and output data are safeguarded against unauthorized access and cybersecurity threats [1] [6]
- Complies with legal and regulatory requirements including data protection [6] [8]

Trustworthy AI

AI systems that are transparent and explainable with the relevant meaningful information appropriate to their context available, so that those that engage with them understand and can contest outcomes.

Criteria of Trustworthy AI considered include:

- Science-based that minimising bias and misinformation from sample selection, stereotyping, and out-group homogeneity to avoid adverse impact the climate resilience and nature [2] [3]
- Transparent, setting out clear limitations of AI and providing understandable information [1]
- Appropriate levels of explanation are enabled so that the decision criteria and output of AI systems can be reasonably understood, challenged and validated [6]
- Where feasible and useful, plain and easy-to-understand information provided on the sources of data/input, factors, processes and/or logic that led to the prediction, content, recommendation or decision, to enable those affected by an AI system to understand the output [5]
- Information provided that enable those adversely affected by an AI system to challenge its output [5]

Ethical AI

AI systems that are fair, inclusive, and sustainable, aligning with ethical principles e.g. ASEAN Guide on AI Governance and Ethics with considerations embedded across the life-cycle to enhance physical, social, economic and environmental well-being.

Criteria of Ethical AI considered include:

- Designed with and trained on diverse local datasets to accurately reflect and serve different climatic, environmental and demographic contexts
- Accessible and beneficial to diverse communities and supports equitable distribution of the benefits of AI-driven solutions regardless of socio-economic status, race and gender and disability [1] [4]
- Empowers communities including indigenous people, and promote public-private-people partnerships (PPPP) [3]
- Addresses the carbon footprint of the AI itself, such as by improving energy efficiency in AI training and deploying AI in regions with a greener energy mix [3] [4]

Climate action and key sub-areas

Climate Action In Southeast Asia

The ASEAN region faces significant climate challenges, rendering it one of the most vulnerable areas globally. The region has experienced severe economic losses and fatalities due to climate-related disasters like floods, droughts, and typhoons.

Despite ongoing efforts to enhance adaptive capacities and mitigate greenhouse gas emissions, more actions are required to deliver greater success. The ASEAN State of Climate Change Report also emphasises the need for increased regional cooperation and ambitious climate policies to effectively address these challenges while striving towards Sustainable Development Goals [3].

For the purpose of this study climate action has been defined as Mitigation and Adaptation.

Climate Change Mitigation

Mitigation of climate change is defined as a human intervention to reduce emissions or enhance the sinks of greenhouse gases.

The ASEAN region emits greenhouse gas (GHG) emissions from fossil fuel combustion as well as land use, land use change and forestry.

To achieve net-zero emissions, the ASEAN region needs to enhance both its energy management and sink functions.

Over the last two decades, the region has seen an increase in the GHG emissions from energy use. Among the sectors contributing to GHG emissions due to fuel combustion, and industrial process and product use, the following sectors have been found to be the main emitters in the region:

- Energy & Emissions Management
- Transport
- Manufacturing Industries & Construction
- Agriculture, Forestry and Other Land Use (AFOLU)

Notwithstanding other sectors that are relevant to climate change mitigation and the differences in the mitigation priorities across the regions, electricity & heat production, transport, and manufacturing industries & constructions sectors have been flagged as the top emitters from burning of fossil fuel among the countries in the region, whereas AFOLU is also a major source of emissions in the region [3]. In view of that, four sectors listed above will be the key sub-areas of mitigation to be analysed in this study.

Climate Change Adaptation

Adaptation to climate change is defined as the process of adjustment, or facilitation of adjustment, to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. The ASEAN region is highly exposed and vulnerable to climate change due to a myriad of factors including high levels of poverty in some countries, high dependency on climate-sensitive sectors for livelihoods, and existence of multiple natural hazards

While climate change adaptation is needed across many different sectors in the region, some have been prioritised as the key sectors for adaptation interventions among the countries in the region [3]. These include Food & Agriculture, Water Resources, and Forest & Biodiversity. In addition, considering that the region is rapidly urbanising, the consideration of urban resilience against climate change is of paramount importance.

Notably, these sectors are also alluded to in the UK's 2030 Strategic Framework for International Climate and Nature Action, which outlines an integrated approach to addressing climate and nature challenges on the global stage [2]. Considering the above, the key sub-areas of adaptation to be analysed in this project are:

- Food & Agriculture
- Water Resources
- Forest & Biodiversity
- Urban Resilience

Enabling Pillars

In addition to the responsible AI definition and climate focus the study provides insights on the critical enablers needed to build capacities for harnessing inclusive, accountable, and safe AI for development in Southeast Asia. In the context of this study, the enabling pillars are defined as follows:

01 Data

How can investments potentially support development of locally relevant, and inclusive datasets, including on Southeast Asian languages to unlock the benefits of AI?

02 Computing

How can investments trigger public-private partnerships that potentially improve / democratize access to computing for AI research and innovation towards development impact, making it more sustainable and affordable for Southeast Asian researchers and innovators?

03 Talent and Skills

How can investments potentially create or scale up research labs on responsible AI in Southeast Asian Universities, and support technical skill development which could target a diverse range of local talent including women and people with disabilities through a holistic, ecosystem approach?

04 Responsible Governance

How can investments potentially support the use of AI as a force multiplier for good governance and public service delivery, and which (kinds of) investments should therefore be prioritised?

05 Innovation

How can investments potentially support frontier AI research and the testing of new AI applications with the highest potential for impact on SDGs? This includes new generative AI use cases for advancing development objectives, and predictive AI with stronger focus on local innovation to support the wider ecosystem development.

06 Scaling

How can investments potentially crowd in financing and robust technical support to scale up the more promising innovations, and attract commercial capital, to address development challenges?

02 Country Assessments

AI Overview in Southeast Asia

Overview of AI Landscape

The AI landscape in Southeast Asia is rapidly evolving, with the potential to contribute nearly US$1 trillion to the region's GDP by 2030, representing a 10-18% uplift [1]. This growth is driven by a business-friendly environment, as the region's governance is characterised by open policies, a soft regulatory approach, and non-binding frameworks, making the region highly attractive to big tech and AI solution providers [2].

ASEAN has taken an active role in shaping the AI ecosystem through initiatives such as the Digital Economy Framework Agreement (DEFA), the ASEAN Guide on AI Governance and Ethics, and the ASEAN Responsible AI Roadmap. These efforts are complemented by bilateral and multilateral collaborations to further advance AI development in the region.

Numerous countries have begun introducing tailored policies to guide AI growth. However, levels of readiness and implementation vary significantly across countries. The impact of AI to economic growth is expected to vary across the region.

ASEAN Member State	Economic Impact of AI in 2030	Percentage of 2030 GDP
Malaysia	USD 115 billion	14%
Thailand	USD 117 billion	13%
Indonesia	USD 366 billion	12%
Vietnam	USD 109 billion	12%
The Philippines	USD 92 billion	12%
Brunei, Cambodia, Laos, Myanmar (combined)	USD 41 billion	10%
All Southeast Asian nations	USD 950 billion	13%

Source: Analysis by Kearney and EDBI, 2020 [1]

Common AI Applications in Climate Action

The use of AI for climate action in Southeast Asia is still in its early stages, however, several key areas have already emerged where AI is driving significant positive impacts in both adaptation and mitigation efforts across the region.

Agriculture

AI is increasingly being applied in the agriculture sector across the region. Southeast Asia is a key player in global agricultural exports but struggles with low productivity and high crop wastage, which can reach up to 17% [3]. AI has the potential to transform this sector by accurately predicting up to 90% of crop diseases and optimising pesticide and fertilisation needs through both drone technology and image recognition algorithms [1].

Disaster Relief

The use of machine learning (ML) in disaster preparedness and response is expanding, particularly in weather forecasting and crisis management. For instance, AI models have been developed to predict floods by analyzing complex patterns, providing timely alerts to at-risk communities. Additionally, AI has been utilised in disease surveillance tools in countries like the Philippines, enhancing early warning systems and response strategies [4].

Energy

AI is recognized for its potential to optimise power grids, reduce inefficiencies, and integrate decentralized renewable energy sources, contributing to a more sustainable energy future. ML is commonly employed to forecast power demand and supply, improve planning, and monitor renewable energy sources [4].

- **High Risk**: AI use lacks safety, trust and/or ethics, and is likely to cause harm
- **Medium Risk**: AI use has some safety, trust and/or ethical concerns, but risks are manageable with oversight
- **Lower Risk**: AI is mostly safe, trustworthy and ethical, with reduced potential for harm
- **Lack of Evidence / Unreported**

Risks of AI to Climate Action in Southeast Asia

This is an overview of the risks and challenges that AI can pose to climate action in Southeast Asia, highlighting both similarities and differences across the region. While many countries face shared issues, the extent of these challenges varies based on local context. This comparison underscores the need for tailored approaches to ensure AI is used in a safe, ethical and trustworthy manner in addressing climate change. The degree of risk that AI poses to climate action refers to the potential for unsafe, untrustworthy, and/or unethical AI use, based on definitions outlined in page 8.

Most pressing risks that AI poses to climate action	Indonesia	Philippines	Thailand	Malaysia	Vietnam	Cambodia	Myanmar	Lao PDR	Timor-Leste
Digital Divide The disparity in access to AI remains a pervasive issue regionally, resulting in the amplification of economic inequalities especially for lower-skilled workers in sectors like agriculture and manufacturing.	Limited digital access for rural farmers	Most costly internet services regionally, limiting digital access particularly in lower-income households	Limited digital access for rural farmers and female farmers	Rural connectivity is rapidly improving, but there is still a big capacity gap among rural farmers	Limited digital access for rural farmers	Limited digital access for rural farmers	Limited digital access for rural farmers and female farmers	Limited digital access for rural farmers	Slow, expensive and unreliable internet access especially in rural areas
Data Limitations and Algorithmic Bias AI-driven climate initiatives may be compromised by insufficient or poor-quality data and algorithmic biases, leading to inaccurate climate predictions or output that fail to consider local context.	Initiatives enhancing climate data collection with local involvement **(see p. 132 for Case Study on High Carbon Stock Approach)**	AI disaster and weather tools have faced difficulty predicting worst-hit areas due to limited data available	AI-driven agriculture solutions may prioritise yield over sustainability due to lack of alignment to environmental guidelines	Investments are being made to enhance climate data collection and improve local representation	Risk of overreliance on historical datasets not trained for local context (e.g. Mekong Delta and coastal data), yielding inaccurate results	Lack of local climate data collection processes and digital infrastructure	Foundational digital infrastructure missing, hindering capacity for accurate climate data collection	Foundational digital infrastructure missing, hindering capacity for accurate climate data collection	Foundational digital infrastructure missing, hindering capacity for accurate climate data collection
Data Privacy and Security The deployment of AI in climate initiatives may pose risks of unauthorised access, misuse of data, and cyberattacks on climate monitoring systems.	Data security risks e.g. in the carbon trading system	Risks of proliferation of online illegal wildlife trade	Risks of misuse of surveillance data previously reported	Highest rate of personal data leaks in key Asian markets	Data protection laws are being tightened to reduce incidences of data leaks	No comprehensive cybersecurity and data protection	No national general data protection law	Has legal safeguards to protect and secure data	Has legal safeguards to protect and secure data
Environmental Footprint of AI AI is highly resource-intensive, raising environmental concerns particularly for the rapidly growing data centre markets in the region.	Rapidly growing data centre market raising concerns about resource use	Environmental impact of AI not widely reported or raised as a national concern yet	Huge e-waste problem exacerbated by tech advancement	Fastest growing data centre market in Asia, raising concerns on resource constraints	Hotspot for hyperscalers and AI-based data centres				
Proliferation of Climate Misinformation Bad actors may use AI to amplify false narratives about climate change, often entwined with political messaging.	AI amplifies misleading climate narratives often linked to politics	AI amplifies harmful narratives often linked to politics, e.g. nuclear energy	AI is being harnessed as a tool to combat false news reports and misinformation	Rising concerns about the use of AI to aid in greenwashing	Rising concerns about AI's potential to spread misinformation				

Key Risks of AI to Climate Action in Southeast Asia

AI poses pervasive risks to climate action across the region, affecting multiple sectors and stakeholders. Below is an overview of the most pressing regional challenges and their broader implications.

Digital Divide

AI technologies disproportionately benefit areas in Southeast Asia with robust internet access and data connectivity. Only two-thirds of Southeast Asia's population has access to the internet, leaving approximately 150 million adults in Southeast Asia without access, with stark disparities between urban and rural regions [5]. This divide is also apparent between nations. Countries that are more technologically advanced are better positioned to benefit from AI, while more vulnerable countries in Southeast Asia risk being left behind.

Amplification of Economic Inequalities

The rise of AI technologies poses a significant risk of exacerbating existing social and economic inequalities in the region. Gender inequality and bias may also arise as a result of poor representation in datasets and embedded biases in algorithmic systems. [6] For example, in agriculture, the Asia-Pacific region is home to 450 million smallholder farmers, producing over 80% of its food [7]. While AI technologies can greatly enhance agricultural productivity, it could widen income disparities between higher-skilled workers in commercial farms, and lower-skilled smallholder farmers. This is because smallholder farmers have limited capacity and lack infrastructure to adopt advanced AI technologies compared to larger commercial farms [8]. Beyond agriculture, sectors such as manufacturing and logistics are also vulnerable, where AI-driven automation could significantly reduce demand for lower-skilled labour. Within the region, well-resourced nations are also better positioned to leverage AI technologies while countries more vulnerable to climate change risk being marginalised [4].

Environmental Impact of AI

AI development requires significant electricity and water usage, posing risks due to its large environmental footprint. The increasing size and accuracy of models such as LLM (Large Language Models), as well as the data centre boom in the region, escalate this environmental burden. As a result of technological advancement, Southeast Asia is also experiencing challenges with e-waste management, with large amounts of discarded electronics exported globally to the region, exacerbating health risks for marginalized communities and adding pressures to already strained environmental resources. In 2021, the region generated approximately 12.3 million metric tons of e-waste, with countries like Thailand accumulating significant amounts due to relaxed environmental regulations [9].

Climate Change Misinformation

Conversation AI models can provide answers that increase risk of misinformation, especially regarding climate change where conflicting climate narratives already exist. Experts caution that generative AI models could be intentionally used to create false information and fabricate sources, spreading inaccurate scientific claims. Additionally, the lack of transparency regarding how these models produce specific outputs raises concerns about their trustworthiness and reliability.

Algorithmic Bias

Algorithmic bias represents a critical risk associated with the widespread adoption of AI in Southeast Asia, leading to discriminatory practices that can marginalise certain groups. Such biases can skew hiring processes and perpetuate socio-economic inequalities, particularly affecting marginalised communities. Moreover, the predominance of Western-centric data models often fails to account for the region's diverse cultural and linguistic landscape, further exacerbating issues of fairness and access in decision-making processes.

Privacy and Data Security Issues

The implementation of AI technologies raises significant privacy and data security concerns across Southeast Asia. The region’s fragmented and inadequate cybersecurity measures can expose sensitive personal information, leading to breaches that undermine public trust in digital systems. The rapid deployment of AI tools without robust regulatory frameworks increases the risk of data misuse and potential violations of user privacy rights. Such cases have risen across the region, with a significant number of cases reported from Myanmar and Vietnam.

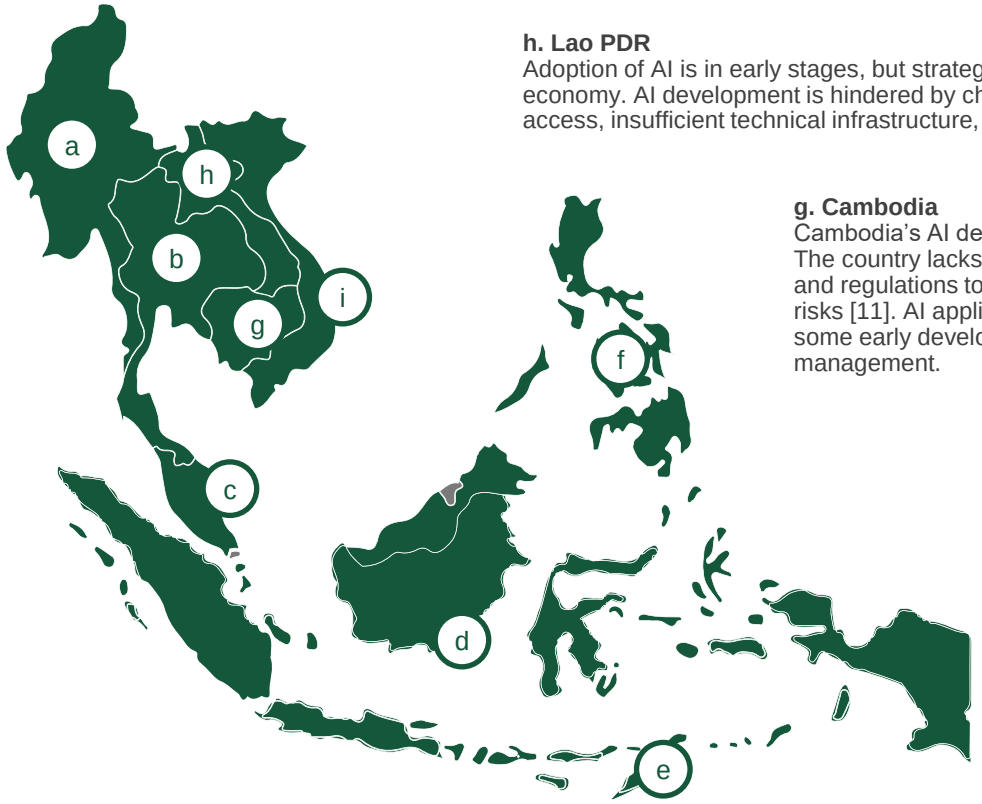
Overview of AI Adoption in Southeast Asia

a. Myanmar
While Myanmar's technology adoption is on the rise, the regulatory framework remains underdeveloped and lacks specific legislation governing AI [11]. Use cases in climate action remain nascent.

b. Thailand
AI adoption among Thai organisations is increasing. According to the AI Readiness Measurement 2024 survey by the AI Governance Clinic, 16.5% of Thai organisations surveyed have integrated AI ethics into their operations [12]. AI use cases in climate action are rapidly developing, most notably in adaptation (agriculture and disaster relief).

c. Malaysia
Significant progress has been made in developing AI, with dedicated strategies and governing bodies fostering an ecosystem for AI innovation, but application of AI for climate action remains fragmented and lacks a coordinated framework. Key risks associated with AI include the carbon footprint from the rapid expansion of data centre infrastructure, among others [13].

d. Indonesia
Indonesia's regulatory environment for responsible AI is ahead of many regional peers but lacks legal enforceability currently [14]. Indonesia receives significant public support and private investment from large actors to develop AI applications that can help address national climate issues.



h. Lao PDR
Adoption of AI is in early stages, but strategies and plans are in place for digital economy. AI development is hindered by challenges such as limited internet access, insufficient technical infrastructure, and a shortage of skilled talent [11].

i. Vietnam
Vietnam is progressing in AI adoption with a national strategy supporting research, development and application of AI [11]. Government policies foster innovation, while growing private investment reflects confidence in the country's AI ecosystem.

g. Cambodia
Cambodia's AI development remains at an early stage. The country lacks a national AI strategy, specific laws and regulations to harness AI's potential and address its risks [11]. AI application in climate action is nascent, with some early development in agriculture and AFOLU management.

f. The Philippines
The Philippines is establishing a regulatory body to manage AI use [16]. Major tech companies are investing in the country's digital and climate transformation. Development finance institutions support climate action by providing technical and financial assistance in collaboration with the government.

e. Timor-Leste
AI development in Timor-Leste is still underdeveloped, with no national strategies for its advancement [15]. Although there are some isolated initiatives exploring AI for climate action, the primary focus has been on enhancing basic digital literacy and connectivity.

Enabling Pillars

01 Data

Current Status

- Lack of hyperlocalised climate data: There is a lack of long-term historical data at a hyperlocal resolution, which is essential for accurate climate modelling. The region faces gaps in data collection infrastructure.
- Costly: Collecting, cleaning, and processing climate data can be costly, which may pose a barrier for many initiatives.

Notable Regional Efforts

- ASEAN Disaster Information Network: A data repository of all historical and predicted hazards across member states, managed by AHA Centre [20].
- Open Data: ASEAN is working on establishing an ASEAN open data network, which aims to improve the availability and accessibility of data across member states. While open data is being made more available, climate data is often not available in most government portals.

02 Computing

Current Status

- Rising investor interest: Southeast Asia has made notable strides in developing computing infrastructure to support AI, receiving significant investments in data centres, cloud computing, and high-performance computing. These efforts help foster innovation and drive AI adoption across different sectors.
- Digital infrastructure gaps: Only 52% of the population in Southeast Asia has access to the internet, with rural areas being particularly underserved. By 2040, it is expected that more than 40% of the digital infrastructure investment gap will be in Asia [21]. This gap affects the region’s AI deployment and its economic competitiveness.

Notable Regional Efforts

- Data centre and cloud infrastructure investment: Investment in cloud and data infrastructure is growing in the region. The region's data centre market attracted $10.23 billion in investments in 2023, with projections reaching $17.73 billion by 2029 [22].

03 Talent and Skills

Current Status

- Skills gaps: Southeast Asia faces disparities in AI skills across its workforce, with varying levels of expertise in different countries. A key gap is the lack of a multi-disciplinary workforce that can bridge the technical aspects of AI with the specific needs of climate action.
- Brain drain: The skills gap is exacerbated by the region's brain drain, where skilled professionals often migrate for better opportunities, further hindering AI application for climate action. According to a study by EDBI and Kearney in Southeast Asia, 85% of employers found difficulty in finding technical talent that can work on AI-related activities [1].
- Jobs: While there are concerns about job displacement due to AI, the EDBI and Kearney study suggests that this issue may be overemphasized in Southeast Asia [1]. Overall, AI is expected to create more jobs than it displaces. AI adoption is expected to boost Southeast Asia's GDP by 13 - 18% by 2030 [1], creating millions of new jobs in the region.

Notable Regional Efforts

- AI Ready ASEAN, led by the ASEAN Foundation and supported by a US$5 million grant from Google.org, aims to equip 2.5 million individuals from all 10 AMS with AI skills [23].
- ASEAN Working Group on AI (WG-AI) was established to facilitate knowledge sharing, dialogue and strengthen the region’s AI ecosystem.

04 Responsible Governance

Current Status

- Soft regulatory approach: Currently 6 out of 10 AMS have national policies on AI (Singapore, Indonesia, Thailand, Vietnam, Malaysia and the Philippines). Despite efforts to enhance regional AI governance, most countries adopt a soft regulatory approach with nonbinding policies [17].
- Varied adoption: Countries are at varying levels of AI adoption, making it challenging to harmonise regulations. For example, Malaysia is more advanced in AI adoption compared to Lao PDR and Myanmar.

Notable Regional Efforts

- The ASEAN Guide on AI Governance and Ethics serves as a unifying framework to promote ethical AI practices [18].
- The ASEAN Responsible AI Roadmap serves to complement the Guide, providing step-by-step guidance for all AMS on how to implement and measure responsible AI. The ASEAN AI Safety Network will support each AMS' implementation.
- The Digital Economy Framework Agreement (DEFA) is a binding agreement between AMS that aims to accelerate the region's digital economy, set to facilitate cross-border data flows and data standards.

05 Innovation

Current Status

- Emerging landscape: Many developing countries in Southeast Asia are still in the early stages of AI adoption, let alone adopting recent AI innovations such as Generative AI. Limited resources, infrastructure, and expertise hinder progress. According to the EDBI and Kearney study, 76% of respondents regard SEA's AI ecosystem as immature and fragmented, impacting companies' willingness to experiment and innovate [1].

Notable Regional Efforts

- Locally tailored LLMs: SEA-LION is a group of open-source Large Language Models, developed by a Singaporean startup, that is trained on eleven major Southeast Asian languages, and thus strongly understands the region's diverse contexts, languages, and cultures [24]. Thailand and Malaysia are also developing their own LLMs catered to their country context. These LLMs including SEA-LION has been designed to support a wide range of applications, from translation services to customer service chatbots to enable effective communication across diverse linguistic groups [25].
- Private sector investment: Major technology companies are increasingly engaging in the exploration, development, and testing of AI technologies in SEA. For example, Microsoft signed an MoU agreement with the Thai government to establish an AI laboratory that will create advanced solutions, including solutions catered to Thailand's farming sector [26].

06 Scaling

Current Status

- Support from tech MNCs and investors: With substantial investments from tech giants like Google, Microsoft, and ByteDance in Southeast Asia, these companies can provide valuable financial resources and technical expertise that can support scaling of AI initiatives focused on climate resilience. According to data from Preqin, venture investment in Southeast Asia's young AI businesses amounted to US$1.7 billion in 2024 [27]. 122 AI funding deals have taken place in Southeast Asia in 2024 [27]. While this number is relatively low when compared to the larger APAC region, it demonstrates the rise in investor interest for AI in Southeast Asia.
- Difficulty in scaling: Scaling AI solutions in Southeast Asia beyond proof-of-concept and pilot testing remains difficult [30], facing challenges such as a lack of visibility, misalignment with investors' priorities, and limited infrastructure to support large-scale implementation [30], especially in rural or underserved areas [31].

Notable Regional Efforts

- Climate tech funding: Climate tech innovations from Southeast Asia are increasingly gaining attention from investors. The region's climate tech market is projected to grow from $102 billion in 2023 to $350 billion by 2030 [32].

07 Gender Equality, Disability and Social Inclusion

Current Status

- Significant inequalities: Southeast Asia faces sharp gender inequality, reflected in its 2024 Social Institutions and Gender Index score of 39, revealing higher inequality than the global average of 29 [28]. Research indicates that AI systems often reflect existing gender biases, which can exacerbate inequalities. According to the Global Index on Responsible AI, only 30% of workers in AI globally are women, highlighting an underrepresentation that skews data and outcomes [29].

Notable Regional Efforts

- Addressing gender in AI: Several Southeast Asian countries have taken steps to begin addressing gender issues in AI, as outlined in the Global Index on Responsible AI, The Philippines held an AI Dialogue on integrating gender perspectives into AI policies, while Cambodia’s AI Landscape study highlighted the need to boost female representation in STEM, including AI, for more inclusive innovation. Malaysia’s National Artificial Intelligence Roadmap (2021-2025) prioritises gender inclusivity by addressing barriers to women's leadership in technology fields [29].

Overview of Stakeholder Systems

In AI development, a robust stakeholder ecosystem plays a crucial role in driving progress and innovation. Key stakeholders can be categorised into four key groups:

- Government
- Large-scale tech companies
- Startups / SMEs
- Civil society (academia and multilateral organisations)

These stakeholders often collaborate, creating numerous complementarities and mutual benefits that help advance the development of AI as well as key enablers in Southeast Asia.

Across all stakeholders, the government plays a central role, regulating and overseeing development to ensure alignment with national objectives. AI governance in this region is characterized by a soft regulatory approach, where policies and guidelines are typically adopted on a voluntary basis. This flexibility contributes to the effective collaboration among stakeholders.

This is a non-exhaustive list of key complementarities between stakeholder groups, supplemented by examples from across the region of how stakeholders work together to produce positive environmental, social and economic outcomes.

Startups / SMEs and Large-Scale Technology Companies
Startups and SMEs contribute innovation and agility, while large-scale technology companies provide infrastructure, funding, and expertise, facilitating the development of AI-driven climate solutions. For example, **see case study on Dokter Tania in Indonesia (page 145)**, an AI chatbot for farmers launched by local company Neurafarm, which received international technical and financial support from technology providers including Nvidia and Cisco. By leveraging complementary strengths, these partnerships enhance scalability, accelerate impact, and improve the accessibility of AI for climate action.

Governments and Academia
Governments also work closely with academia to foster innovation and address specific national challenges through rigorous research. For example, **see case study on Project Nationwide Operational Assessment of Hazards (page 143)** by the Philippines' Department of Science and Technology, supported by the University of the Philippines, which enhances national disaster preparedness by leveraging AI. Additionally, **see case study on AI Solutions for Mangrove Blue Carbon in Vietnam (page 142)** delivered in part by Can Tho University in Vietnam with support from Vietnam's Department of Forestry to enhance mangrove monitoring using AI. These collaborations enhance academic research capabilities while supporting government initiatives for technological advancement and economic growth.

Startups / SMEs and Multilateral Organisations
In Southeast Asia, AI innovation and development is nascent and rapidly developing, with several countries in the region reliant on external financing and support. Multilateral organisations play a crucial supporting role by providing resources, expertise, and funding to small-scale technology startups and SMEs. For example, the Asian Development Bank (ADB) supports local tech providers through the "ADB Ventures" program [33]. This programme offers funding and mentorship to startups developing technologies, including AI technologies, that address climate change and other critical issues. Additionally, **see case study on High Carbon Stock Approach in Indonesia (page 136)** a collaboration between GIZ and local groups including Ekologika and Indonesian Community Mapping Network. Such partnerships can help startups scale their impactful solutions while achieving sustainable development goals for the region.

Indonesia

Indonesia

Overview of Landscape

Indonesia is estimated to see a 12% boost in its GDP (or US$366 billion) by 2030 owing to its strategic AI adoption [1]. Indonesia's regulatory environment for ethical, safe and trustworthy AI is ahead of many regional peers but lacks legal enforceability and legislation necessary for successful implementation.

- Indonesia has a *National AI Strategy* (Stranas KA) which aims for its country to become a competitive digital economy and emerge as a significant AI player by 2045.
- The Ministry of Communication and Informatics issued the *AI Ethical Guidelines* while the Financial Services Authority released *Ethical Guidelines on Responsible and Trustworthy AI in Financial Technology* in 2023. These provide temporary guidelines but are non-legislative and require support for implementation.
- Public-private partnerships such as the establishment of AI innovation centre *Pusat Inovasi Kecerdasan Artifisial (PIKA)* aim to drive coordinated AI innovation and deployment.

Jakarta, Indonesia source: National Geographic

Climate Change in Indonesia

Indonesia aims for net zero greenhouse gas emissions by 2060 [2]. The country boasts rich natural resources that play a critical role in carbon storage and biodiversity. However, the country faces several significant climate challenges:

- Energy production: In 2022, coal was the largest source of CO_2 emissions, accounting for 58% of total emissions [3].
- Deforestation: AFOLU is a significant contributor to GHG emissions in Indonesia [4].
- Disaster vulnerability: 97% of Indonesia's population lives in disaster-prone areas [5].

AI Application for Climate Action

Mitigation

Electricity

While this sector is the largest contributor to Indonesia's emissions [6], this sector is boosting its renewable energy production, supported by digitalisation.

- Renewable Energy: Indonesia aims to increase its share of renewables to 23% of the national mix by 2025, leveraging technology [7]. For example, the Solar Energy Estimator for Rooftop Indonesia project initiated by GIZ, GSMA and BAPPENAS utilises AI, ML and satellite imagery to create a model that automatically detects roof spans, thus informing the potential for PV solar systems on rooftops in certain areas [8].
- Geothermal Energy: Indonesia has the world's largest geothermal potential. AI application can significantly enhance efficiency and reliability of geothermal energy operations. Star Energy, Indonesia's leading geothermal energy producer, integrates AI and ML-powered open-integration platform Kyndryl Bridge, to automate its workflows and enable predictive maintenance to prevent system failures [9].

Emissions Management

Emerging AI-powered carbon management platforms in Indonesia serve to support emissions monitoring and management. iin is an example of a local carbon management platform in Indonesia that aims to enhance nature-based reforestation [10]. **See case study on Jejakin on page 140.**

Manufacturing Industries & Construction

AI adoption for climate action in manufacturing is still in early stages, largely driven by each organisation's commitment to operational efficiency. A study by IBM discovered that Indonesian manufacturing firms are increasingly using AI for creating dashboards, inventory management, demand prediction, as well as data processing [11].

Jakarta, Indonesia. Source: Antara News

Agriculture, Forestry and Other Land Use (AFOLU)

To combat Indonesia's serious deforestation and peatland fire issues, AI-driven technologies are used to support forest conservation.

- Forest Mapping: Through the FAIR Forward Initiative by GIZ, local participatory groups collect data to enhance forest classification and identify high-carbon storage forests that need protection using AI [12]. **See case study on High Carbon Stock Approach in Indonesia (page 136).**
- Illegal Logging Detection: AI tools help detect illegal logging, helping to reduce deforestation.
- Wildfire Prediction: AI model FireCNN can help prevent 50-76% of peatland wildfires in Central Kalimantan, utilising historical climate data [13].

Adaptation

Food & Agriculture

Agriculture supports millions of livelihoods and can leverage AI to improve productivity and sustainability in systems.

- Agriculture management: Stranas KA Strategy focuses on developing a national database to manage and optimise food availability.
- Farming innovations: AI-powered tools are improving farming efficiencies in Indonesia by increasing access to information. **See case study on Dokter Tania.**
- Aquaculture: The NN Marlin application developed by National Research and Innovation Agency (BRIN) uses ML to locate the densest fishing grounds, making fishing more targeted and less harmful [14]. Another innovation in Indonesia is JALA, an app which helps shrimp farmers increase productivity in the shrimp industry. Farmers can enter data directly into the JALA App and receive AI-enabled analytics to help forecast shrimp harvests [15].

Urban Resilience

Indonesian startups have developed innovative solutions to boost urban resilience and adaptation.

- Disaster Relief: AI is supporting more informed and timely decisionmaking in the event of disasters, through the rise of AI-powered real-time disaster information sharing systems and tools. **See case study on PetaBencana.id on page 141.**
- Waste: Startups in Indonesia are employing AI to track waste treatment and incentivise proper waste disposal methods. For example, Indonesian startup Gringgo is leveraging AI-based solutions to address Indonesia's waste management problems [16].

Papua, Indonesia source: ARUP

Risks and Challenges

- Unsafe AI use
- Non-trustworthy AI use
- Unethical AI use

Indonesia's deployment of AI for climate action holds immense potential but also presents key risks and challenges that may lead to the proliferation of non-responsible AI. Proactively addressing these issues will help ensure that AI technologies are leveraged safely, responsibly, and inclusively for climate action efforts.

Risks of Data Fraud in Carbon Trading

Indonesia launched its carbon trading market in 2023 and opened its domestic market to global investors as of January 2025. While speculative, there are concerns that Indonesia's carbon trading market may be vulnerable to carbon fraud [17], including risks of false reports [18]. In the capital market sector, Indonesia's Financial Transaction Reports and Analysis Centre received a significant increase in suspicious financial transaction reports, highlighting potential vulnerabilities in new financial systems [18]. AI misuse, such as generating fake environmental data or satellite imagery for fraudulent carbon credit claims, could undermine the market's integrity [19]. Proactive monitoring of AI-enabled processes such as carbon-offset calculations by institutions like the SRN-PPI and IDX Carbon in Indonesia is essential to maintain trust, necessitating the enhancement of their capabilities to combat this risk.

Classification of AI misuse

Climate Change Disinformation and Misinformation

Generative AI poses risks by enabling the spread of synthetic content, such as deepfake videos, counterfeit reports, and voice cloning. In Indonesia, misinformation is already prevalent, especially pertaining to climate change matters. While a majority of Indonesians (78%) believe that climate change is happening [20], misleading narratives – often shaped by vested interests, including political and economic actors – continue to circulate online. AI amplifies these narratives by automating and scaling the dissemination of false or misleading climate information, making it more difficult to counteract with credible sources.

Classification of AI misuse

Labour Displacement

The adoption of AI technologies presents risks of labour displacement, particularly in regions with limited access to digital skills training and internet connectivity. As automation transforms key employment sectors in rural areas including agriculture and manufacturing, the limited rural digital infrastructure and skilling opportunities may pose challenges for smooth workforce transitions and exacerbate regional inequalities.

Classification of AI misuse

Digital Divide

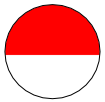
Indonesia's digital divide remains a significant barrier to inclusive AI deployment. Unequal access to digital infrastructure and technology, particularly in rural and underserved areas, limits participation in AI-driven climate initiatives, as seen amongst rural smallholder farmers in Indonesia who face foundational issues such as limited internet access [21]. This disparity risks deepening socio-economic inequalities, with urban areas reaping the benefits while rural communities are left behind.

Classification of AI misuse

Lack of Awareness and Readiness

A lack of public awareness and preparedness for AI adoption hinders its safe and effective deployment for climate action. Many Indonesians are unfamiliar with AI applications, limiting their ability to engage with and trust such technologies. Without robust awareness campaigns and training programs, societal buy-in for AI-driven climate solutions may remain limited, reducing their overall impact.

Classification of AI misuse



Stakeholder System

Below is a stakeholder ecosystem of key organisations advancing AI for climate action across various roles, including regulation, policy, implementation, investment, research, and innovation. Each organisation plays a critical role, collectively forming a comprehensive ecosystem that drives progress in the application of AI for climate action. This list of key stakeholders is non-exhaustive.

Regulators / Government Sector

Organisations responsible for regulating AI and establishing policy to promote safe AI development

- **Ministry of Communication and Digital Affairs (KOMINFO):** Led the Indonesia Digital Roadmap 2021-2024 and oversaw development of AI Ethical Guidelines
- **National Research and Innovation Agency (BRIN):** Drives AI research and innovation to address climate challenges and developed the National AI Strategy
- **Collaborative AI Research and Industrial Innovation Association (KORIKA):** Fosters industry-academic partnerships, supporting initiatives like the AI Innovation Hub to accelerate AI-driven climate technologies
- **Ministry of Environment:** Oversees initiatives to solve for environmental issues including biodiversity, pollution control, and sustainable resource management
- **Ministry of Forestry:** Oversees the management, conservation, and rehabilitation of Indonesia's forests

▶ Indonesia is advancing AI governance led by KOMINFO and supported by research efforts from BRIN. It is also enhancing cross-stakeholder partnerships through KORIKA. However, Indonesia's AI guidelines are currently nonbinding have yet to be implemented and enforced [22].

Larger Private Sector Players

Large-scale technology businesses investing in Indonesia's digital and climate transformation

- **Microsoft:** Advances AI for climate resilience in Indonesia, as demonstrated by its AI for Earth initiative, as well as leads key national digital skilling programmes
- **Yandex Group:** Develops advanced data analytics and AI capabilities
- **Gojek:** Integrates AI to enhance green mobility and supply chain efficiency in Indonesia
- **Grab:** Drives climate-friendly innovation with AI-powered solutions for ride-sharing and last-mile logistics
- **PT Telkom Indonesia:** Largest telco provider in Indonesia, supports digital connectivity and AI adoption
- **Samsung:** Invests heavily in AI research and development globally, focusing on applications like smart devices and energy efficiency

▶ There is huge investment interest in Indonesia's digital economy but climate application is still emerging. Microsoft is dominant, announcing a $1.7bn investment in 2024 to advance Indonesia's cloud and AI capabilities which includes building new cloud and AI data centres, and training 840,000 members of the population [23].

Smaller Private Sector Players

Smaller-scale domestic businesses that deploy AI applications in climate action across Indonesia

- **Duitin:** integrates AI in waste management to optimise recycling efforts and reduce landfill waste
- **Aruna:** Fisheries e-commerce app that uses AI-powered analytics connect fishers to markets while reducing food waste
- **Bioniqa:** Leverages AI for real-time monitoring and optimisation of carbon capture processes
- **Jejak.in:** Jejak.in applies AI to monitor and manage carbon offsets and reforestation efforts, demonstrated by its tree-tracking platform
- **PT Marlin:** Partnership between PT Marlin and government agency BRIN to deploy NM Marlin, an app which employs ML to provide fishing data and ocean analytics, enabling sustainable fisheries management

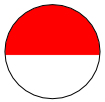
▶ Indonesia's climate tech startup ecosystem is rapidly growing, most notably agritech startups. Local startups and enterprises have begun developing and deploying AI technologies to address Indonesia's climate change needs and challenges [25].

Civil Society / Academia

Organisations that support AI growth through innovation, R&D and knowledge sharing efforts

- **Artificial Intelligence Innovation Centre (PIKA):** Drives AI innovation to support Indonesia's National Strategy for Artificial Intelligence
- **Indonesia Climate Modelling & Policy Hub:** Facilitates collaboration on climate modeling to inform policies
- **Indonesia AI Society:** Advocates for ethical AI practices and develops guidelines to ensure responsible AI use
- **Universitas Indonesia:** Conducts research on climate change and AI and its intersections
- **JKPP (Participatory Mapping Network):** Engages communities through participatory mapping to enhance local decision-making in climate action **(see case study 3 on High Carbon Stock Approach in Indonesia on page 136).**

▶ These organisations conduct research and actively engage with communities to advance AI applications for climate action most relevant to local needs, ensuring inclusivity. This is done through projects like the ClimateSmart Indonesia Initiative, using data to predict and mitigate climate-sensitive health issues [26].



Enabling Pillars

Developing and deploying safe, responsible and inclusive AI in Indonesia requires a supportive environment consisting of key enablers below.

a) Responsible Governance

Indonesia is actively integrating advanced technologies like AI and blockchain into its climate action frameworks. Indonesia has established the Climate Change Control and Carbon Trade Management Agency (BP3I-TNK) which will oversee and manage sustainable climate efforts and leverage technology to ensure transparency in carbon trading.

Key Challenges:

- Transparency: Corruption and fund misuse remains a significant challenge.
- Lack of GEDSI focus: Indonesia ranks poorly in gender equality, at 87th place according to the Global Gender Gap Report 2023. If this remains unaddressed, AI can result in the amplification of existing gender inequalities in Indonesia.
- Non-legislative: Indonesia's guidelines for ethical AI use lack legal enforceability necessary for successful implementation.

b) Talent and Skills

There are large-scale investments to upskill Indonesia's workforce to create a talent pool ready for a green and digital transition. The Green Digital Economy Platform, an international collaboration between Indonesia, Korea and other partners, integrates AI-driven tools like predictive analytics, IoT, and machine learning into its framework to empower 62 million Indonesian farmers [27]. The platform also aims to build innovative skills like meta farming and carbon trading [27]. The Ministry of Agriculture is also actively building capacity among agricultural extension agents and farmers to use technologies such as AI to enhance farming processes [28]. Initiatives led by non-profit organisations such as Rural ICT Camps and the National School of Community Networks in Indonesia also aim to close urban-rural digital gaps by equipping rural communities and youth with technological skills, including use of AI [29].

Additionally, Microsoft announced a $1.7 billion investment to advance Indonesia's cloud and AI ambitions, providing AI skilling opportunities for 840,000 Indonesians [23], including 300,000 vocational school students via the AI TEACH for Indonesia programme [24], women through the Ready4AI&Security programme which will provide cybersecurity career development opportunities [23], as well as 10,000 Indonesian developers who will be trained on generative AI skills via Microsoft's AI Odyssey programme [23]. Digital inclusion is prioritised, equipping all Indonesians with key AI skills to apply to climate action.

Key Challenges:

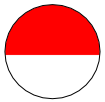
- Training marginalised groups: There is a need to make AI training more accessible to marginalised groups to ensure they can fully participate and benefit from AI training initiatives [29].

c) Data

Efforts are underway to enhance the availability of high-quality climate data in Indonesia. For example, Indonesia Climate Data Explorer, developed by the World Resources Institute in collaboration with Indonesian government agencies like BAPPENAS, is an open online bilingual platform that compiles national and provincial climate policy data, aggregating locally sourced information to improve climate data accessibility and quality [30]. Additionally, Ministry of Agriculture's implemented its Indonesia Agriculture War Room initiative, which is a large-scale command centre project which uses AI to power a centralised data hub that processes agricultural data for data streamlining and monitoring [31].

Key Challenges:

- Data availability: High-quality, localised climate data is scarce, which hampers the development of accurate climate models. Most available data is at a continental scale, making it less useful for addressing hyperlocal climate challenges.
- Linguistic Barriers: Many communities rely on local languages for communication. The absence of datasets in these languages can hinder effective climate action in these areas [32].
- Cost: Collecting, tagging, training and maintaining large datasets can be highly costly.
- Privacy Concerns: Ensuring data privacy and security while collecting and using large datasets for AI applications is a challenge that Indonesia is working to resolve [32].



d) Computing

Indonesia's computing infrastructure is expanding through a mix of domestic and international investments in data centers and cloud platforms. Microsoft's $1.7 billion investment in cloud and AI infrastructure, as well as developments by domestic operators like Telkom Indonesia, DCI Indonesia and Biznet Data Centres, is significantly enhancing the country's computing capabilities. Yandex, a Russian tech company, plans to introduce its search engine platform and its digital services to further advance Indonesia's digital economy [33].

Key Challenges:

- Access to technology: There is unequal access to advanced computing technologies, which can widen the digital divide and limit the participation of smaller organisations and researchers [AE].
- Cost: The high cost of physical computing infrastructure is a major barrier for development.

e) Innovation

Indonesia's National AI Strategy (Stranas KA) emphasises Industrial Research and Innovation as one of its four key focus areas, aiming to develop AI solutions for critical sectors including food security and smart cities, which align with climate action efforts. The country’s innovation landscape has shown significant growth, with agrifoodtech startups alone raising over $165 million across 26 deals in 2020, addressing challenges in food security and agricultural productivity [34].

Key Challenges:

- Regulatory barriers: Indonesia has strict regulations that may delay or hinder innovation such as lengthy and complex certification processes, high VAT rate and restrictions [35].

f) Scaling

Initiatives like the Just Energy Transition Partnership are helping to attract investment and support the scaling of AI-driven climate solutions, positioning Indonesia as a leader in sustainable development.

Key Challenges:

- Technical Support: There is a lack of robust technical support systems to help scale promising AI innovations and integrate them into broader climate action strategies [36].
- High costs: Innovation and scaling may be hindered by high costs of and limited funding for R&D activities and deployment of solutions [36].

The Philippines

The Philippines

Overview of Landscape

The Philippines is poised to leverage AI to boost its GDP by 12% by 2030, according to a 2020 report by EDBI and Kearney [1], aiming to become a global hub for big data processing and AI-driven services. The AI regulatory landscape in the Philippines is evolving, with efforts underway to establish a dedicated body for managing AI use. While formal legislation is limited to the Data Privacy Act, there is a strong commitment to building a responsible AI ecosystem through regulation, policy and partnerships.

Formal legislation:

- The Data Privacy Act: Plays a critical role in AI governance, safeguarding individuals' rights and preventing unauthorised use of information, patterned after EU standards.

Relevant house bills:

- Artificial Intelligence Regulation Act: Establishes principles for AI development, working towards an "AI Bill of Rights" to protect against unsafe systems, algorithmic discrimination, and privacy violations.
- Artificial Intelligence Development Act: Proposes the creation of the Artificial Intelligence Development Authority to implement and oversee responsible AI.


Manila, Philippines

Roadmaps and guidelines:

- National AI Strategy Roadmap 2.0, officially launched on July 2024, aims position the Philippines as a Centre of Excellence in AI research and development by fostering innovation, investment, talent.
- Principles and Guidelines for an Ethical and Trustworthy Use of AI in the Government (published as a draft memorandum in April 2024): This Circular provides guidelines for ethical and trustworthy use of AI technology in government.
- The Philippines plans to lead the development of an ASEAN Legal Framework for AI during its ASEAN chairmanship in 2026 [19].

Climate Change in The Philippines

In 2022 and 2023, the World Risk Index ranked the Philippines as the country with the highest disaster risk. Without significant action, climate risks are projected to cause GDP losses of up to 6% annually by 2100 [2].

The country has pledged to cut emissions by 75% by 2030 and increase the share of renewable energy in the energy mix to be over 50% by 2050 [3].

AI Application for Climate Action

Mitigation

Electricity

- Smart energy analytics: Local startup Exora Technologies platform uses AI and data analytics to help users find the best electricity contracts and reduce their energy bills, potentially reducing costs by up to 30% [4].
- Liquid cooling: Converge ICT Solutions and Supermicro has introduced AI-powered data centres with sensor-based smart liquid cooling systems that reduce energy consumption by up to 40%, setting a benchmark for sustainable infrastructure [5].

Emission Management

- The Department of Environment and Natural Resources (DENR) employs a Decision Support System that integrates analytics to enhance environmental planning [20]. Real-time data processing capabilities allow for forecasting of environmental trends, facilitating more effective disaster response and conservation efforts.

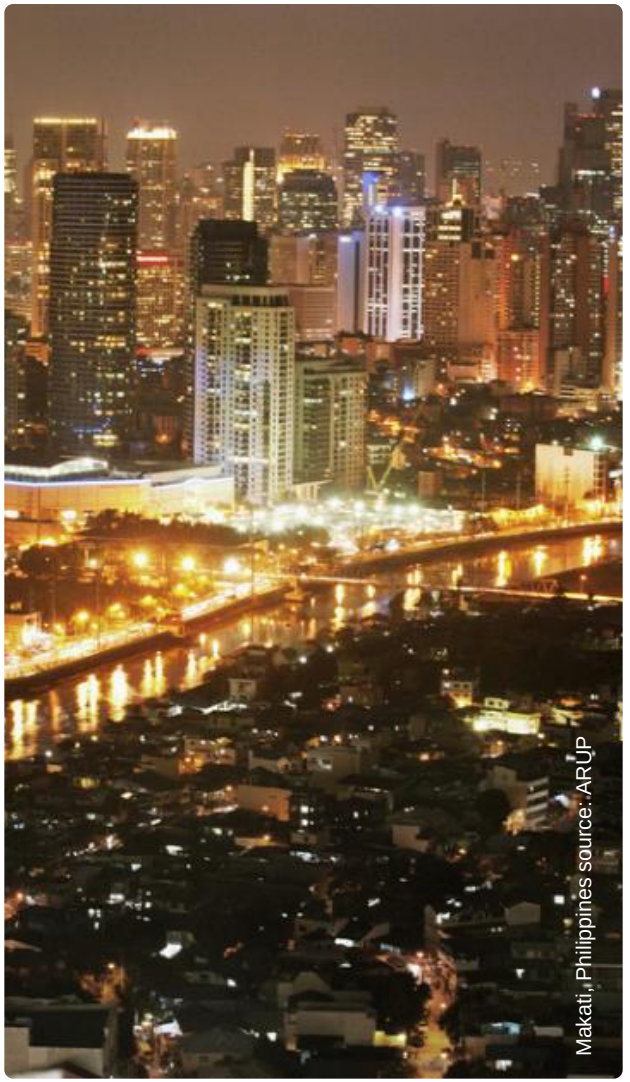
Forestry and other Land Use (FOLU)

Illegal logging: Illegal logging is a major problem in Philippines which contributes to deforestation and leads to the loss of biodiversity, soil erosion, and water pollution [21]. AI technologies, particularly computer vision techniques, leverages the imagery data from satellite and drone to monitor and detect land use changes. Such technologies are used to detect illegal logging activities and assess reforestation progress. Rainforest Connection (a non-profit organisation in the US) teamed up with Huawei to monitor illegal logging [22].

Adaptation

Food and Agriculture

Climate-smart agriculture: The Philippines is an agricultural country with 47% land areas for agricultural use [23]. Increasingly erratic weather patterns and extreme weather events, such as tropical typhoons, significantly impact agricultural productivity.



Makati, Philippines source: ARUP

AI-driven predictive models analyses large volumes of historical weather, temperature, and humidity to forecast upcoming weather patterns which helps manage infestations and safeguard crop yields against climate variability. These tools also support irrigation management, ensuring water efficiency during droughts. Project SARAI, by the University of the Philippines Los Baños, uses remote sensing and real-time weather data to forecast seasonal crop using AI [24].

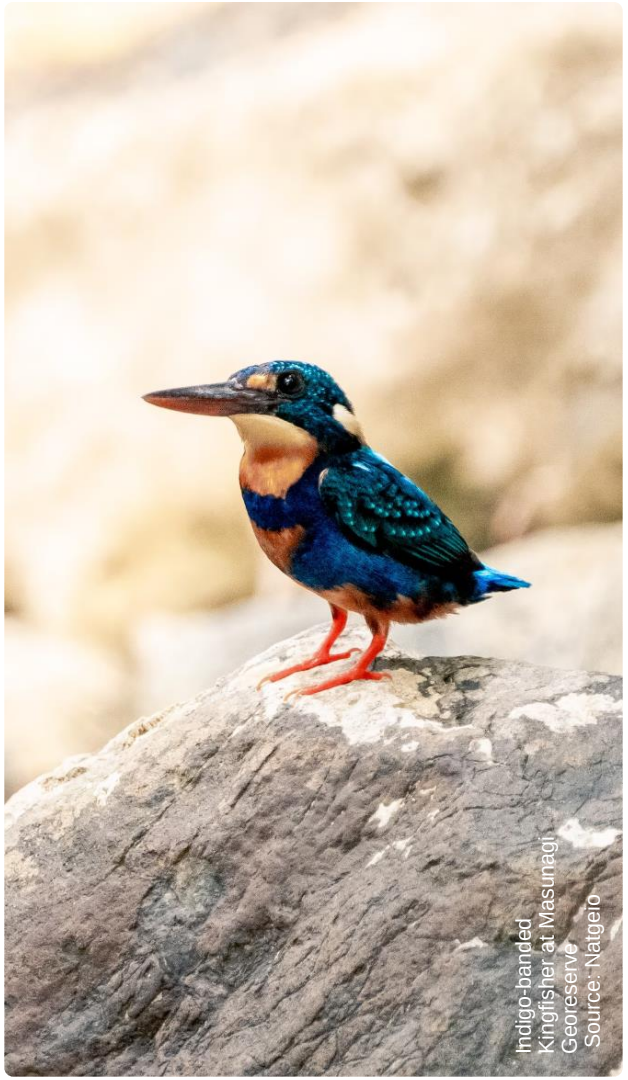
Biodiversity

Illegal wildlife trading: The Asian Development Bank and DENR collaborated with Senti AI to develop an AI-powered dashboard that monitors illegal wildlife trade. This tool aggregates data from multiple platforms, tracking 158 species of flora and fauna and supporting enforcement efforts to combat biodiversity loss [6].

Urban Resilience

Disaster management: AI plays a pivotal role in disaster management. JICA introduced to the Philippines AI-based systems to enhance real-time data collection and communication during disasters. Similarly, the Netherlands Red Cross developed the "Priority Index," which combines open datasets to predict typhoon impacts and streamline aid distribution, was utilised during Typhoon Haima to enable faster response times by identifying worst-hit areas within 24 hours [7].

Flood risk: The Department of Science and Technology (DOST) deployed a Rainfall and Water Level Monitoring System in Pangasinan to mitigate flood risks [25]. This AI-powered system generates accurate forecasts, helping local governments implement timely risk management strategies, thereby reducing community vulnerabilities to water-related disasters.



Indigo-banded Kingfisher at Masungi Georeserve Source: Natgeio

Risk and Challenges

Unsafe AI use
Non-trustworthy AI use
Unethical AI use

The Philippines' deployment of AI for climate action holds immense potential but also presents key risks and challenges that have led to the rise non-responsible AI. Proactively addressing these issues will help ensure that AI technologies are leveraged responsibly to advance climate action efforts.

Data Shortage and Bias

There is pressing concern about potential biases in environmental data analysis and policy formulation, as highlighted by the Department of Environment and Natural Resources (DENR). This risk has grown evident in disaster relief efforts in the Philippines. A recent initiative, 510 Global, aims to enhance disaster relief by developing a "Priority Index" that utilises open data such as wind speeds and rainfall [8]. During Typhoon Haima, this model supported faster distribution of supplies by predicting and identifying worst-hit areas. However, it faces difficulties in predicting extreme damage scenarios. There is a need for more comprehensive data, such as building damage data and victim statistics, to mitigate biases in its model [8]. Furthermore, the introduction of AI technologies like Spectee Pro, designed to improve disaster response by analysing social media data and supported by JICA, also faces challenges related to data quality and verification processes.

Without adequate local data, AI models may produce skewed outputs favouring regions with more robust datasets, causing significant disparities in disaster reduction efforts based on area and income levels.

Classification of AI misuse

Illegal Wildlife Trade Proliferation

The illegal wildlife trade (IWT) in the Philippines illustrates how AI and technology, if misused or inadequately managed, can contribute to adverse impact on biodiversity. While AI presents opportunities to combat environmental crimes like IWT, the IWT market has shifted significantly to digital platforms, creating a complex challenge for enforcement agencies like the DENR. Criminals use online platforms to trade wildlife discreetly, bypassing traditional surveillance methods. A TRAFFIC report revealed that reptile advertisements on Facebook alone were valued at ₱26.5 million ($570,148), reflecting the scale of illegal activities enabled by technology in the Philippines [9]. AI tools for tracking and investigating such crimes are poorly regulated, and as a result have been exploited by bad actors.

Classification of AI misuse

Inequitable Disaster Relief Communication

Effective communication during disaster relief in the Philippines has been hampered by existing emergency protocols, which often lack relevance and timeliness. An expert highlighted that survivors of recent storms had received up to 300 messages each within a short time-frame [10], rendering communication overwhelming and ineffective. While integrating smarter AI tools could help address these shortcomings, challenges persist due to the country's digital divide, with smartphone penetration limited to 72.7% [11]. As a result, certain groups may not have equal access to AI-driven resources or timely information during crises, potentially increasing their vulnerability when disasters strike.

Classification of AI misuse

Climate Change Misinformation

The challenge of misinformation regarding climate-related matters has been significantly exacerbated by AI in the Philippines. For example, on the topic of nuclear energy. The Bataan Nuclear Power Plant was constructed in the 1980s but never operated due to safety concerns heightened by the Chernobyl disaster. An unauthenticated fake audio clip allegedly featuring the late former president Ferdinand Marcos criticizing former president Corazon Aquino for "wasting" the Bataan Nuclear Power Plant was circulated to support calls for its revival [12]. On the other hand, false claims about missing equipment at the plant were spread online but have since been debunked by the Philippine Nuclear Research Institute, which confirms that all essential components, including the nuclear reactor, remain intact. This environment of distrust amplified by AI misuse undermines efforts to communicate the safety and technological advancements of sustainability-related topics in the Philippines.

Stakeholder System

Below is a stakeholder ecosystem of key organisations advancing AI for climate action across various roles, including regulation, policy, implementation, investment, research, and innovation. Each organisation plays a distinct role, collectively forming a comprehensive ecosystem that drives progress in the application of AI for climate action. This list of key stakeholders is non-exhaustive.

Regulators / Government Sector

Organisations responsible for regulating AI and establishing policy to promote safe AI development

- **Department of Science and Technology (DOST):** Drives capacity building, innovation and R&D for AI and its applications across areas including agriculture and resilience [27]
- **Department of Information and Communications Technology (DICT):** Oversees national development of technologies including AI, digital infrastructure
- **Department of Trade and Industry (DTI):** supports responsible AI integration in key sectors, in alignment with the National AI Roadmap
- **Department of Environment and Natural Resources (DENR):** Oversees national environmental protection. Internally incorporates ethical AI framework within the department
- **Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA):** Enhances disaster readiness with AI-powered weather forecasting systems

▶ Highly involved in AI usage regulation, setting internal guidelines to promote safe development. DENR has developed its own ethical framework for AI, highlighting the high capacity for AI regulation within the government, though efforts remain siloed across various departments [28].

Larger Private Sector Players

Large-scale technology businesses investing in the Philippines' digital and climate transformation

- **Alibaba Cloud:** Large cloud solutions provider that has one data centre in the Philippines, expected to be powered by 100% renewable energy by 2030 [29]
- **IBM:** Tech MNC offering advanced climate risk analytics through its Environmental Intelligence Suite
- **Senti AI:** Leading AI services provider and first Philippine company to earn the Google Cloud Machine Learning Specialisation
- **Atmo:** Leading air quality monitoring provider in the Philippines, utilising AI technology to deliver real-time data using air quality sensors [30]
- **Globe:** Major telco provider providing quality digital infrastructure necessary for AI
- **Spectee:** Disaster response technology provider in the Philippines, employing AI to analyze real-time data

▶ Major tech players are advancing the Philippines' digital and climate transformation through infrastructure development, local talent upskilling, and partnerships with government and academia [33]. Their involvement strengthens AI ecosystem.

Smaller Private Sector Players

Smaller-scale domestic businesses that deploy AI applications in climate action across the Philippines

- **Komunidad:** Weather intelligence platform in the Philippines, providing early warning systems
- **Humble Sustainability:** Leading circular economy startup in the Philippines, aiming to bring 1 billion items back into circularity by 2030
- **Talino Venture Studios:** Significant venture builder in the Philippines, recently securing $5 million to scale fintech solutions that promote financial inclusion for underserved communities [31].

▶ The local climate tech sector is nascent and still being developed. Companies that apply technology to climate efforts are in the early stages of navigating how to deploy AI responsibly [34].

Civil Society / Academia / DFIs

Organisations that support AI growth through innovation, R&D and knowledge sharing efforts

- **Asian Development Bank:** Provides technical and financial assistance for initiatives such as the Digital Innovation Sandbox, in which AI is one of the key focus areas
- **Japan International Cooperation Agency:** Funds infrastructure projects that enhance data-driven decision-making for disaster risk reduction
- **World Bank:** Provides technical and financial assistance for responsible AI development in the Philippines
- **University of the Philippines:** Drives cutting-edge AI research in the country, as the university with Philippines' first Ph.D. programme in AI [32]
- **Mapua University:** Conducts foundational AI courses for students to equip them with critical digital skills
- **Oscar M. Lopez Centre:** A foundation dedicated to developing science-based solutions for climate change.

▶ DFIs are pivotal in advancing climate action in the Philippines, collaborating closely with the government to provide technical and financial support [35]. Universities and centres advance research, innovation, and partnerships to drive AI and climate-related initiatives.

Enabling Pillars

Developing and deploying safe, responsible and inclusive AI in the Philippines requires a supportive environment consisting of key enablers below.

a) Responsible Governance

The Philippines' government is actively working towards the integration of responsible and ethical AI through various large-scale initiatives. The Philippine government follows a Cloud First Policy, which encourages government agencies to streamline operations, enhance service delivery, and promote data sovereignty by transitioning from legacy systems to centralised cloud services [13]. DICT leads these efforts, managing over 600 agencies and ensuring compliance with both local and international security standards. The Department of Environment and Natural Resources is launching an internal generative AI awareness program to promote ethical AI use among staff, when dealing with AI for environmental analysis and policy formulation.

Key Challenges:

- Need for comprehensive policy or law: AI is not yet addressed in one comprehensive Philippine statute, making AI regulation fragmented.

b) Talent and Skills

The Philippines faces a shortage of 200,000 workers with IT skills [14]. Recognising the threat of mass automation from AI, the Philippines has enacted the Philippine Digital Workforce Competitiveness Act to prioritise digital transformation in education. Additionally, the country has passed the Second Congressional Commission on Education Act II, aimed at enhancing the technology skills and competitiveness of the workforce. There is also the Protection of Labour Against AI Automation Act which prohibits the use of AI as the sole basis for employment decisions, protecting job processes and preventing unethical use of AI. Partnerships between academia and private sector (e.g. Alibaba Cloud) are also underway to train local talent.

Key Challenges:

- Internet poverty: Almost 16% of Filipinos are classified as "internet poor," meaning they lack the financial capacity to afford at least one gigabyte of internet data per month [15]. This situation significantly limits access to online education and job opportunities, contributing to the overall skills gap in the workforce.

c) Data

The country has data capabilities that varies across different climate areas. There is stronger data collection and management in areas like weather monitoring and deforestation, while significant data gaps remain in sectors like the blue economy.

.Key Challenges:

- Cybersecurity: The Philippines face high risk of cyberattacks and security breaches such as malware, data leakage, and compromised websites. This is a result of the country's limited data protection measures. Only 45% of enterprises are equipped with cybersecurity measures to protect data in their AI models [16].
- Awareness: There is a lack of awareness regarding the importance of local data gathering for climate action. Many stakeholders recognise its significance after experiencing climate disasters, leading to a reactive rather than proactive approach to data collection.
- Data availability: Localised climate data is scarce as many datasets are aggregated at a higher more continental level. This was cited as an issue by researchers predicting sea level rise, noting that the country lacks observation stations necessary for measuring sea level rise.

d) Computing

There are numerous data centre developments in the Philippines, most notably the establishment of VITRO Sta. Rosa by PLDT Group, which is the first local data centre operator to have the capability for handling AI workloads [17]. In the public sector, government agencies use shared cloud services, utilising a centralised infrastructure to manage their data, led by DICT [18]. Additionally, DTI will be establishing an Innovation Gateway that will host a Centre for AI Research, poised to enhance innovation in sectors including energy, water, etc.

Key Challenges:

- Computing infrastructure gap: Only 20% of Philippine enterprises have GPUs that can handle workload requirements for AI [16], limiting the usage of AI among enterprises.

- **e) Innovation**

The Philippines is advancing its innovation ecosystem to leverage AI in combating climate change. The Science for Change Program (S4CP), initiated by the Department of Science and Technology, plays a crucial role in this effort by promoting R&D that addresses sustainability challenges [26]. This programme encourages partnerships between research institutions and the private sector to ensure that R&D outputs are market-driven and can contribute to climate action.

Challenges:

- Licensing and patenting issues: Existing guidelines on licensing agreements for patents and royalties need revision to facilitate better commercialisation of research, especially those related to AI applications in climate change.

f) Scaling

The Philippines is dedicated to scaling responsible AI, currently done through bodies like the National Innovation Council. There is a need for robust technical and financial support to help scale AI innovations that can combat climate impacts.

Thailand

Thailand

Overview of Landscape

The AI market in Thailand is poised for significant growth, projected to generate up to US$2 trillion (71.31 trillion baht) by 2030, representing a 20-fold increase from 2021 [1]. A key milestone in this journey is the development of the Thai Large Language Model (LLM). This model is designed for diverse applications in sectors such as medicine, tourism, and business, addressing local needs and driving efficiency in these domains [2].

AI adoption among Thai organisations is steadily increasing, with 73.3% of organisations planning to adopt AI in the future. However, only 16.5% of organisations have integrated AI ethics into their operations, while 43.7% are exploring how to address ethical considerations in their AI practices [3].

In 2022, the National Artificial Intelligence Action Plan (2022–2027) in 2022 was released, which aims to enhance the country's readiness for AI development. This strategy also emphasises preparedness in social, ethical, legal, and regulatory dimensions to support responsible AI use. Efforts for advancing AI ethics and governance is supported by the National AI Policy and Action Plan Steering Committee.

The National Science and Technology Development Agency (NSTDA) published ethical guidelines for AI in 2022 to promote ethical AI practices, but these guidelines are currently non-binding.

Bangkok, Thailand source: ARUP

Climate Change in Thailand

Thailand is highly vulnerable to climate change, ranked among the top ten countries most affected. By 2048, the country's GDP could decline by 43.6% due to temperature rises of up to 3.2°C [4]. Flooding and land erosion has become increasingly concerning. To help respond to these challenges, Thailand aims to reach carbon neutrality by 2050 and net-zero by 2065, while its National Adaptation Plan emphasizes integrating adaptation into key economic sectors such as agriculture and health

AI Application for Climate Action

Mitigation

Energy

AI enabled solutions, like Samui AI-Driven Energy Efficiency, provide real-time energy monitoring, help business optimise energy consumption in industrial environment. By leveraging AI algorithms and machine learning, these solutions monitor energy usage, predict maintenance needs, and optimise settings for machinery and HVAC systems [5]. Samui AI-Driven Energy Efficiency focuses on optimising energy consumption in industrial plants to reduce downtime and integrate renewable energy sources.

Emission Management

By leveraging the benefits of IoT sensors, smart emission management solutions could continuously monitor emission data in real-time and uses AI systems to forecast future emissions based on historical data and current operating conditions. Thaicom's CarbonWatch platform, Thailand's first satellite and AI-powered carbon credit system, revolutionizes emission management by leveraging remote sensing and geospatial data. Certified under the Thailand Voluntary Emission Reduction Program (T-VER), it accurately calculates carbon sequestration in forests, supporting Thailand's carbon neutrality goals. Partnering with the Mae Fah Luang Foundation, the platform is deployed in community forests, enabling data-driven emission tracking and sustainable land management. This innovation enhances real-time carbon monitoring, fostering a low-carbon economy and advancing climate resilience efforts in Thailand [6].

Transport

Smart Grids: Combining smart grids with AI technologies could screen, analyze, and monitor the electricity demand and supply through surveillance systems; thus, further optimising the electricity demand and supply, detecting unusual activities or emergencies, and alerting authorities [7]. Saraburi has implemented their own AI-enabled smart grid optimisation. This solution includes real-time data analysis from smart meters and sensors to identify energy waste, predict potential outages, and integrate renewable energy sources more effectively. [8]

Bangkok, Thailand source: ARUP

Adaptation

Food & Agriculture

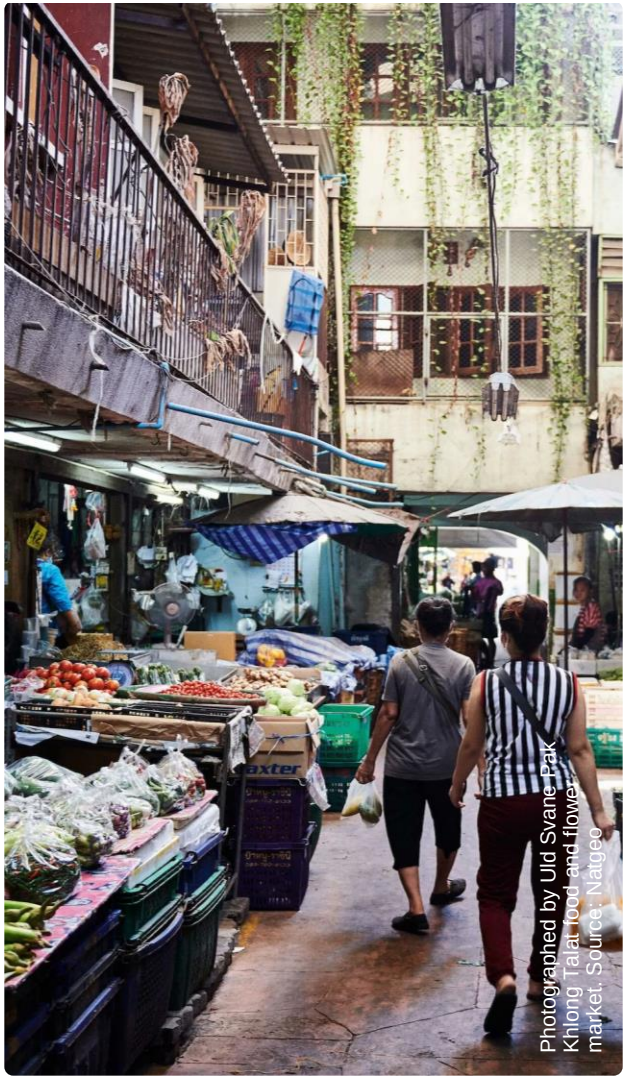
AI-based solutions are enhancing Thailand's agricultural sector, a crucial pillar of its economy that employs roughly 12 million people in Thailand [9].

- National Strategy for Agriculture: Thailand's 20-year Agriculture and Cooperative Strategy (2017–2036) incorporates AI to boost productivity through weather forecasting, pest monitoring, and plant growth analysis.
- Climate-smart agriculture: AI-driven predictive models are employed to forecast weather patterns and manage infestations, safeguarding crop yields against climate variability. These tools also support irrigation management, ensuring water efficiency during droughts, such as Thailand Automation Based Smart Water Management System [10].
- Smart farming: There are platforms that integrate data across government agencies and agricultural cooperatives [11] to streamline services like rice diagnosis, fertilisation, and soil analysis, such as CyberBrain [12]. Farmers benefit from enhanced resource planning and improved access to innovative technologies. **See case study on EasyRice, agritech startup offering AI-based solutions to improve rice quality inspection (page 149).**
- Smart Greenhouses: The National Science and Technology Development Agency is developing AI-enabled greenhouse monitoring that regulate environmental conditions, to boost productivity.
- Innovation: Startups like Ricult and ListenField use AI and ML to analyse weather patterns, monitor crop health, and predict yields. Ricult's platform has seen signups from almost 400,000 farmers, to help enable data-driven farming decisions. ListenField focuses on cost reduction and operational efficiency for farmers [13].

Urban Resilience

AI-based algorithms enhance Thailand's capacity to predict and respond to events:

- Disaster Monitoring & Response: AI has enabled analysis of large datasets from satellites, sensors, and other sources to detect natural disaster risks like floods and droughts. The SERVIR Southeast Asia initiative uses AI to process satellite data for disaster relief, food security [14], and air quality management [15], operating in Thailand and Laos. This tool predicts pollution levels three days in advance, helping authorities issue warnings and mitigate risks.



Photographed by Uld Svane Pak Khlong Talat Tod and flower market. Source: Natgeo

Risk and Challenges

Unsafe AI use
Non-trustworthy AI use
Unethical AI use

Thailand's deployment of AI for climate action holds immense potential but also presents key risks and challenges that have led to the rise non-responsible AI. Proactively addressing these issues will help ensure that AI technologies are leveraged responsibly to advance climate action efforts.

Digital Divide

The rapid adoption of AI may result in the exacerbation of economic inequality, particularly in Thailand's agricultural sector and rural areas. Smallholder farmers constitute a substantial part of the agricultural landscape in Thailand, with approximately 7.15 million agricultural households in 2022 [16]. Due to their smaller scale of production, they may struggle to access or utilise AI-driven tools due to financial constraints, lack of training, and insufficient digital infrastructure. This technological divide could hinder equitable agricultural development and widen gaps between large-scale commercial farming companies and smaller-scale producers in Thailand.

More broadly, unequal access to AI technologies, digital infrastructure, and affordable broadband among low-income and rural communities perpetuates social exclusion. Without targeted interventions such as affordable internet, digital literacy programs, and subsidized AI technologies, marginalized populations risk being left behind, further deepening existing inequalities.

Classification of AI misuse

Labour Displacement in Traditional Sectors

The adoption of AI has raised some concerns of job displacement in Thailand, particularly those in unskilled or manual labour roles. The Thai National Labour Development Advisory Council estimates that 45% of the total workforce risk losing their jobs to digitalisation [17]. Applied AI in agriculture and healthcare took off in 2010, with CyberBrain enabling AI-powered community-based knowledge sharing across multiple stakeholders on agricultural practices [17]. However, Thailand's digital transformation will only be smooth with adequate upskilling, job preparedness programmes, and a dedicated focus on ensuring equitable transition of female empowerment in low-skilled labour markets.

Classification of AI misuse

Surveillance

While AI tools such as drones and sensor networks are increasingly deployed for climate monitoring purposes such as to monitor deforestation, carbon emissions, and illegal fishing, these technologies have also been misused for other purposes. For instance, in southern Thailand, it was reported that while 8200 cameras powered by AI were installed and designed to monitor risk and safety of Thai people, it was used specifically to track and monitor minority communities as a form of surveillance [18]. Such misuse undermines trust in AI and raises ethical concerns regarding privacy and consent.

Classification of AI misuse

Lack of Ethical Guidelines for AI

AI-driven systems for climate solutions, while efficient, can inadvertently prioritise short-term productivity over long-term environmental sustainability, favouring Thailand's private sector over local communities [19]. For example, AI-powered recommendations for fertilizer use or irrigation in agriculture have helped farmers to maximize yields, but fail to account for long-term impacts such as soil depletion, water contamination, or loss of biodiversity. These unintended consequences could undermine Thailand's long-term efforts to achieve sustainable development and climate resilience on the local level. There is a need to refine Thailand's National AI Ethics Guideline published by NSTDA, ensuring that AI deployment in climate areas are guided by sustainability principles [19].

Classification of AI misuse

Stakeholder System

Below is a stakeholder ecosystem of key organisations advancing AI for climate action across various roles, including regulation, policy, implementation, investment, research, and innovation. Each organisation plays a distinct role, collectively forming a comprehensive ecosystem that drives progress in the application of AI for climate action. The list below is non-exhaustive.

Regulators / Government Sector

Organisations responsible for regulating AI and establishing policy to promote safe AI development

- **Ministry of Digital Economy and Society (DES):** Critical in Thailand's AI landscape, spearheading upskilling and the launch of Guidelines for the Application of Generative AI with Good Governance for Organisations as well as Thailand's Anti-Fake News Centre
  - **National AI Policy and Action Plan Steering Committee:** Focused on promoting AI ethics and governance, infrastructure and capacity building [20]
  - **Electronic Transactions Development Agency (ETDA):** Proposed AI Sandbox to provide a controlled environment for testing and developing AI technologies
- **Ministry of Higher Education, Science, Research, and Innovation (MHESI):** Oversees research and innovation and manages six higher-education institutes
- **National Science and Technology Development Agency (NSTDA):** Published ethical guidelines for AI
- **Ministry of Natural Resources and Environment:** Central agency dedicated to advancing national climate change efforts

▶ Strong government support for AI deployment [21][22], however, these agencies often operate independently without a cohesive AI governance framework, leading to overlapping responsibilities and gaps [22]

Larger Private Sector Players

Large-scale technology businesses investing in Thailand's digital and climate transformation

- **Microsoft:** Microsoft Thailand's "AI for All Thais" initiative aims to train 1 million Thais in AI skills
- **HUAWEI Thailand:** Invested 5.5 billion baht since 2018, with plans to further develop AI and cloud solutions for Thailand
- **Alibaba Cloud:** Digital services provider enabling development of climate solutions such as its Climate Technology Platform
- **NVIDIA:** Pivotal in driving AI innovation in Thailand, providing advanced GPU technology and training programs
- **TCC Technology:** Large Thai digital services provider focusing on building an AI-powered cloud platform that can support local businesses' growth

▶ The private sector in Thailand is increasingly engaged with the public sector in the development and regulation of AI technologies as well as talent development [21], with major multinational corporations like Microsoft playing a pivotal role [23]

Smaller Private Sector Players

Smaller-scale domestic businesses that deploy AI applications in climate action across Thailand

- **PAC Corporation:** SME providing energy-saving technologies, saving consumers on energy costs
- **CyberBrain:** AI-powered agri-tech platform to optimise agricultural practices
- **Blue River Technology:** agriculture-focused startup known for its AI-driven "See & Spray" technology
- **Ricult:** Agri-tech startup that provides AI-powered insights to farmers in Thailand
- **MuvMi:** Ride-sharing startup operating electric tuk-tuks in Bangkok, planning to expand its fleet and reducing carbon emissions in urban transport

▶ There is significant momentum in deploying AI technologies for climate action especially in agriculture and resource management, largely led by startups and domestic companies [21][22]

Civil Society / Academia / DFIs

Organisations that support AI growth through innovation, R&D and knowledge sharing efforts

- **AI Governance Clinic by ETDA:** Government initiative to promote responsible AI in support of Thailand's national AI strategy
- **Artificial Intelligence Centre of Thammasat University:** Academic research center focused on advancing AI technologies and ethical standards
- **Artificial Intelligence Research Institute:** Collaboration between Vidyasirimedhi Institute of Science and Technology (VISTEC) and the Digital Economy Promotion Agency (DEPA) to drive AI adoption in Thailand's business sector
- **National Supercomputing Centre of Thailand:** Government-backed facility that provides high-performance computing resources to support advanced research in AI

▶ Strong partnership between public sector and academia [21] which drive the development of ethical AI frameworks and knowledge sharing across Thailand [24]. These organisations will need to improve coordination to ensure synergy in research and innovation efforts

Enabling Pillars

A supportive environment is critical to support the development and deployment of safe, responsible and inclusive AI in Thailand. This environment is characterised by key enablers below.

a) Responsible Governance

The Minister of Digital Economy and Society announced the launch of the "Guidelines for the Application of Generative AI with Good Governance for Organisations." [25] This comprehensive framework aims to establish structured governance for the responsible application of generative AI at the enterprise level, responding to the urgent need for guidelines in a fast-evolving digital landscape. Additionally, the Ministry of Digital Economy and Society is actively combating fake news through the Anti-Fake News Centre, collaborating with over 300 government agencies and leveraging AI to verify news reports, while promoting partnerships with banks and media networks to enhance awareness regarding misinformation [26]. This initiative demonstrates the government's strong commitment to ensuring the trustworthy use of technology.

Key Challenges:

- Public participation: The guidelines drafting process lacked sufficient public consultation, involving only selected stakeholders from academia, government, and industry. This exclusion has led to a focus on benefits for developers and manufacturers while neglecting concerns on privacy and user rights.

b) Talent and Skills

Thailand is actively attracting skilled talent and upskilling its workforce to meet the needs of its growing digital economy. Organisations such as the AI Engineering Institute have been established for knowledge sharing, research and innovation.

Thailand has introduced the Global Digital Talent Visa [27] which aims to attract up to 600 highly skilled individuals from leading universities worldwide to contribute to Thailand's AI sector, expected to enhance the country's ability to drive innovation. The country has also set up initiatives such as the Young Smart Farmer Program [28], in which >12,000 farmers from 2014 and 2018 [29] were recruited and taught how to deploy technologies in farming for improved sustainability and productivity [11].

Key Challenges:

- Insufficient human capital: The demand for digital skills outpaces supply, creating a gap in the workforce necessary to support AI initiatives

c) Data

Thailand has made significant strides in enhancing its data collection capacity for climate action through various initiatives and policies. One key development is the Climate Change Bill [30], which mandates the creation of a central database to track GHG emissions across multiple sectors, including energy, transport, and agriculture. This legislation is designed to facilitate compliance and reporting requirements for businesses, thereby improving the accuracy of GHG inventories. Additionally, the National Framework for Climate Services [31] aims to integrate climate information into decision-making processes, linking scientific knowledge with practical applications in sectors such as agriculture and urban planning.

Key Challenges:

- Hyperlocal data is often underrepresented in national datasets, making it difficult for policymakers to implement targeted interventions.
- Document inconsistencies: Documents in local and state government agencies lack machine readability and consistent documentation formatting hindering the quality of data available to be inputted into AI models.
- Lack of clear standards for data collection among different ministries, which results in limited data sharing and inadequate access to comprehensive datasets.
- The lack of robust data protection regulations raises fears about privacy violations and misuse of personal information, which can hinder public trust in AI systems.

d) Computing

Thailand has invested in improving cloud computing capabilities, enabling faster data processing for models, including climate AI models. The Thai government has also launched the National Supercomputing Centre [32] to advance the country's ability to process large-scale data using high-performance computing systems, which can be applied in predictive climate models and environmental monitoring.

Key Challenges:

- Limited access: Access to high-performance computing infrastructure remains limited outside of major urban centres. Smaller companies often face difficulties in affording or accessing cutting-edge AI tools.

e) Innovation

ETDA has proposed an AI Sandbox [33] to provide a controlled environment for testing and developing AI technologies. This initiative aims to address the current lack of facilities and legal frameworks for structured AI testing. Thailand is fostering innovation through institutions like the National Science and Technology Development Agency (NSTDA), which supports AI R&D projects focused on sustainable agriculture, water and clean energy.

f) Scaling

The Digital Economy Promotion Agency (DEPA) [34] plays a pivotal role in nurturing AI startups and domestic AI providers by offering access to big data and advanced AI technologies. This initiative equips businesses with the tools to develop innovative solutions and compete globally. Under the Thailand 4.0 strategy, government initiatives actively support scaling AI in key sectors such as renewable energy, sustainable agriculture, and waste management.

Malaysia

Malaysia

Overview of Landscape

Malaysia is advancing its AI capabilities, with the National AI Roadmap 2021-2025 forming the backbone of these efforts, aiming to harness AI for economic transformation and improved public services. To support the implementation of the National AI Roadmap 2021-2025, the Ministry of Science, Technology, and Innovation (MOSTI) also launched the National Guidelines on AI Governance and Ethics to guide the deployment of responsible AI. [1]

The establishment of the Ministry of Digital and the set up of the National AI Office under the governance of the National Digital Economy and 4IR Council further underscore Malaysia's commitment to streamlining digital strategies, including the scaling of AI initiatives across industries [1].

AI is projected to be a significant economic driver for Malaysia. By 2030, AI could contribute US$115 billion in productive capacity for the country [2]. The government's proactive stance, including policies and regulatory frameworks, provides a conducive environment for AI development, positioning Malaysia as a key player in the Southeast Asian AI ecosystem.

Vortex Tower KLCC source: ARUP

Climate Change in Malaysia

Malaysia was historically a net carbon sink due to its vast tropical forests, which sequestered significant amounts of carbon. However, post-2005, Malaysia became a net emitter, with over 70% of its emissions coming from energy production and transportation.[3] This shift marks a critical challenge in balancing economic growth with sustainable practices.

The impacts of climate change are already being felt, with average temperatures projected to rise by 1.1 to 1.5°C by 2050 and up to 2.1°C by 2100. Water security is threatened as climate change disrupts the water cycle, while coastal zones face increased vulnerability from sea-level rise, leading to erosion and loss of land. Agricultural productivity, particularly rice yields, is expected to decline by 2030, and urban areas, which house 75% of the population, are increasingly exposed to climate risks. Furthermore, the Orang Asal and Asli communities face threats to their cultural and natural heritage due to shifting weather patterns and environmental changes [4].

AI Application for Climate Action

Mitigation

Electricity

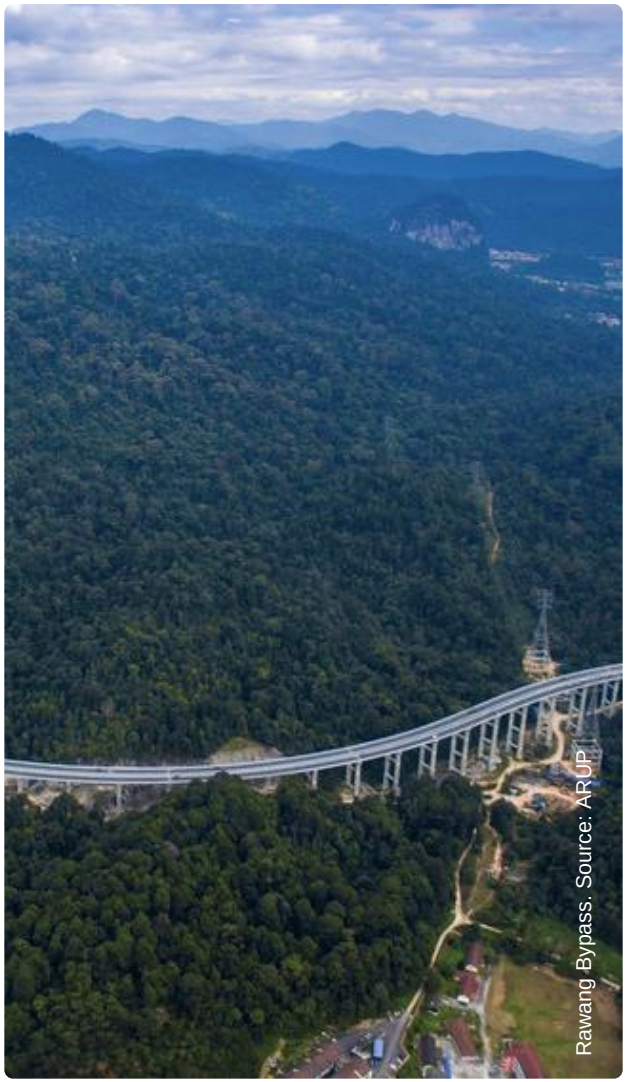
Malaysia's biggest electricity utility, Tenaga Nasional Berhad (TNB), is actively working towards a shift to renewable energy. The company has introduced several initiatives aimed at cutting carbon emissions, such as the implementation of smart grids and AI-driven energy management systems. These advanced digital technologies enhance energy distribution efficiency and minimize waste, supporting TNB's objective of reaching net-zero emissions by 2050 [5].

Transport

AI is aiding the development of more efficient transportation systems in Malaysia. For instance, real-time data analytics powered by AI is being used to optimise traffic flow and reduce carbon emissions. Intelligent traffic management systems, such as smart traffic lights and predictive analytics for vehicle routes, are helping to lower congestion and fuel consumption at road intersections in Putrajaya, Perak and Johor [6].

Agriculture Forestry and other Land Use (AFOLU)

Initiatives to integrate digital technology into Malaysia's agriculture sector are already in progress. One such initiative is the Digital Agtech programme, launched by the Malaysia Digital Economy Corporation (MDEC). This program focuses on incorporating digital technologies into farming, with the goal of transforming the sector into a highly skilled, digitally-driven industry. Another example is the Smart Sawah Berskala Besar (Smart SBB) programme, which aims to boost paddy yield per hectare. This initiative uses advanced digital technologies such as drones for crop monitoring and input spraying, along with AI-driven irrigation systems, to optimise agricultural practices. By employing these technologies within an economy-of-scale framework, the program has enhanced efficiency and productivity in rice cultivation [7].


Rawang Bypass. Source: ARUP

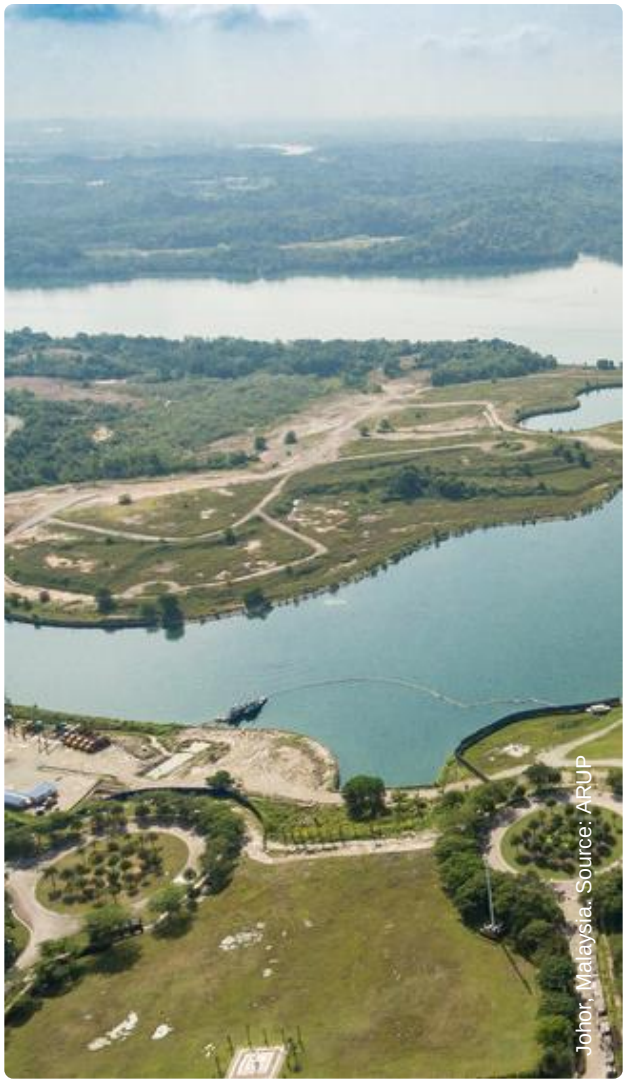
Adaptation

Urban Resilience

Malaysia is taking significant steps to enhance urban resilience and disaster management in response to severe floods and monsoon rains that threaten student safety and the conduct of national examinations. By utilising a combination of radio-frequency identification (RFID), Internet of Things (IoT) devices, Malaysia is creating a dynamic system that adapts to changing weather conditions, particularly in flood-prone regions like Kelantan, Terengganu, and Pahang. Key initiatives include real-time flood monitoring through RFID-enabled sensors, an AI-driven automated decision-making system to assess safety for students and tracking of student movements to ensure safe routes [8]. This comprehensive approach not only prioritises student safety but also fosters a sustainable and adaptable framework for the future.

Water Resources

As Selangor is one of the country's most populous and economically vibrant states, the demand for high-quality water is critical, especially in light of ongoing environmental challenges such as pollution and climate change. In response, Air Selangor is exploring advanced water treatment technologies that utilise AI to monitor and assess the quality of raw water from Selangor's rivers before it reaches the state's 34 water treatment plants. It emphasised that AI could detect at-risk water sources 24 to 48 hours in advance, facilitating a proactive approach to managing water pollution. This initiative aims to develop or procure AI solutions for real-time river quality monitoring and to incorporate technologies like ultrafiltration, ensuring that the public has access to safe and high-quality drinking water amidst the challenges faced by the state [9].



Johor, Malaysia. Source: ARUP

Risk and Challenges

Unsafe AI use
Non-trustworthy AI use
Unethical AI use

In Malaysia, the adoption of AI could potentially pose significant risks, including exacerbating labour displacement, deepening the digital divide. Additionally, AI technologies can enable greenwashing by promoting misleading environmental claims, while the expanding data centres in Malaysia may contribute to a substantial carbon footprint, undermining sustainability efforts.

Labour Displacement

Against the backdrop of growing emphasis on climate action and the transition to a digital and green economy, many jobs are anticipated to be impacted. A study by Talent Corporation Malaysia (TalentCorp) found that approximately 620,000 jobs across 10 key sectors—such as aerospace, electronics, energy, ICT, and pharmaceuticals—are at risk of displacement or convergence due to AI, digital technologies, and the green economy. Of the 3.5 million employees in these sectors, 18% are highly impacted and face job displacement, while 53% will need to reskill to remain relevant. The study highlights the need for workers to adapt by acquiring new skills, with emerging roles primarily in AI, digital technologies, and the green economy [10].

Classification of AI misuse

Digital Divide in AI Adoption for Agriculture

The digital divide and AI adoption pose significant challenges for Malaysian smallholder farmers, especially in rural areas like Sabah and Sarawak. Many lack access to digital technologies, high-speed internet, and advanced farming tools, putting them at a disadvantage compared to larger enterprises that can utilise AI solutions. This gap prevents smallholders from benefiting from technologies like AI-powered apps for weather forecasting, crop monitoring, and market price predictions.

The high cost of AI technologies also limits adoption. Precision farming tools, which use AI to optimise water usage, fertilizer application, and pest control, are increasingly common in Malaysia's large-scale palm oil and rubber plantations. However, smallholder farmers, who make up around 40% of Malaysia's agricultural sector, often cannot afford these tools like drones and sensors, which exacerbates inequality within the sector [11].

Additionally, many farmers, particularly older generations, struggle with digital literacy, hindering their ability to use AI tools effectively. This lack of skills creates barriers to using technologies that could improve productivity, deepening the divide between tech-savvy plantation conglomerates and traditional farmers of these technologies and those who cannot.

Classification of AI misuse

Use of AI for Greenwashing

Malaysia is actively adopting the International Sustainability Standards Board (ISSB) standards for sustainability reporting, with the Securities Commission (SC) at the helm of this initiative. The goal is to implement the ISSB's IFRS S1 and S2 standards to enhance the transparency and reliability of climate-related and environmental disclosures by Malaysian companies, aligning them with global best practices. In addition, AI-powered tools and capacity-building programs are being introduced to help businesses meet these new regulations, with the aim of reducing greenwashing and increasing accountability.

However, the growing use of AI applications for environmental reporting presents both opportunities and risks. While there is no concrete evidence yet, there is potential for unscrupulous businesses to misuse AI, creating the illusion of sustainability through polished, data-driven claims that lack real environmental impact. These businesses could leverage AI tools to enhance greenwashing, making their sustainability efforts appear more credible than they actually are.

Classification of AI misuse

Carbon Footprint of Data Centres

The rapid expansion of data centres in Malaysia, particularly in Johor, is raising concerns about their environmental and social impacts. From 2021 to June 2024, the government approved 89 digital economy projects, amounting to RM131 billion, with many focusing on data centres [12]. These projects are driven by the growing demand for technological services such as social media, cloud computing, e-commerce, and AI. Malaysia's strategic location, affordable land, low-cost utilities, and government incentives make it an attractive destination for these

large-scale data centres, promising significant economic benefits and job creation.

However, the environmental consequences of these data centres are significant. They consume large amounts of electricity, with Tenaga Nasional Berhad (TNB) estimating that electricity demand from these centres could reach over 5,000 megawatts by 2035 exceeding 40% of Peninsular Malaysia's current power capacity. This could strain the national power grid, especially as Malaysia's energy supply is largely fossil-fuel-based, with renewable energy accounting for only 22% of the grid by 2050. Additionally, data centres require vast amounts of water, with a 100 MW centre using about 4.16 million litres daily—equivalent to the water usage of a city of 10,000 people. This could worsen Malaysia's already looming water shortages, which may escalate in the next five years due to climate change and ageing infrastructure [13][14].

Classification of AI misuse

Stakeholder Ecosystem

The stakeholder ecosystem in Malaysia consists of public agencies, private sector entities, and academia, each playing a vital role in AI development. Public agencies lead in providing guidance and regulatory frameworks for AI advancements. This list of key stakeholders is non-exhaustive.

Regulators / Government Sector

Organisations responsible for regulating AI and establishing policy to promote AI development

- **Ministry of Science, Technology and Innovation (MOSTI):** Published AI Guidelines and the AI Roadmap 2021 - 2025, leading national AI adoption [1]
- **National Digital Economy and 4IR Council (Prime Minister's Office)**: leads the governance structure to drive and ensure effective implementation of 4IR initiatives, including those related to AI and climate action
- **Ministry of Digital**: collaborating with Google Cloud on the "AI at Work" initiative to integrate AI into public officers' workflows
- **The National AI Office (NAIO)**: recently launched to spearhead AI initiatives in the country, including those related to climate action6
- **Malaysian Digital Economy Corporation (MDEC):** MDEC has partnered with Alibaba to implement the City Brain program in Kuala Lumpur, using AI for urban planning and development.
- **Ministry Of Natural Resources And Environmental Sustainability:** Develops national environmental policies, oversees sustainability initiatives and manages natural resources
- **Ministry of Higher Education:** Drives AI-related education and talent development through academic partnerships

▶ Malaysia's AI policy and governance is continuously improving, emphasising innovation, talent development, strategic public-private collaborations and ethical use through its Roadmap and Guidelines. [1] [15]

Larger Private Sector Players

Large-scale technology businesses investing in digital and climate transformation

- **Microsoft**: Planned to invest US$2.2 billion for cloud and AI-led digital transformation to develop AI infrastructure and foster innovation in climate solutions
- **Google**: Investment of US$3 billion will boost AI capabilities and support climate-related data processing and analysis
- **YTL Group**: Developed the YTL Green Data Centre Park in Johor, the first in Malaysia to be powered by renewable solar energy, a step in creating energy-efficient AI infrastructure
- **Tenaga Nasional Berhad (TNB)**: deploys AI across its energy ecosystem to optimise grid management, enhance predictive maintenance, and accelerate its transition to renewable energy.

▶ Multinational corporations (MNCs) such as Microsoft have made significant investments in Malaysia, helping to build AI infrastructure and develop AI-related skills. [16]

Smaller Private Sector Players

Smaller-scale domestic businesses that develop or deploy AI applications

- **Fairatmos**: uses AI-powered satellite imaging, data analysis, and rapid project assessment technologies to help communities and businesses identify, verify, and monetise carbon offset opportunities across Southeast Asian forests
- **Mobiva**: provides real-time hazard maps and emergency measures using crowd-sourced mobile data, which is critical for building climate resilience and community response
- **CarbonGPT:** developed an AI-driven, cloud-based carbon management platform that simplifies sustainability reporting for businesses by reduces operational costs.
- **Centre for Advanced Data Science (CADS)**: A notable organisation with potential climate technology applications collaborated with the Penang Skills Development Centre (PSDC) to develop the first AI Workforce Analytics platform.

▶ Smaller private start-ups or companies have also helped in provision and implementation of AI solutions in different sectors. [15][17]

Civil Society / Academia

Organisations that support AI growth through innovation, R&D and knowledge sharing efforts

- **Universiti Teknologi Malaysia (UTM)**
  - **Faculty of AI**: Developing cutting-edge research in technological solutions for environmental challenges
  - **Centre for AI and Robotics (CAIRO)**: Potentially developing AI applications for climate modeling and adaptation strategies
  - **Big Data Centre (BDC)**: Likely contributing to climate data processing and analysis
- **Malaysia Centre for the Fourth Industrial Revolution (Centre4IR)**: Initiated ESG Innovation Challenge and focuses on the energy transition and digital transformation as its main workstreams.

▶ Academia also plays a crucial role in cultivating a skilled AI workforce, with institutions like UTM leading the way as the host of Malaysia's first AI faculty [18]

Enabling Pillars

a) Responsible Governance

Malaysia introduced the National Guidelines on Artificial Intelligence Governance and Ethics (AIGE) to establish a framework ensuring ethical standards in AI development and adoption. The guidelines serve as a voluntary reference for stakeholders, including AI users, policymakers, and technology providers, aiming to promote the responsible use of AI in line with Malaysian values and the principles of Rukun Negara. The framework is designed to educate stakeholders on AI ethics and encourage adherence to the Seven Key Principles of AI, which include fairness, reliability, safety, privacy, inclusiveness, transparency, accountability, and human benefit[8]. While the AIGE are not legally binding, it aligns with Malaysia's ongoing efforts to strengthen its technology laws, such as the 2024 Cyber Security Act and the amendments to the Personal Data Protection Act 2010. The AIGE are expected to influence future AI-related legislation, shaping the governance of AI in Malaysia as the technology evolves [19].

The Malaysian Communications and Multimedia Commission (MCMC) also introduced a new regulatory framework for internet messaging and social media service providers, gazetted in August 2024. This framework requires platforms with at least eight million users in Malaysia to obtain an Applications Service Providers Class (ASP(C)) License. One of the key provisions of the framework is for content moderation, such that service providers must enforce strict content moderation policies to prevent misleading ads, harmful content, and scams. They must also manage risks from misinformation and harmful AI-generated content, such as deep fakes, and be transparent about their content policies and advertising practices.

Key challenges or gaps:

- While the introduction of the AIGE is a good start to promote safe, trustworthy and ethical AI, it is not legally binding so the uptake of its principles may be limited.
- The new regulatory framework by MCMC was objected by leading technology and internet firms,. Which are pushing back against the Malaysian government's proposed licensing regime under the new regulatory framework.

b) Scaling and Computing

Malaysia is rapidly scaling up its investment in AI, particularly as part of its broader push towards digitalisation and automation, aligned with its New Industrial Master Plan 2030 (NIMP 2030). Malaysia has made AI a cornerstone of its industrial and digital transformation strategies. For example, the Malaysia Digital Economy Corporation (MDEC) aims to attract RM1 billion in digital investments and generate 49,000 new jobs across various sectors by 2025 [20].

Major technology companies are making substantial investments to enhance Malaysia's AI and cloud infrastructure. Oracle has committed over $6.5 billion to establish a public cloud region in the country, which will offer access to a range of infrastructure and SaaS services. Additionally, Microsoft has pledged a $2.2 billion investment to build cloud and AI infrastructure, which includes the creation of a national AI Centre of Excellence, enhancements in cybersecurity, and AI training programs for 200,000 people. Furthermore, NVIDIA is collaborating with local companies to improve Malaysia's AI infrastructure, with plans for solar-powered supercomputers and the development of large language models in Bahasa Melayu [21].

Key challenges or gaps:

- While Malaysia is making significant strides in scaling up its AI and computing infrastructure, there remains a notable gap in the large-scale application of AI across various sectors for climate change mitigation and adaptation.

c) Talent and Skills

The Nationwide AI-Roadmap 2021 survey highlights that Malaysia primarily sources its AI talent through upskilling current employees, fostering industry-university partnerships, and utilising job advertisements. As AI continues to evolve, the key skillsets in demand include data science, AI engineering, and AI business strategy.

To address these needs, the National AI Roadmap 2021-2025 outlines a three-pronged approach: offering comprehensive and inclusive AI education, reskilling and upskilling the existing workforce, and attracting and retaining top AI talent. This strategy aims to build a robust AI talent pool to support Malaysia's digital transformation [22].

Key challenges or gaps:

- Malaysia is experiencing a significant brain drain, with 1.86 million Malaysians working abroad in 2022, predominantly in Singapore, where many occupy high-skill positions and show little intention to return. The migration is driven by higher wages in Singapore and is compounded by Malaysia's wage disparities [23].

Vietnam

Vietnam

Overview of Landscape

Vietnam's AI ecosystem has seen remarkable growth, with significant investments and initiatives driving its progress. Following the $800 million funding pledge at the Vietnam Venture Summit 2020, the country has continued to attract attention from global investors, particularly for AI startups. Government efforts, such as the National AI Strategy and partnerships like Google's "Build for the AI Future" initiative, aim to develop over 7,000 experts and 500 startups through various funding and capacity building initiatives [1].

In 2020, Vietnam launched a national strategy on research, development, and application of AI towards 2030, aiming to make the country a regional hub for AI innovation. The strategy targets placing it among the top four ASEAN countries in AI and the top 50 globally. By 2023, Vietnam had attracted over $1 billion in related investments [2].


Ho Chi Minh City, Vietnam source: ARUP

Climate Change in Vietnam

Vietnam is highly vulnerable to climate change due to its long coastline, reliance on agriculture, and densely populated deltas. Vietnam's low-lying coastal and river delta regions have very high vulnerability to rising sea-levels. It is estimated that up to 9 million people will be affected by fluvial flooding by 2040 and up to 12 million people will potentially be affected by coastal flooding by 2070–2100 without effective adaptation action [3].

Rising sea levels threaten to submerge up to 40% of the Mekong Delta by 2100, causing widespread displacement and decrease in agricultural productivity, while coastal erosion endangers infrastructure and ecosystems. Together, these changes endanger livelihoods, exacerbate rural poverty, and strain Vietnam's economy, public health, and ecosystems, affecting approximately 55% of the local population [4].

AI Application for Climate Action

Mitigation

Transport

Vietnam's transport industry is set for transformation through the collaboration of FPT, Yamaha Motor, and Ecopark, aiming to develop autonomous electric vehicles powered by AI and LiDAR technologies [5].

FPT will provide advanced self-driving software, Yamaha will offer technical and vehicle support, and Ecopark will supply logistics and infrastructure. These vehicles will feature capabilities such as autonomous route navigation, obstacle detection, auto-parking, and mobile app-based bookings, which will support long-term sustainable urban planning. This partnership aligns with Vietnam's vision of adopting smart, eco-friendly public transportation and advancing autonomous vehicle technology to improve urban mobility and living standards.

Agriculture Forestry and other Land Use (AFOLU)

In Vietnam, AI-driven remote sensing techniques are revolutionising forest cover monitoring. Researchers have developed a neural network-based method that segments satellite images captured over different periods, achieving a high detection accuracy of 95.4% — surpassing traditional methods. This automated and precise approach minimises reliance on domain-specific knowledge, making it highly effective for detecting changes, particularly in coastal forests. The system aids in sustainable land use, conservation, and forest ecosystem management [6].

Adaptation

Urban Resilience

Hybrid AI techniques has been proven to improve flood risk assessment and provide a valuable framework for enhancing urban


Ninh Binh, Vietnam

flood resilience in a typical urban neighbourhood in Vietnam. By integrating flood susceptibility, derived from factors like topography and hydrology, with flood consequences, including human health and financial impacts, this approach offers a comprehensive understanding of flood risks. For urban neighbourhoods, such as those in Quang Nam province, the highly accurate flood risk maps can guide targeted infrastructure planning, emergency response strategies, and sustainable urban design. This ensures that urban floors—critical spaces for residential, commercial, and social activities—are better protected against flooding, thereby enhancing the overall resilience and safety of urban communities in Vietnam [7].

Forest & Biodiversity

A recent research study introduced a hybrid AI approach, Particle Swarm Optimized Neural Fuzzy (PSO-NF), to model forest fire susceptibility in Lam Dong province, Vietnam. The model combines a Neural Fuzzy inference system (for fire prediction) with Particle Swarm Optimisation (to optimise model parameters). The PSO-NF model is a superior tool for identifying fire-prone areas and supports forest fire management and planning in tropical regions. By integrating AI solutions like the PSO-NF model, Vietnam can enhance its preparedness for forest fires, mitigate environmental damage, and safeguard ecosystems in the face of changing climatic conditions [8][9].


Ninh Binh Province, Vietnam

Risk and Challenges

Data Privacy
AI applications in climate action often require extensive data collection, which raises privacy and surveillance concerns, particularly in Vietnam where data privacy laws are still developing. AI systems designed to monitor energy consumption, transportation, or environmental conditions could collect personal data without adequate safeguards, leading to potential misuse for surveillance or the targeting of individuals or communities. These data, if mishandled, could be misused in sophisticated AI-powered scams which are increasingly prevalent in Southeast Asia [10].

Classification of AI misuse

Labour Displacement
As AI becomes more integrated into industries, some low-skilled jobs, especially in sectors like agriculture, manufacturing, or resource management, could be displaced by AI-driven automation [11]. This displacement is likely to hit rural and economically disadvantaged workers the hardest. Vietnam is one of the world's largest exporters of coffee, produced mainly in the Central Highlands. If AI technologies are introduced to automate agricultural processes, such as AI-guided machinery or automated sorting and packaging systems, this could lead to job losses for low-wage workers in the region. Without proper reskilling programs, these workers may struggle to find new employment, exacerbating income inequality.

Classification of AI misuse

Digital Divide
Vietnam's rural areas, particularly those in the Mekong Delta and Central Highlands, face challenges in accessing technological infrastructure, including AI-based climate solutions. Urban areas such as Ho Chi Minh City have more advanced AI capabilities due to better infrastructure, which could deepen inequality between these regions [12]. In the Mekong Delta, smallholder farmers struggle to access the predictive AI models that could help manage saltwater intrusion, while wealthier farmers and corporations have better access to these resources.

Classification of AI misuse

Lack of Local Nuance
Vietnam's diverse ecosystems, including the Mekong Delta and extensive coastlines, present unique environmental conditions. Research has shown that there is an overreliance on historical datasets [13]. AI models that were not trained with or sensitive towards these contextual data may yield inaccurate predictions or ineffective solutions [14]. Furthermore, local cultural, socio-economic dynamics and ethical issues (e.g. privacy, surveillance, bias, etc.) might also be overlooked in climate AI models [15], hence posing the potential risk of proposing strategies that are culturally insensitive or impractical in the Vietnamese context.

Classification of AI misuse

Accuracy of Data Models
The accuracy of AI-enabled climate models is critical, as poorly trained or generalised systems can lead to inaccurate weather forecasts, flood risk assessments, or resource management strategies, potentially resulting in loss of life and economic harm [16]. For example, an incorrect flood prediction in the Mekong Delta could delay evacuations or misallocate disaster response resources, exacerbating the impacts of natural disasters. Additionally, while AI tools like drones and satellite imagery are invaluable for environmental monitoring—such as tracking deforestation or pollution—they also raise concerns about surveillance overreach. If these technologies are not accurately calibrated or ethically deployed, they might misinterpret data or infringe on civil liberties by inadvertently surveilling local communities without consent. This highlights the dual imperative to enhance the precision of AI models while ensuring they are deployed responsibly and transparently.

Classification of AI misuse

Stakeholder Ecosystem

The following is a stakeholder ecosystem of key organisations driving AI for climate action through various functions, such as regulation, policy, implementation, investment, research, and innovation. Each organisation contributes a unique role, together forming a holistic ecosystem that fosters progress in leveraging AI for climate action. This list of key stakeholders is non-exhaustive.

Regulators / Government Sector

Organisations responsible for regulating AI and establishing policy to promote AI development and implementing national strategy until 2030

- **Ministry of Information and Communications:** play a critical role in implementing the National Digital Transformation Program, which includes AI applications
- **Ministry of Planning and Investment (National Innovation Centre)**: partnered with Google to offer AI-focused programs and scholarships, focusing on capacity building and upskilling [17].
- **Ministry of Natural Resources and Environment:** Central government body responsible for managing Vietnam's natural resources and environment, including climate change.
- **Synergistic Initiatives**: The Digital Transformation Agenda (DTA) aims to leverage digital technologies, including AI, to drive economic growth and promote social development, across governmental agencies [18].

▶ Vietnam takes a holistic approach to AI. The Ministry of Science and Technology (MOST) leads the implementation of Vietnam's AI Strategy, while other ministries, agencies, and local governments are tasked with integrating the Strategy into their functions and laws [19].

Larger Private Sector Players

Large-scale technology businesses investing in digital and climate transformation

- **Nvidia**: Partnered with the Vietnamese government to establish AI research and development centres and AI data centres in Vietnam [20]
- **Google**: Developed the AI-enabled flood-forecasting platform, Flood Hub, which helps forecast extreme flooding occurrences and mitigate flood risks.
- **Amazon Web Services**: Regularly organises events that promote cloud technology adoption and its potential for driving innovation in various sectors, including climate action [21]
- **FPT Corporation**: Collaborated with Nvidia, focusing on generative AI and green transformation for sustainability, and climate action [22].

▶ Vietnam's long term AI strategy has attracted a number of large private corporations, including Nvidia and Google. Google launched a partnership with NIC in upskilling and capacity building, while also considering the construction of a large hyperscale data centre [20][21][23][24].

Smaller Private Sector Players

Smaller-scale domestic businesses that develop or deploy AI applications

- **BusMap**: Collaborated with VinBus to quantify carbon emissions from electric buses, converting travel distance into carbon savings [25].
- **AIMVIE (AI Solutions for Mangrove Blue Carbon)**: Uses AI and satellite imaging to monitor mangrove forests and their carbon sequestration capabilities. The startup aims to help people adapt to global climate change by developing advanced monitoring technologies for forest ecosystems [26].
- **Solano**: Founded by Vietnamese Oxford and Cambridge engineers, focusing on developing affordable renewable energy hardware; creating a marketplace platform for energy trading; making renewable energy more accessible to residential markets [27].

▶ Vietnamese smaller-scale businesses are increasingly adopting AI to enhance efficiency and competitiveness; with retailers using AI for inventory management and personalized customer service. These firms exemplify the diverse ways domestic businesses are utilising AI to drive innovation across sectors [23][28].

Civil Society / Academia

Organisations that support AI growth through innovation, R&D and knowledge sharing efforts

- **The International Research Center for Artificial Intelligence (Hanoi University of Science and Technology)**: key stakeholder driving AI research and development in Vietnam, including applications for climate action [29].
- **International Rice Research Institute (IRRI)**: developed climate-resilient rice varieties with AI to help local farmers [30]
- **Synergistic Initiatives**: Vietnam Software & IT Services Association (VINASA) established an Ethical AI Committee, with FPT, a global leading technology corporation, participating as a founding member [31].

▶ Civil society and academia drive Vietnam's AI strategy by developing skilled talent, advancing research, and fostering innovation tailored to local needs. They ensure ethical AI practices advocate for policies that balance technological progress with societal well-being. By raising public awareness and promoting AI adoption in critical sectors, they help position Vietnam as a leading AI nation by 2030 [32].

Enabling Pillars

Developing and deploying safe, responsible and inclusive AI in the Vietnam requires a supportive environment consisting of key enablers below.

a) Responsible Governance

Investments in AI should prioritise the development of systems that enhance public service delivery and governance efficiency, such as AI-powered tools for monitoring environmental data or managing urban planning in flood-prone areas. Key investments include AI platforms for real-time environmental monitoring, disaster response systems, and transparent decision-making tools that integrate climate metrics, ensuring they support sustainable development and resilience against climate change.

Key Challenges:

- Limited AI governance frameworks: Vietnam lacks comprehensive policies and regulations for AI, particularly for its ethical use in governance and public service delivery [33]. Without clear frameworks, AI deployments risk being unregulated, potentially leading to misuse, bias, or inefficiencies.

b) Talent and Skills

Private sector funding on responsible AI in Vietnam is present but still lacking, focusing on applications in climate resilience and sustainability [34]. Technical skill development initiatives must include diverse groups, such as women and people with disabilities [35], through scholarships and training programs. These efforts can nurture talent for creating AI solutions like predictive climate models or renewable energy optimisation systems, driving inclusive growth and climate action.

Key Challenges:

- Talent gap: The AI talent pool in Vietnam remains limited, particularly in specialised areas like climate-focused AI applications or responsible AI practices. This talent gap constrains innovation and slows progress in developing AI solutions tailored to local environmental and societal challenges, such as predictive models for flooding or renewable energy optimisation systems.

c) Data

Investments should target the creation of locally relevant datasets, including climate and disaster-related data, to support AI innovations. Mobile and IoT technologies could generate granular, real-time environmental datasets for AI training while ensuring privacy and equity. Addressing gaps in local-language and public datasets can unlock and enable inclusive AI solutions [34], such as early warning systems for climate risks or localised sustainability tools for agriculture and urban planning.

Key Challenges:

- Lack of Data: The absence of high-quality, localised datasets hinders the ability to train AI models that are accurate and contextually applicable to Vietnam. This is particularly critical for climate-related data, where the lack of granular, real-time, or historical datasets limits the effectiveness of AI in addressing issues like deforestation monitoring, agricultural planning, or disaster risk management [36].

d) Computing

Public-private partnerships should focus on democratising access to computing infrastructure, making AI innovation more affordable and sustainable for researchers in Vietnam. Green data centres and cloud services powered by renewable energy can reduce the carbon footprint of AI research while enabling projects that tackle climate challenges, such as AI-driven deforestation monitoring or emissions tracking systems.

Key Challenges:

- High cost & entry barrier: Computing infrastructure for AI research, remains prohibitively expensive and concentrated in a few urban centres [37]. This disproportionately affects smaller-scale innovators and researchers, limiting their ability to develop impactful AI solutions for climate action, such as carbon emission tracking or renewable energy grid optimisation.

e) Innovation

Investments in frontier AI research should prioritise solutions with strong potential for climate action, such as generative AI for energy-efficient urban designs or predictive AI for optimising renewable energy grids. Funding mechanisms can also support local innovators in testing AI applications like carbon sequestration modelling or precision farming technologies, aligning innovation with Vietnam's climate goals and the broader Sustainable Development Goals (SDGs).

Key Challenges:

- Limited funding for cutting edge research: Innovators in Vietnam often face challenges in securing funding for projects that tackle complex, long-term problems like climate change. The lack of risk-tolerant capital discourages experimentation and stifles the development of groundbreaking AI applications, such as AI-driven climate adaptation strategies or energy-efficient urban planning tools [37] [38].

e) Scaling

To scale AI innovations, investments should crowd in commercial capital and technical expertise, focusing on climate resilience solutions at scale, such as scalable solar energy forecasting systems or AI-driven water resource management tools. Establishing regional AI innovation hubs can attract investors while ensuring that impactful solutions are deployed widely to address Vietnam’s development and climate challenges effectively [38].

Key Challenge:

- Lack of Capital Investment: Many promising AI solutions for climate action fail to secure sufficient investment to scale beyond pilot phases. This challenge is compounded by a lack of visibility for such projects, insufficient alignment with investors' priorities, and limited infrastructure to support large-scale implementation, especially in rural or underserved areas [37].

Myanmar

Myanmar

Overview of Landscape

While Myanmar's digital landscape is expanding rapidly with increasing interest in AI technologies, the regulatory framework remains underdeveloped and lacks specific legislation governing AI. As of 2023, Myanmar ranks low in government AI readiness compared to its regional peers, scoring a low of 30.91 out of 100 for the Government AI Readiness Index 2023 [1].

As of February 2025, the Minister for Science and Technology announced that a draft National AI Strategy and Policy is under development to help integrate AI into the country's sectors. The policy also aims to raise awareness about ethics and regulations to follow to ensure responsible AI deployment [2].

Myanmar sees an increasing focus on IT security and risk management. The country is facing a rise in cyber-related fraud, necessitating more robust cybersecurity measures and legal enforcement.


Shwedagon Pagoda, Myanmar | Source

Climate Change in Myanmar

Natural disasters exacerbated by climate change are estimated to cost Myanmar up to 3% of its annual GDP [3]. Myanmar was ranked the second most vulnerable country globally to extreme weather events according to the 2021 Global Climate Risk Index. Myanmar has set ambitious targets to reduce greenhouse gas emissions by 29% unconditionally and up to 49% conditionally by 2030 compared to business-as-usual scenarios [4]. Largest emitters are its agriculture, energy and transport sectors.

The Myanmar Climate Change Strategy (2018-2030) outlines the government's commitment to integrating technology into climate action plans, emphasizing the need for innovative solutions like AI to achieve sustainability goals.

AI Application for Climate Action

Mitigation

Electricity

Myanmar is actively expanding its renewable energy technologies to address its energy needs and combat climate change.

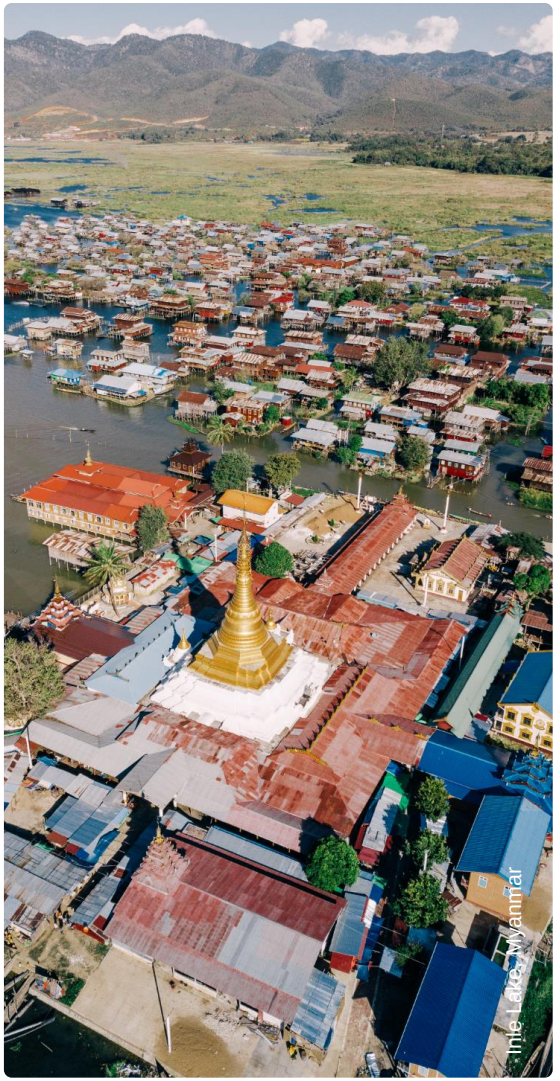
- Omdena, a global collaborative platform on ethical AI, called for a local challenge titled “AI-Driven Micro-Grid Optimisation for Rural Electrification in Myanmar”, aiming to pilot the use of AI to improve access to electricity in rural Myanmar through creating an optimization algorithm for real-time energy distribution and storage management [5].
- Sigenergy Commercial & Industrial Energy Storage Solution leverages AI, specifically intelligent control algorithms, to manage solar energy for a poultry farm in Myanmar, successfully storing energy and managing shortfalls in solar power generation [6].

Adaptation

Food and Agriculture

Agriculture, including forestry and fishing, accounted for approximately 20.43% of Myanmar's GDP in 2023 [7]. Innovative AI applications in agriculture include:

- Rice yield predictions: SERVIR, a USAID and NASA initiative, has implemented AI-powered models to guide decision-makers in Myanmar, offering granular, high-resolution insights into rice productivity [8]. This enables timely interventions, better resource allocation and sustainable farming practices, ultimately improving resilience against climate-induced disruptions.



Urban Resilience

AI technologies are being utilized for disaster risk reduction and management.

- Flooding: During the 2021 floods in Myanmar, the AI platform FloodAI was employed to process satellite images, significantly improving the speed and accuracy of flood assessments compared to traditional methods [9].
- Waste: Startups like RecyGlo are utilising technology to improve waste collection processes. They plan to integrate AI and machine learning to optimise waste collection routes, thus increasing efficiency and reducing emissions associated with waste transport.


Shwedagon Pagoda, Myanmar, source

Stakeholder System

Below is a stakeholder ecosystem of key organisations advancing AI for climate action across various roles, including regulation, policy, implementation, investment, research, and innovation. Each organisation plays a critical role, collectively forming a comprehensive ecosystem that drives progress in the application of AI for climate action. This list of key stakeholders is non-exhaustive.

Regulators / Government Sector

Organisations responsible for regulating AI and establishing policy to promote responsible AI development

- **Ministry of Science and Technology:** Leads the drafting of Myanmar's National AI Strategy and Policy, focusing on ethical guidelines
- **Ministry of Natural Resources and Environmental Conservation (MoNREC):** Oversees the Myanmar Climate Change Strategy (2018–2030)
- **Environmental Conservation Department (ECD):** Implements climate policies under MoNREC, leveraging AI for environmental monitoring and mainstreaming climate action into national planning
- **Myanmar Climate Change Alliance (MCCA):** Leads initiatives (under MoNREC/ECD) that integrate AI into climate policy frameworks, promoting data-driven solutions for resilience and emissions reduction, funded by the EU

▶ Myanmar's regulatory landscape for AI in climate action remains nascent [2]. There is no dedicated AI policy in place yet, and targeted implementation of AI for climate action relies on ad-hoc projects.

Larger Private Sector Players

Large-scale technology businesses investing in Myanmar's digital transformation

- **Global Technology Co., Ltd:** A leading Myanmar-based tech innovator integrating AI into telecom and digital services
- **Huawei:** A major player in Myanmar's telecom infrastructure, deploying 5G and cloud services, and collaborating with local providers like MPT for network upgrades
- **Ooredoo:** Invests in Myanmar's telecom sector, expanding 4G/5G coverage and digital services
- **YCP Group:** Consultancy partnering with Myanmar businesses, offering tailored solutions in AI, automation and ML

▶ Myanmar's private sector landscape for AI characterised by a mix of local and some international players, but lack a specific climate focus, with most digital solutions centred around digital infrastructure development [20].

Smaller Private Sector Players

Smaller-scale domestic businesses that deploy AI applications in climate action across Myanmar

- **RecyGlo:** Uses AI-powered route optimization for waste collection and recycling operations
- **Omdena Myanmar:** Developed an AI-driven microgrid optimiser for rural renewable energy systems
- **Expa.ai:** Provides AI-driven CRM and analytics tools to help businesses optimise supply chains, which can also reduce operational footprints

▶ Myanmar's startup ecosystem is rising slowly but steadily in tech areas such as fin-tech and e-commerce, however tech applications to climate action is still limited [21].

Civil Society / Academia

Organisations that support AI growth through innovation, R&D and knowledge sharing efforts

- **UN Habitat Myanmar:** Leads the Myanmar Climate Change Alliance (MCCA), developed the Myanmar Climate Change Policy alongside government [22]
- **Myanmar Climate Action Network (M-CAN):** Network of climate actors in Myanmar who have committed to advancing climate action
- **Food and Agricultural Organisation (FAO):** Long history of cooperation in Myanmar's agricultural sector, supporting the deployment of AI tools for climate-smart agriculture [23]
- **SERVIR Southeast Asia:** Develops AI-powered geospatial tools to help Myanmar and Mekong region governments make climate-resilient decisions
- **Parami University:** Has a focus on enhancing AI capabilities through implementing training courses on AI literacy

▶ Myanmar's AI-driven climate initiatives rely heavily on multilateral partnerships and civil society organisations, which provide critical technical expertise, funding, and platforms for collaboration

Enabling Pillars

A supportive environment is critical to support the development and deployment of safe, responsible and inclusive AI in Myanmar. This environment is characterized by key enablers below.

a) Responsible Governance

The Myanmar government has no national plan nor strategy and is beginning to establish a legal framework for AI governance, which aligns with its broader digital policies [10].

Key challenges and gaps:

- Capacity building: Local government capacity needs strengthening to effectively create and enforce regulations for responsible AI usage.
- Limited regulatory frameworks: Current legislation does not comprehensively address AI-specific issues, leading to uncertainty in AI governance [11].
- Gender inequalities: Ranked 123rd in the 2023 Global Gender Gap Report and the worst in Southeast Asia, Myanmar's gender inequality poses significant challenges for AI development, underscoring the urgent need for policymaking to address this issue and ensure equitable AI development [12].

b) Talent and Skills

There are growing efforts underway to enhance digital literacy in the nation. Educational institutions are increasingly integrating AI into their curricula to prepare a skilled workforce capable of leveraging AI technologies [13]. At Parami University in Myanmar, the Padauk Classroom project is being implemented to enhance AI capabilities amongst students, educators and community-based organisations. It involves a 10-week training on digital literacy and AI usage [14].

Key challenges and gaps:

- Low digital literacy: A significant portion of the population lacks basic digital skills, hindering the effective adoption of AI technologies. Over 12 million learners have been affected by interruptions to education due to instability, which hampers the development of a skilled workforce necessary for advancing AI initiatives [15].

c) Data

Myanmar's National Environmental Policy emphasizes the importance of data integration for climate resilience. Initiatives are being developed to improve access to climate-related data for better decision-making.

Key challenges and gaps:

- Data protection: There is currently no comprehensive law on personal data protection, which raises concerns about privacy and security.
- Impact of conflict on data: Ongoing conflicts in Myanmar have severely disrupted data collection efforts, leading to significant gaps in information. The displacement of communities complicates the ability to gather accurate data.
- Data quality: Myanmar's historical climate data is often incomplete or inconsistent, which hampers the ability to analyse trends and make informed decisions regarding climate action (e.g. temperature, rainfall patterns) [11].
- Hyper-localised data gap: The absence of detailed, localized information means that policymakers and stakeholders may not fully grasp how climate change affects specific regions or communities differently.

Computing

Myanmar's computing infrastructure is still developing, which is crucial for processing large datasets necessary for AI applications.

Key Challenges and Gaps:

- Underdeveloped infrastructure: Myanmar has limited computing infrastructure which limits the ability to run complex AI algorithms [16].
- Connectivity issues: As of early 2023, only 44% of the population had internet access, impacting the deployment of cloud-based AI systems [17].

e) Innovation

Myanmar's AI innovation landscape is in its formative stages, with various initiatives aimed at fostering R&D. Currently, innovation related to climate action remains limited [18].

Key challenges and gaps:

- Limited domestic capacity: Myanmar's R&D capabilities in AI are still developing, leading to a reliance on foreign technology providers. This dependence can hinder the localisation of solutions tailored to Myanmar's local context.
- Need for collaborations: Enhanced collaboration among government, academia, and the private sector is crucial to foster a robust ecosystem.

• f) Scaling

There are several promising pilot AI projects in Myanmar aimed at enhancing climate resilience and other sectors, which aim to expand country-wide.

Key challenges and gaps:

- Financing: Scaling AI initiatives can be costly and difficult to finance. The need for substantial investment is compounded by the political instability that makes funding difficult to secure [19].

Cambodia

Cambodia

Overview of Landscape

Cambodia's development and adoption of AI-driven technologies remain at an early stage. The country lacks a national AI strategy, specific laws and regulations, and a central coordinating body to harness AI's potential and address its risks. In the Government AI Readiness Index 2023, Cambodia ranks poorly, reflecting low preparedness across three key areas: strategic vision for AI governance, the technology sector, and data and infrastructure.

Efforts to improve AI readiness include plans to develop a code to regulate AI use among citizens and businesses. Additionally, Cambodia has launched an Ethics of AI Readiness Assessment to guide the creation of a National Strategy for AI. Key policies shaping Cambodia's digital ecosystem include:

- Cambodia Digital Economy and Society Policy Framework 2021–2035: Aims to establish a strong and resilient digital ecosystem that adapts to technological advancements and responds effectively to crises.
- Cambodia Digital Government Policy 2022–2035: Seeks to improve citizens' quality of life and build trust through enhanced public services, supported by national coordination and implementation mechanisms.

Pnom Penh, Cambodia source: ARUP

Climate Change in Cambodia

Approximately 15% of Cambodia's population and 16% of its agricultural land are at risk of flooding [1]. By 2050, climate change could reduce the country's GDP by an estimated 3-9.4% [2]. The Land Use, Land-Use Change, and Forestry (FOLU) sector is the largest contributor to greenhouse gas (GHG) emissions, followed by agriculture.
Cambodia acknowledges the potential of AI to support its climate change goals. The country has highlighted the use of digital technologies in its NDCs and explicitly recognizes AI as a tool to address climate challenges (UNFCCC).

AI Application for Climate Action

Below is a non-exhaustive overview of key climate areas where AI is most applied, highlighting the types of innovations and technologies deployed to achieve positive climate impact.

Mitigation

Agriculture Forestry and other Land Use (AFOLU)

Deforestation in Cambodia is driven by activities such as legal and illegal logging, charcoal production, mining, and economic land concessions for commodity crop plantations.

Key AI initiatives addressing these issues include:

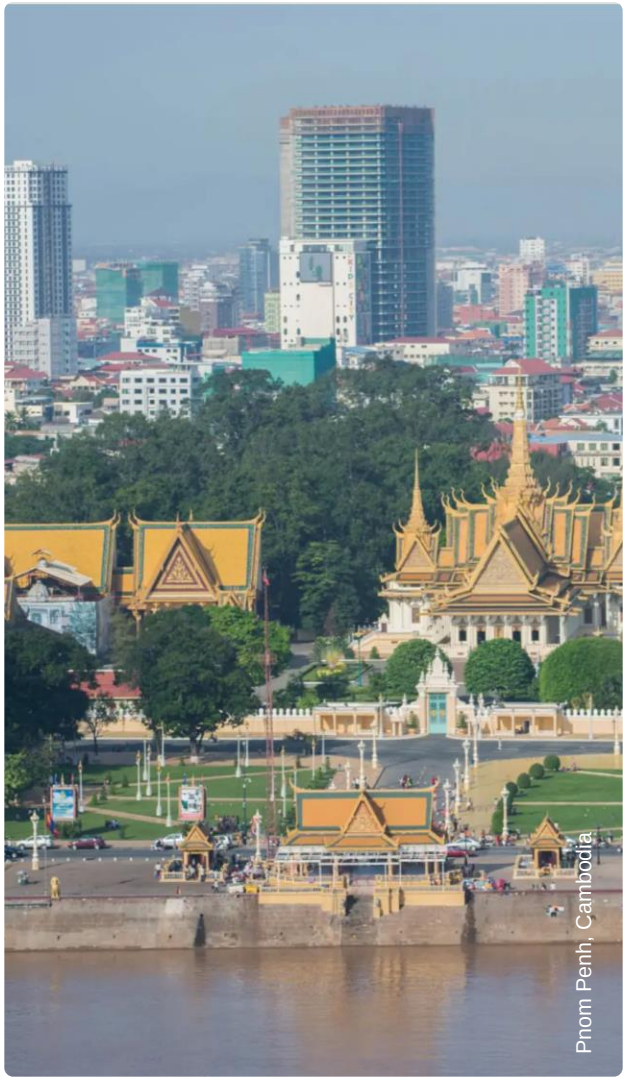
- SERVIR-Mekong Initiative: A collaboration between USAID and NASA, this project developed the Cambodia Protected Area Alerts System, which monitors real-time forest changes and external threats such as forest fires in the Prey Lang Extended Landscape through the use of AI and geospatial technology.
- Protected Area Monitoring Platform: Launched by Cambodia's Ministry of Environment, this platform integrates ground-based and remote-sensing data to improve conservation law enforcement.

Adaptation

Food and Agriculture

Agriculture and fisheries account for 22% of Cambodia's GDP and employ nearly 49% of its labour force. 65% of Cambodians depend on these sectors for their livelihoods. Innovative AI applications in agriculture include:

- ADB Cambodia Climate Resilient Rice Commercialisation Sector Development Program: As part of this project, AI and remote sensing technologies were used to estimate crop yields at individual plot levels, to help farmers inform decisions about planting and resource allocations. 16,000 beneficiaries in the project area were made aware of crop yield gaps, especially for female-headed households [3]. This innovative approach was taught to ministry staff and experts by ADB to understand how to apply AI for agriculture development projects.


Pnom Penh, Cambodia

- ChivCheat: In 2024, Cambodia is the second-largest producer of cashew nuts globally, generating revenue of US$1.15 billion according to the Cashew Nuts Association of Cambodia [4]. To enable smallholder cashew farmers to make more informed decisions that can improve productivity, a tech startup created a user-friendly AI-powered chatbot accessible via Telegram, a widely used messaging app in Cambodia. Farmers can interact with the tool in Khmer using images, voice messages, or text, enabling disease detection, increased crop yields, and improved financial returns. The chatbot, powered by Google's Gemini API, offers research-based recommendations tailored to farmers' needs [5].

Water

Water and wastewater management in Cambodia remains inefficient. There are innovative approaches being introduced in Cambodia to combat this challenge.

- Sagera program: This program aims to improve water management in the Angkor region of Cambodia. It involves installing a network of sensors over a 400 km² area and developing a decision support system using AI [6]. The program addresses water-related challenges such as flood control, recharging water tables, improving access to water for neighboring populations. This project is expected to bring impact to approximately one million inhabitants in the surrounding areas [6].

Stakeholder System

Below is a stakeholder ecosystem of key organisations advancing AI for climate action across various roles, including regulation, policy, implementation, investment, research, and innovation. Each organisation plays a critical role, collectively forming a comprehensive ecosystem that drives progress in the application of AI for climate action. This list of key stakeholders is non-exhaustive.

Regulators / Government Sector

Organisations responsible for regulating AI and establishing policy to promote responsible AI development

- **Ministry of Post and Telecommunications (MPTC):** Spearheads national AI governance, developing frameworks for ethical AI adoption and digital economy growth [17]
- **Ministry of Industry, Science, Technology, and Innovation (MISTI):** Developing Cambodia's National AI Strategy [18], focusing on economic growth, digital infrastructure, and ethical AI governance
- **Ministry of Environment:** Leads Cambodia's climate change strategies and supports AI-powered tools for sustainability
- **National Council for Sustainable Development (NCSD):** Oversees climate policy integration, including planning under Cambodia's Long-Term Strategy for Carbon Neutrality (2050)

▶ Cambodia's AI-for-climate efforts remain in early stages, with government agencies focusing on policy frameworks while leaning heavily on international partners for technical and financial support.

Larger Private Sector Players

Large-scale technology businesses investing in Cambodia's digital and climate transformation

- **Smart Axiata:** Cambodia's leading telecom operator driving digital infrastructure with $90M+ investments in 4.5G/5G networks. Signed MoU with the Ministry of Environment to drive AI-powered forest monitoring initiatives [19]
- **Google:** Committed to developing Cambodia's digital sector, focusing on AI, cloud services, and digital literacy.
- **SpaceX/Starlink:** Planning engagements with Cambodian government to expand satellite internet coverage, particularly for climate-vulnerable rural areas lacking terrestrial connectivity
- **Huawei:** Huawei has a strong presence in Cambodia, contributing to digital transformation across sectors, including digital services for the energy sector

▶ While climate-focused digital development and investments remain emergent, tech companies present in Cambodia are increasingly integrating sustainability into digital infrastructure projects.

Smaller Private Sector Players

Smaller-scale domestic businesses that deploy AI applications in climate action across Cambodia

- **ChivCheat:** Startup that aims to enable smallholder cashew farmers to make more informed decisions that can improve productivity, through a user-friendly AI-powered chatbot
- **CAM-Science**: Provides IoT-based smart irrigation systems with AI-driven water management to optimize crop yields and combat drought.
- **Azaylla:** An AI-powered agriculture supply chain platform that connects farmers to markets
- **Greenovator:** Creates digital platforms for farmers in Mekong region to manage farms sustainably, using data analytics to mitigate climate risks like floods or droughts.

▶ These startups reflect Cambodia's emerging agritech ecosystem, where AI is increasingly applied to climate sectors such as agriculture. Most remain early-stage, relying on accelerators like and international partnerships for scaling [20].

Civil Society / Academia

Organisations that support AI growth through innovation, R&D and knowledge sharing efforts

- **Cambodia Academy of Digital Technology (CADT):** Conducts applied AI research in agriculture, healthcare, and language technology, while fostering innovation through startup programs and digital skills training.
- **Asian Development Bank (ADB):** Supports technology-enabled climate resilience projects, including flood forecasting systems and smart agriculture initiatives across the Mekong region.
- **SERVIR-Mekong:** A NASA-USAID partnership deploying geospatial AI tools for climate adaptation, such as satellite-based deforestation tracking and drought monitoring.
- **Cambodia Climate Change Alliance (CCCA):** CCCA programme, supported by UNDP, the European Union and the Swedish Government, engages a wide range of stakeholders and promotes innovative partnerships for Cambodia's climate change response.

▶ International organisations play a crucial role in driving AI deployment for climate change by providing technical and financial support for Cambodian initiatives

Enabling Pillars

A supportive environment is critical to support the development and deployment of safe, responsible and inclusive AI in Cambodia. This environment is characterized by key enablers below.

a) Responsible Governance

The Cambodian Government will draft a legal framework for AI governance for the nation, which is embedded within the country's broader digital policies [7]. This aims to regulate AI's impact while maximizing its potential to address challenges.

Key challenges and gaps:

- Capacity building: Local government capacity needs strengthening to improve legislation and regulation needed for responsible AI usage [8].

b) Talent and Skills

The Cambodian Government and academic institutions aim to utilize AI to enhance both general literacy and digital literacy nationwide. The Digital and Innovation Policy Research Centre at the Cambodia Academy of Digital Technology is collaborating with the University of California, Berkeley to facilitate technology and skills transfer to increase digital literacy [9].

Key challenges and gaps:

- Low digital literacy: Only 30% of the population possessing basic digital skills, according to a recent report from the ASEAN Foundation [10]. This low level of digital proficiency can hinder the effective adoption of AI technologies for climate initiatives.

c) Data

The country's National Council for Sustainable Development (NCSD) has been supporting efforts to integrate climate data into national policy frameworks [11]. Cambodia has been part of regional and international efforts to improve climate data accessibility, such as the development of the Cambodia Climate Change Portal [12]. This portal aggregates various climate-related datasets, offering valuable insights for decision-making on climate resilience.

Key challenges and gaps:

- Lack of data protection: Cambodia does not yet have a comprehensive law on personal data protection. However, the draft personal data law includes provisions aligned with international best practices, which can form a foundation for responsible AI adoption.
- Accuracy in risk assessments: The validity of AI-based risk assessment models remains a concern. Integrating geospatial data with survey and evaluation data, as well as incorporating long-term climate projections into localized datasets, is necessary to improve precision and effectiveness in addressing climate challenges [13].
- Data accessibility and quality: A lack of updated, granular, and accessible data undermines efforts to evaluate and monitor project impacts comprehensively.

d) Computing

In Cambodia, computing infrastructure is still in development.

Key challenges and gaps:

- Limited infrastructure and capacity: Cambodia's computing infrastructure remains underdeveloped, limiting the ability to process large datasets and run sophisticated AI algorithms for climate action, such as predictive modelling [14].
- Connectivity issues: Reliable and high-speed internet is still a challenge in many parts of Cambodia, which undermines the widespread use of cloud-based AI systems necessary for decision-making tools and climate data analysis.

e) Innovation

Cambodia’s AI innovation landscape is still developing, with progress needed to establish a robust ecosystem capable of addressing climate challenges. The Cambodia Academy of Digital Technology can play a pivotal role by fostering research and innovation through collaboration with stakeholders [15].

Key challenges and gaps:

- Limited domestic capacity: Cambodia’s limited AI research and development capabilities may result in dependence on foreign technology providers or consultants. This reliance could diminish national ownership of climate solutions [16].

f) Scaling

While there are several promising pilot AI projects in Cambodia aimed at climate resilience, scaling these efforts to achieve national impact remains a significant challenge.

Key challenges and gaps:

- Costly process that requires investment and funding.

Lao PDR

Lao PDR

Overview of Landscape

Lao PDR is at an early stage of AI adoption. While its AI ecosystem is not as advanced as those of neighbouring countries, the government has recognised digital transformation as a key driver for economic growth. AI and digital technologies have been incorporated into Lao PDR's Digital Economy Development Plan 2021–2025, which aims to enhance the nation's digital infrastructure, foster innovation, and build capacity in emerging technologies. Current efforts include partnerships with international organisations to support AI use in sectors such as agriculture. However, AI development is still constrained by limited internet penetration, technical infrastructure, and a lack of specialised talent [1].

Patuxay Monument. Source: https://www.pinyourfootsteps.com/vientiane-exploring-the-capital-of-laos/

Climate Change in Lao PDR

Lao PDR's heavy reliance on natural resources, especially agriculture and hydropower, makes it particularly vulnerable to climate risks.

Its first national climate change strategy was fully developed in 2010 to address climate change management. However, its implementation was ineffective due to incomplete plans, lack of alignment with updated laws, unclear goals and timelines, inadequate financial support, limited access to funding, and poor implementation of projects. The said strategy has since been updated last year to the National Strategy on Climate Change towards 2030 to respond to both domestic and international changes in the climate scene. [2]

The government has also committed to international climate goals, including its Nationally Determined Contribution (NDC), which aims to achieve a low-carbon

AI Application for Climate Action

Mitigation

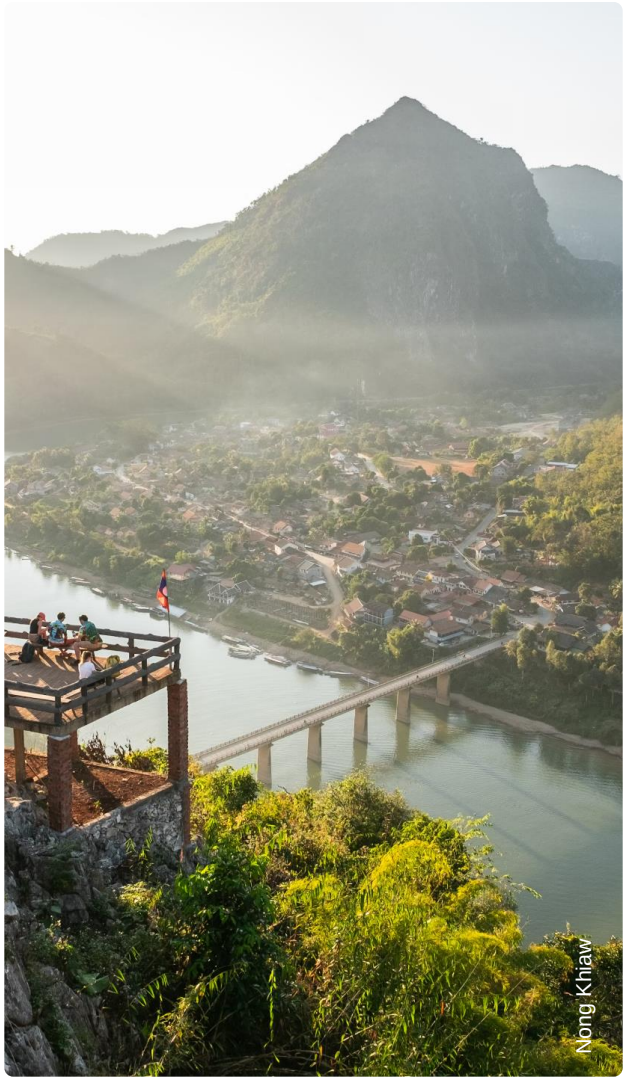
Electricity

The Solar Flex-Grid project in the remote villages of Kobong and Thapaiban in Lao PDR showcases how this innovative technology can rapidly and efficiently provide electricity to households. The transition to cleaner energy in Lao PDR is further supported by smart grid technologies, which include a grid planning tool capable of autonomously detecting roof areas using high-resolution satellite data, powered by an AI-based computer vision pattern recognition algorithm [3]. This algorithm is trained to automatically recognise roof surfaces based on parameters such as roof size, material, colour, shape, and automatically determine expected energy consumption [3]. In such cases, frequently used algorithms typically include Convolutional Neural Networks (CNNs) and its families, such as U-Net and ResNet.

Adaptation

Food and Agriculture

The Food and Agriculture Organisation (FAO) and the Department of Meteorology and Hydrology (DMH) have launched the pilot application of the Drought and Flood Trigger Methodologies for Anticipatory Action. This is the first initiative of its kind in Lao PDR, using modern technology, particularly AI, to monitor and predict potential disasters, with a specific focus on droughts that could affect the agricultural sector in advance. DMH has successfully tested and applied the drought methodology in Luang Prabang, Savannakhet, and Oudomxay provinces, implementing anticipatory action interventions to help communities mitigate the negative impacts on the agricultural sector. [4]



Stakeholder System

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Regulators / Government Sector

Organisations responsible for regulating AI and establishing policy to promote responsible AI development

- **Ministry of Technology and Communications (MTC):** Spearheads AI integration into government operations and private sectors, focusing on digital governance and socio-economic development.
- **Ministry of Posts and Telecommunications (MPT):** Develop telecoms infrastructure and information-sharing bridges for the country
- **National Internet Center (NIC):** Manages data infrastructure for AI deployment, ensuring compliance with cybersecurity standards.
- **Ministry of Natural Resources and Environment (MONRE):** Leads national climate policy and oversees implementation
- **Department of Climate Change (DCC): C**oordinates Lao PDR's NDC implementation and climate data management

▶ Lao PDR's AI governance is nascent and evolving, focused on digital transformation and infrastructure development but still lacks a dedicated AI regulatory framework [13].

Larger Private Sector Players

Large-scale technology businesses investing in Lao PDR's digital and climate transformation

- **GDMS (Global Digital Management Solutions):** first cloud service provider in Lao PDR, operating a local data centre in Vientiane that adheres to international standards
- **Unitel (Star Telecom):** A leading telecom operator investing in digital infrastructure and IoT solutions for smart cities and agriculture
- **Huawei:** Operates in Lao PDR, providing telecoms infrastructure and smart city solutions
- **Microsoft:** Partners with MPT to enhance cloud adoption, digital skills training and digital transformation
- **Lao Telecommunications Company (LTC):** Offers internet and mobile services, supporting digital inclusion through scholarships and startup incubators

▶ Lao PDR's tech sector is foreign-influenced, with telecoms driving connectivity and agribusinesses piloting climate-related solutions. Local AI innovation is limited beyond basic digital services [14].

Smaller Private Sector Players

Smaller-scale domestic businesses that deploy AI applications in climate action across Lao PDR

- **Bolaven Farms:** Pilots AI-powered climate monitoring systems for coffee growers in the Bolaven Plateau, predicting weather impacts on crop yields
- **Lao Agritech Co.:** Creates low-cost soil sensors with machine learning to advise farmers on fertilizer use and pest risks via SMS alerts
- **Greenovator Laos:** Adapts its regional agri-platform (originally from Cambodia) to connect Lao farmers with AI-based market pricing and logistics tools
- **Agri-Gel Nano Applied Tech:** Develops AI-driven hydrogel solutions to optimize water retention in soil, reducing irrigation needs for drought-prone regions
- **Namjai Farmers Collective:** Tests drone-based AI imaging to detect forest encroachment in agroforestry zones, supporting sustainable land use

▶ Lao PDR's agritech startup ecosystem is nascent and growing, with a large focus on agricultural soutions.

Civil Society / Academia

Organisations that support AI growth through innovation, R&D and knowledge sharing efforts

- **Food and Agriculture Organisation:** FAO collaborates with the government to develop AI-powered solutions to enhance its agricultural resilience
- **Asian Development Bank:** Large financier for Lao PDR, with a focus on infrastructure, climate resilience and energy, including technology applications
- **National University of Laos (NUOL):** Conducts research in AI applications
- **Research Institute for Smart Technology, Ministry of Technology and Communications:** Collaborates with China's Chongqing College of Electronic Engineering to develop AI and Big Data capabilities, focusing on smart technology training and research in agriculture, education, and environment

▶ AI development remains reliant on international funding and support, yet notable efforts are underway to strengthen local research capabilities regarding AI and its applications to climate sectors.

Enabling Pillars

Computing
GDMS (Global Digital Management Solutions) is the first cloud service provider in Lao PDR, operating a local data centre in Vientiane that adheres to international standards. DMS is also responsible for hosting key e-government platforms, such as the Civil Registration and Vital Statistics (eCRVS) platform and the Lao Education and Sports Management Information System (LESMIS). GDMS is providing Disaster Recovery Service for the Lao National Single Window (LNSW), which is part of the Trade Facilitation Programme implemented by Laos [5].

Besides, the first government-operated eco data centre in Lao PDR was also completed in Vientiane in November 2016, mainly supporting e-government applications and seeks to strengthen the local IT industry. [6]

Key challenges or gaps:
- Digital government remains as the main theme of the use of the existing computing resource. There is no clear evidence that there are plans for allocation of the computing power to AI for climate actions.
- The access to the benefits of these computing resources could also be limited on the ground, with only 25.5% of population has access to the Internet in 2017 [7]
- Power supply remains fragmented across regions. This inconsistency can affect the reliability of computing infrastructure necessary for running AI systems effectively.

Data
High-quality data is the backbone of AI systems, and in Lao PDR, data collection is often fragmented and inconsistent.

Key challenges or gaps:
- Limited financial resources hinder the development and maintenance of comprehensive data collection systems necessary for effective AI applications in climate action.[8]
- One key challenge is the availability of data, particularly in the local language.
- It is also recognised that data limitations may obscure and add uncertainty to the evaluation of historical temperature changes as well as hinder reliability of climate hazard and risk predictions with AI. [9]

Talent and Skills
Lao PDR's shift towards a low-carbon, digital economy will demand the development of green skills across all sectors and levels of the workforce. According to the country's Digital Economy Strategy, the ICT workforce currently accounts for just 0.3 percent of the total labour force nationwide as of 2022. [10]

Key challenges and gaps:
- It was reported that schools and curricula do not provide the necessary skill training to stay competitive. Specifically, limited computer classes and technology usage, and limited fields of study especially relating to digital economy were quoted among the top three gaps in school curricula.

Responsible Governance
Lao PDR is actively pursuing the development of its digital economy as a means to enhance socio-economic growth and improve competitiveness. The country has outlined several key strategies for this transformation:
- National Digital Economy Development Vision (2021-2040): A long-term plan to transform Lao PDR into a digital economy, leveraging digital technologies to enhance living standards and economic performance [11].
- National Digital Economy Development Strategy (2021-2030): A strategy detailing objectives to build a strong digital ecosystem, including improvements in infrastructure, digital literacy, and innovation across sectors [12].
- National Digital Economy Development Plan (2021-2025): A five-year plan focused on immediate actions to implement the long-term vision and strategy, prioritising key steps for digital transformation.[1]

Key challenges or gaps:
- Given the relatively underdeveloped state of AI in Lao PDR, the country has yet to establish formal guidelines or regulations specifically focused on ensuring responsible AI development and deployment.

Timor-Leste

Timor-Leste

Overview of Landscape

Timor-Leste, a small island nation in Southeast Asia, is in the nascent stages of adopting digital technologies, including AI. While the country has made strides in enhancing its digital infrastructure, such as expanding internet access and integrating ICT into government services, AI development is still in its infancy.

Its Strategic Development Plan 2011-2030 outlines the nation's commitment to technological advancement, but AI-specific initiatives are scarce. The focus has been more on fundamental digital literacy and connectivity rather than advanced AI capabilities. Limited access to computing infrastructure and skilled AI professionals presents a challenge, although international development agencies, like the UNDP, are beginning to explore opportunities for AI in key sectors [1].

Climate Change in Timor-Leste

Timor-Leste, a small island nation in Southeast Asia, is in the nascent stages of adopting digital technologies, including AI. While the country has made strides in enhancing its digital infrastructure, such as expanding internet access and integrating ICT into government services, AI development is still in its infancy.

Its Strategic Development Plan 2011-2030 outlines the nation's commitment to technological advancement, but AI-specific initiatives are scarce. The focus has been more on fundamental digital literacy and connectivity rather than advanced AI capabilities. Limited access to computing infrastructure and skilled AI professionals presents a challenge, although international development agencies, like the UNDP, are beginning to explore opportunities for AI in key sectors such as agriculture and disaster management [1].

AI Application for Climate Action

Timor-Leste is highly vulnerable to the impacts of climate change, including rising sea levels, increasing temperatures, and more frequent extreme weather events like cyclones, floods, and droughts. These changes threaten the country’s agricultural productivity, water resources, and coastal communities. As a predominantly agrarian society, with the majority of the population dependent on subsistence farming, climate change poses a severe risk to livelihoods and food security. The National Adaptation Programme of Action (NAPA), developed in 2010, outlines Timor-Leste’s priorities for addressing climate change, focusing on adaptation measures in agriculture, water, and disaster risk reduction [2].

Adaptation

Food and Agriculture

The Food and Agriculture Organisation (FAO) conducted a study investigating the use of AI to trigger anticipatory actions for droughts. Anticipatory action involves using forecasts of extreme weather events alongside risk information to identify and implement locally-led interventions. This research focuses on developing a methodology for triggering agricultural drought responses in Timor-Leste, an Indo-Pacific country with limited observational data. Drought is a significant natural hazard in Timor-Leste, severely affecting livelihoods and being further intensified by the escalating impacts of climate change. The study introduced a methodology for triggering drought-related anticipatory action in Timor-Leste, using a combination of six indicators. These triggers have been implemented and tested across five municipalities: Baucau, Viqueque, Oecusse, Covalima, and Liquica [3].

Resilience

In January 2020, Mercy Corps, in collaboration with Similie, launched a pilot project to strengthen the development of an early warning system for Timor-Leste. The project aims to deploy and test advanced AI algorithms to improve alert thresholds for natural disasters, such as flooding, by analysing data from hardware sensors. The primary goal is to enhance community preparedness and response capabilities, thereby reducing vulnerability to climate-related disasters and supporting Timor-Leste's ability to better prepare for and respond to such events [4].

Ataúro, Timor Leste source: Timor Leste tourism

Stakeholder System

Below is a stakeholder ecosystem of key organisations advancing AI for climate action across various roles, including regulation, policy, implementation, investment, research, and innovation. Each organisation plays a critical role, collectively forming a comprehensive ecosystem that drives progress in the application of AI for climate action. This list of key stakeholders is non-exhaustive.

Regulators / Government Sector

Organisations responsible for regulating AI and establishing policy to promote safe AI development

- **Secretary of State for Environment:** Leads national climate policy coordination and UNFCCC engagement, including oversight of AI applications in environmental monitoring.
- **National Directorate for Climate Change:** Implements climate adaptation projects and manages Green Climate Fund accreditation (critical for tech-enabled solutions).
- **Ministry of Transport and Communications:** Emerging role in digital governance, though AI-specific regulations remain undeveloped.
- **Ministry of Agriculture, Livestock, Fishery and Forestry:** Pilots basic AI/remote sensing for food security but lacks dedicated AI capacity.

▶ Timor-Leste's AI governance and climate efforts are heavily reliant on international support with limited local capacity for AI innovation. The government focuses on climate resilience through its National Adaptation Plan, but AI-specific initiatives remain underdeveloped.

Larger Private Sector Players

Large-scale technology businesses investing in Timor-Leste's digital and climate transformation

- **Telemor (Viettel):** The largest mobile operator in Timor-Leste, offering mobile, internet, and fixed broadband services. It has significantly increased mobile penetration across the country
- **Telkomcel** (Indonesian-owned): Provides mobile/data services and launched Timor-Leste's first data centre (2024) for cloud computing [19].
- **ZTE:** Partners with Telkomcel to modernize network infrastructure (e.g., 5G-ready core systems).
- **Microsoft/Google/AWS:** No local offices, but services accessed via regional clouds (e.g., Telkomcel's data centre offers indirect connectivity).

▶ Digital transformation is telecom-led (Telemor/Telkomcel), with cloud/AI adoption reliant on partnerships. Global tech giants operate regionally but lack on-ground investments in Timor-Leste.

Smaller Private Sector Players

Smaller-scale domestic businesses that deploy AI applications in climate action across Timor-Leste

- **T-Leste Innovatech:** Local AI pioneer developing machine learning for agriculture (crop monitoring) and smart traffic systems.
- **Similie:** Flood prediction startup using AI and open-source tech for early warning systems, supported by UNICEF.
- **Bluewave Digital:** Focuses on IoT solutions for water management, partnering with Zero Mass for solar-powered water tech.
- **Timor Tech Solutions:** Implements government-backed smart city projects, including energy-efficient infrastructure.
- **EkoTimor:** Combines IoT and solar tech for sustainable homes

▶ Timor-Leste's startup ecosystem shows early-stage potential in climate AI, led by local startups with international backing.

Civil Society / Academia

Organisations that support AI growth through innovation, R&D and knowledge sharing efforts

- **UNDP Timor-Leste:** Leads climate resilience projects (e.g., flood/landslide early warning systems) and supports digital governance.
- **UNICEF:** Partners with KOICA on climate-resilient infrastructure, including potential AI tools for disaster preparedness in schools/health centres.
- **FAO:** Implements climate-smart agriculture programmes and is exploring AI for crop monitoring.
- **National University of Timor-Leste (UNTL):** Conducts basic research on climate adaptation; no formal AI labs but collaborates with UNDP on data-driven solutions.
- **Mercy Corps:** Pilots community-based climate adaptation solutions such as the development of an early warning system.

▶ Timor-Leste's AI-for-climate ecosystem is nascent and NGO-driven, with civil society laying groundwork for future tech integration and climate action in the country [20]. Local academia also lacks AI capacity, with no dedicated AI research centres existing yet.

Enabling Pillars

Talent and Skills
Nearly two-thirds of Timor-Leste's population is under the age of 30, offering a significant opportunity for the country's AI-enabled future [5]. Timor-Leste recognises the needs on focusing on initiatives to enhance education in Science, Technology, Engineering, and Mathematics (STEM) fields and promote digital skills training among the population. [6]

An interview with Mr Gil Rangel da Cruz, Senior Professional, Ministry of Agriculture, Livestock, Fishery and Forestry (MALFF) Timor-Leste highlighted that international organisations such as Food and Agriculture Organisation (FAO) [7], ASEAN Secretariat, UNICEF and UNEP have an active involvement in training and upskilling government officials and local population. With support from EU and USAID, FAO empowered local women in Betano to adopt climate resilient agricultural practices [8]. ASEAN Secretariat has provided capacity building programmes for economic policy, but no specific training for digital tools or climate action [9].

Key challenges or gaps:
- Long-term viability and efficacy of technology and skillset transfer from UNEP Early Warning and Assessment Division Programme by 2027 is unknown [10].
- The "Timor Digital 2032" plan for local government's long-term development in infrastructure building and coordination does not specifically address AI and climate action [11], only health, education and agricultural sectors.
- With limited local AI capabilities, upskilling programmes and talent retention is a key challenge in Timor-Leste.

Computing
Opened in 2014, the Telkomcel Data Centre was the first of its kind in Timor-Leste, offering cloud computing services and data management solutions. This facility potentially play a key role in supporting local businesses by providing essential data services and local infrastructure for computing and AI operations. [12]

Key challenges or gaps:

- According to UNICEF, many schools do not have any ICT infrastructure and are not covered by the mobile networks [13].
- The carbon footprint of digital infrastructures has not been taken into account in its digital strategy [11].
- Basic digital infrastructure such as internet connectivity in Timor-Leste can be weak and unreliable, as mentioned by Mr Gil*.
- Technological impact of the collaboration between Timor-Leste and Australia to build a submarine cable by April 2025 is unknown [14].

Responsible Governance
Although Timor-Leste has enshrined constitutional protections for personal data and privacy as a fundamental right for its citizens, the country lacks comprehensive legislation specifically addressing cybersecurity, e-government, digital economy infrastructure and personal data protection [15].

While telecommunications is a focus area of infrastructure development in its Strategic Development Plan 2011-2030, AI not alluded to at all in the document [1].

Key challenges or gaps:
- There is no national law or policy or plans covering privacy and data protection, cybercrime, cybersecurity, or other related privacy laws, nor is there a framework governing data use for AI applications [15].
- Low levels of broadband infrastructure to provide digital backbone for mobile and internet services [16].

Data
The lack of quality environmental and climate data poses a serious challenge for adopting AI for climate action. Successful examples include antergroup, who mapped various climate risks (up to 10 hazards and 15 km2 of area) in Timor-Leste using advanced modelling and artificial intelligence [17].

Key challenges or gaps:
- Wider applications of AI in climate resilience is pending, given successful research project led by FAO on anticipatory action for drought risk management [18].

03

Key Actions

Overview

This section outlines key actions under each enabling pillar to help Southeast Asian countries advance safe, trustworthy, and ethical AI for climate action. These actions aim to address existing gaps, unlock new opportunities, and support long-term development in the region. Refer to page 10 for the list of enabling pillars.

Each action topic is designed to address a specific issue or challenge, with a clear rationale explaining why it is needed, what it seeks to achieve and which country(s) it is most relevant for. The actions are categorised into four groups:

- **Policy**: Actions led by regulators, focusing on the development and implementation of laws, regulations, policies, and/or strategic frameworks.
- **Market**: Actions driven by the private sector through innovation, investments, and partnerships that encourage AI adoption.
- **Infrastructure**: Actions that involve capital investments in physical infrastructure to support AI-driven solutions.
- **Research**: Actions aimed at advancing knowledge development through testing, experimentation, analysis.

Each action identifies a lead stakeholder responsible for driving implementation, as well as the direct beneficiaries who will gain from it. Actions tagged with a GEDSI element are linked to improving access and resolving inequality gaps pervasive in this region. For longer-term, more complex challenges where UK expertise aligns with regional needs, research prompts may be proposed, serving as potential long-term investment opportunities for consideration. Refer to the table for all action topics included:

Actions linked to GEDSI

Enabling Pillar	Action Topic
Data	Establish common standards for climate data to improve data sharing, interoperability and quality
	Establish data privacy and security framework and data protection units to oversee compliance, enforce regulations, and investigate breaches of climate data
	Combat climate misinformation
	Improve local climate data collection
	Increase access to historical climate data
	Enhance AI-based climate risk assessments
Computing	Enhance the energy efficiency of data centre operations
	Establish governance of green digital infrastructure and adapt sustainable practices
Talent & Skills	Encourage the use of AI innovations among smallholder farmers
	Build foundational AI literacy necessary to advance climate action
	Nurture talent pool to develop cross-domain expertise in AI and climate change
Responsible Governance	Mandate AI governance frameworks to guide responsible AI use and enhance inclusion
	Create specialised government bodies at the intersection of AI and climate change
Innovation	Foster AI innovation for climate action
Scaling	Attract private investment and involvement to scale AI-driven climate innovation
	Leverage stakeholder networks and funding to scale AI-driven climate innovation
	Close the gender gap in climate tech investment

Cross-Pillar Collaboration Opportunities for the UK to support Southeast Asia (refer to Chapter 4):

- Talent exchange
- Innovation of energy-efficient computing infrastructure
- Funding for priority areas in AI-driven climate action
- Knowledge transfer partnerships
- Bridging the gender gap in climate tech leadership and funding
- Development of local climate data infrastructure

Data

Key Actions for *Data*

1. Establish common standards for climate data to improve data sharing, interoperability and quality

Action Rationale

In the context of this report, climate data refers to the collected information about the Earth's climate, encompassing various measurements and observations of atmospheric conditions over time. This includes data on temperature, precipitation, wind speed, humidity, air pressure, and other atmospheric variables, as well as related metadata [27].

There is a lack of clear standards for climate data collection across ministries and local communities in Southeast Asia. The absence of standardised protocols for climate data collection across ministries and local communities in Southeast Asia presents a significant challenge. This issue, particularly prevalent in Philippines, Thailand, Vietnam, Myanmar, Cambodia, Lao, and Timor-Leste, underscores the need for addressing the deficiency in hyperlocal climate data and establishing clear standards for data collection (see page 42, 51, 65, 71, 76, and 81). Even though not much data deficiency issues have been reported and/or found in Indonesia and Malaysia, yet Malaysia and Indonesia remain working towards enhanced data governance and transparency [27, 36].

When inputted into AI systems, this results in poor machine readability, inconsistent formatting, and inaccurate climate monitoring and analysis. Poor data quality can also lead to AI failures, such as biased predictions and incorrect decisions [1]. By standardising climate data, the public can access and use this information, fostering collaboration and informed decision-making [2], which, in turn, enhances the ethical use of AI.

ASEAN released guidelines and standards to enhance digital data governance and management in 2017 and 2021. However, each country in the region, including Singapore (which is not covered in this action), should foster talent to improve the understanding and application of data standards. Additionally, increasing public awareness of the importance of climate data is crucial to ensure the establishment and success of common standards for climate data.

Action Description

P M

Enforce the adoption and use of standardised communication protocols to collect climate data

Lead: Government, private sectors
Beneficiaries: AI tech providers, local communities

Currently, there are numerous devices available on the market, beyond just IoT devices, that can be used to collect climate data. For example, drones and satellites capture imagery and laser data. These devices are commonly used to monitor sea level rises, wildfires, and crop conditions. IoT devices, on the other hand, collect sensing data such as temperature and humidity. Examples of standardised protocols used globally include MQTT, CoAP, and HTTP for IoT devices used to collect climate data, and Consultative Committee for Space Data Systems standards used to collect satellite data [3]. Standardised protocols can ensure that devices from different manufacturers communicate effectively, thereby reducing compatibility issues and increasing interoperability [4].

P

Establish common metadata standards to describe climate data

Lead: Government
Beneficiaries: Local communities, private sectors

Common metadata standards help to standardise key parameters of collected climate data, such as its data source, time of collection and data type. This enables the comparison of datasets from different regions and time periods, enhancing the understanding of climate patterns and trends. [5]
Countries in Southeast Asia, such as Singapore and Malaysia, are increasingly adopting international standards like the Climate and Forecast Metadata Conventions to ensure interoperability and data quality of climate data [5]. Asia Development Bank has also published a Statistical Data and Metadata eXchange standard in 2024 to offer a comprehensive framework to streamline data activities and promote interoperability in Asia [6]. Despite these efforts, Southeast Asia will need to build local expertise and infrastructure to support the successful implementation of these standards.

P M

Establish climate data quality standards and implement validation algorithms

Lead: Government, AI tech providers
Beneficiaries: Local communities, startups, private sectors

High-quality climate data is crucial for accurate models and predictions. Clear standards improve analysis, enhance interoperability, and create business opportunities for tech providers and startups. ASEAN released the ASEAN Guidelines for Harmonisation of Standards in 2022, focused on industry and trade. While not climate-related, it sets a precedent for future regional climate data standards to improve consistency and coordination.

Southeast Asia can establish climate data quality standards by collaborating with tech providers to integrate smart validation tools. Microsoft Azure, for example, offers data quality services that help data stewards and IT professionals manage data integrity and consistency. Some tech providers also embed automated quality-check algorithms within their platforms. By aligning with global best practices and leveraging advanced technology, the region can enhance climate data reliability, benefiting both research and business sectors.

P

Develop and deploy API standardisation for climate data collection devices to unify data models

Lead: Government, technology provider
Beneficiaries: Local communities, private sectors, startups, AI tech providers, academia

Standardised application programming interfaces (APIs) enable seamless integration of data from diverse devices, regardless of the manufacturer. This is essential for creating unified data models, which simplify the process of combining and analysing environmental data from various sources, such as drones which are often used for land surveying purposes, smart meters used for measuring resource consumption, and other climate data collection devices [7].

APIs facilitate the integration of data from multiple sources, supporting more advanced climate data analysis. However, integrating data from various devices and sources remains challenging due to differences in data formats and collection methods [8]. Additional efforts may be required to address these challenges.

UK Expertise: The UK is a global leader in open data, advocating for transparent and standardised sharing of data to facilitate collaboration. This extends to climate-related data, including its geospatial datasets which have strong adoption of FAIR (Findable, Accessible, Interoperable and Reusable) principles. To facilitate sharing, the UK Government is developing a harmonised Data Exploration License for geospatial data, as well as creating a data sharing agreement among its Partner Bodies [9]. Additionally, the UK's AI Opportunities Action Plan highlights its use of AI to improve public sector data collection and quality. This expertise enables the UK to leverage AI for standardising and enhancing climate data quality, facilitating more effective sharing and collaboration.

Relevant UK Organisations: Government Digital Service, Open Data Institute, UK Data Service, Central Digital and Data Office, UK National Meteorological Service (Met Office)

Research Prompt: How can AI tools improve the standardisation of climate data to ensure quality and interoperability for data sharing?

2. Establish data privacy and security framework and data protection units to oversee compliance, enforce regulations, and investigate breaches of climate data

Action Rationale

In 2020, the average cost of a data breach for organisations in the ASEAN region was approximately US$2.62 million, with an average of 22,500 records compromised per incident [10]. A 2021 survey by the World Bank highlighted that data protection regulations in ASEAN are lacking, particularly in countries like Cambodia and Myanmar [11]. This action seeks to address the challenge posed by the lack of robust data protection regulations in Thailand, Myanmar, Cambodia, and Timor-Leste (see 42, 64, 69, 77). When gathering climate data, it is important to note that personal information may also be collected, such as geographical location data and user profiles from individuals registered on climate monitoring platforms.

Insufficient regulatory frameworks can lead to the misuse of personal data by organisations and AI technology providers, resulting in unethical practices such as discrimination and biased decision-making regarding climate action. Therefore, it is crucial to establish a robust data privacy and security framework for climate data to promote responsible and trustworthy AI applications in this field.

Recently, Southeast Asia has taken steps to address responsible data management throughout its lifecycle, exemplified by initiatives like the ASEAN Data Management Framework. However, the mechanisms for safeguarding data and addressing data breaches remain underdeveloped.

ASEAN released its Personal Data Protection Framework in 2016. It is recommended that Thailand, Myanmar, Cambodia, and Timor-Leste align their national privacy laws with ASEAN guidelines and establish independent data protection authorities to oversee compliance. Additionally, establishing mechanisms for sharing information and best practices among ASEAN countries would enhance collective data protection efforts.

Action Description

M

Establish clear procedures to monitor climate data usage, and to spot and report data breaches

Lead: Government, AI tech providers
Beneficiaries: Local communities, startups, private sectors

For certain types of climate data such as observational and temperature data, it is transmitted continuously in real-time, 24 hours a day. As such, leveraging AI technologies can significantly enhance the ability to detect and report climate data breaches promptly. For instance, Blackpanda, a cybersecurity firm based in Singapore, has successfully implemented AI-driven threat detection and response systems to identify and mitigate data breaches effectively.

When designing such procedures, it is crucial for governments to consider equity and inclusion. This ensures that data accessibility and the reporting of data breaches are available to all community members, including women, people with disabilities, and marginalised groups. By doing so, it helps promote a more inclusive and secure environment for everyone.

UK Expertise: The UK is at the forefront of developing responsible AI systems for cybersecurity and data protection. The UK's AI Security Institute, formerly the AI Safety Institute, focuses on addressing serious AI risks with security implications.

Relevant UK Organisations: AI Security Institute, UK National Meteorological Service (Met Office)

Research Prompt: How can AI-driven systems be optimised to detect and report climate data breaches in real-time while ensuring the protection of privacy and sensitive information in climate datasets?

P

Develop and enforce compliance with climate data privacy protection regulation, and enhance the security risk assessment and audit in software and hardware

Lead: Government, technology providers
Beneficiaries: Local communities, private sectors, startups, AI tech providers, academia

Southeast Asian countries have made significant progress in implementing safeguards against cybercrime, such as preventing unauthorised access, interception, deletion, and interference with databases, and establishing national CERTs. However, many are still in the early stages of developing comprehensive data security measures and adopting cybersecurity standards internally, This is especially severe in Myanmar, which does not have any existing data protection policy. As such, governments must enforce the anonymisation of personal data, restoration data and systems after incidents, as well as conducting ongoing security assessments. [12]
Enhancing climate data privacy protection is crucial for several reasons. It safeguards sensitive climate data from unauthorised access, breaches, and misuse, thereby ensuring the integrity and confidentiality of the data. Additionally, robust data privacy measures can build public trust and confidence in climate initiatives and the organisations handling climate data. This trust is essential for the successful implementation and acceptance of climate policies and programs, as it reassures the public that their data is being handled responsibly and securely (Davies). **See best practice PetaBencana.id from Indonesia on page 141.**

P M

Enhance public awareness of potential cyber threats on climate data and reporting procedures

Lead: Government, private sectors, investors
Beneficiaries: Local communities, startups, tech providers

Human error, such as falling for phishing scams, is a common cause of cyber incidents. The primary cyber threats to climate data include data breaches, data manipulation, ransomware attacks, and phishing attacks. For instance, malicious actors may alter climate data to mislead researchers, policymakers, and the public, which can have serious implications for climate research and policy decisions [13].

Educating the public on recognizing and avoiding these threats can significantly reduce the risk of cyber attacks [14]. When individuals are aware of the signs of a cyber threat and understand the reporting procedures, they can quickly report incidents [15].
There are several ways to enhance public awareness. The most common methods include online and in-person workshops and seminars to educate the public about common cyber threats, such as phishing, malware, and ransomware.

In many remote and local towns where transportation and internet access are limited, governments may need to adopt community-engaged methods to ensure equity, diversity, and inclusion. For example, participating in local events and fairs to distribute educational materials and conduct live demonstrations on recognizing and reporting cyber threats.

Additionally, training community members to become cybersecurity ambassadors can help educate others and provide guidance on reporting procedures.

3. Combat climate misinformation

Action Rationale

Misinformation and disinformation about climate change pose significant risks to climate action, policy-making and public perception. The rapid spread of misleading or false information undermines scientific consensus, delays critical policy interventions and erodes public trust in climate initiatives. In Southeast Asia, where digital and social media are primary sources of information, the proliferation of climate misinformation is particularly concerning. AI-generated misinformation, including manipulated content and misleading narratives, has further exacerbated the challenges, making it difficult for policymakers and the public to distinguish between credible scientific findings and false claims.

False narratives surrounding climate change take various forms, ranging from outright denial of global warming to exaggerated climates that undermine trust in science-based policies. Misleading claims about carbon offset schemes can allow corporations to greenwash their activities, hindering genuine sustainability efforts. Addressing this issue requires a comprehensive approach that ensures access to reliable climate data while deploying AI-driven solutions to detect and mitigate misinformation.

However, combating climate misinformation presents several challenges. One major risk is manipulation of AI systems, where bad actors may exploit or train AI models to evade detection making misinformation harder to identify. Additionally, bias in AI models could arise if misinformation detection tools are not trained on diverse datasets, resulting in inaccuracies, especially in localized context. Data accessibility barriers may also prevent marginalized communities from benefitting from open climate data platforms, particularly if platforms are not multi-lingual or user-friendly.

Action Description

P R

Strengthening open data platforms for climate science to improve transparency

Lead: Government, academia
Beneficiaries: Government, private sector

A fundamental strategy to combat climate misinformation is ensuring that accurate, science-based climate data is widely accessible. This action focuses on creating and enhancing open-access climate data platforms that provide reliable, verifiable and real-time climate information. These platforms shall aggregate data from multiple sources, including government agencies, international climate organisations, and independent researchers, ensuring transparency and accessibility. Several initiatives can serve as models for this effort. UK Met Office Climate Data Portal [16] offers free datasets on temperature, precipitations and some climate projections. Southeast Asia countries such as Indonesia are also advancing open data efforts, with the BMKG Open Data Portal [17] providing some weather forecast data and earthquake data to researchers and the public. Thai Meteorological Department also provides open data regarding on weather and air quality as well [18]. To maximise impact, these platforms should ensure multilingual support for local communities, develop user-friendly interfaces for non-technical users, and foster cross-sector collaboration among governments, universities and business.

M R

Develop AI-powered misinformation detection and fact-checking tools for climate content

Lead: Academia, private sector
Beneficiaries: Government

The rapid spread of false climate narratives on social media and news platforms has made misinformation detection a critical priority. This action involves the development of AI-driven tools that can identify, flag and fact-check climate related misinformation in real-time. These tools should integrate with social media platforms, news agencies and fact-checking organizations to detect misleading narratives and provide accurate counter-information.

Some global initiatives exemplify the power of fact-checking climate claims. Science.feedback.org is a science-driven fact-checking network where climate scientists review news articles for accuracy [19].

One of Google's research projects also came across this. The CLIMATE-FEVER dataset aims to verify real-world climate claims and combat misinformation. It includes 1,535 claims from the Internet, with 7,675 annotated claim-evidence pairs sourced from Wikipedia. Researchers trained AI models to identify and validate claims as supporting, refuting, or lacking sufficient information, enhancing algorithms for climate claim validation and fostering collaboration between climate science and AI communities. [20]

For effective implementation, AI models must be trained on diverse datasets, including local languages and region-specific climate issues. Partnerships with social media platforms and news agencies are essential for real-time misinformation tracking. Additionally, ensuring transparency in AI decision-making processes will be crucial to mitigating bias concerns and enhancing public trust.

UK Expertise: Institutions such as Alan Turing Institute, BBC's Trusted New Initiative and Full Fact Organisation has developed an AI model for detecting false narratives, verifying claims and improving fact-checking methodologies.

Relevant UK Organisations: UK Met Office, Alan Turing Institute

Research Prompt: How can AI tools be leveraged to verify large amounts of climate information efficiently? Is there a transferable methodology that can be adopted across the region?

4. Improve local climate data collection

Action Rationale

Access to accurate and localised climate data is essential for informed decision-making, disaster preparedness and climate action. However, many Southeast Asian countries face significant challenges in collecting, standardising and utilising climate data at the local level. Inconsistent data availability, lack of funding for climate monitoring infrastructure, and limited public awareness about the importance of local climate data hinder effective climate resilience efforts.

Local climate data is crucial for AI-driven climate models, early warning systems, and policy planning. Without accurate and real-time data, governments and communities struggle to anticipate extreme weather events, assess climate-related risks and implement adaptive strategies. Moreover, climate data gaps disproportionately affect rural and vulnerable communities, limited ability to respond to environmental hazards.

Improving local climate data collection is essential to create more reliable AI-powered climate models, thus boosting resilience against climate-related disaster. Strengthening climate data infrastructure will also support regional collaboration, enabling Southeast Asian countries to share insights and develop coordinated responses to climate challenges.

Action Description

P M

Launch public awareness campaigns on the role of local climate data in AI-driven climate resilience

Lead: Government
Beneficiaries: The public

Public awareness campaigns will educate citizens, policymakers, businesses, and community leaders on the importance of local climate data strengthening climate resilience. These campaigns will highlight how AI-driven climate models, early warning system and disaster management strategies rely on accurate and localized data.

Academic institutions are encouraged to conduct research that supports climate action strategies. Collaboration between academia and government agencies is vital for improving data collection and analysis, as well as developing innovative solutions for climate resilience. Additionally, universities play a key role in educating future leaders and practitioners about climate science and sustainable practices.

P M R

Develop public-private partnerships to fund and deploy community-based climate data collection initiatives

Lead: Government, private sector
Beneficiaries: Academia, private sector

Public-private partnerships (PPPs) can provide funding, technology, and expertise to expand community-led climate data collection (**See case study NOAH in the Philippines on page 143**). Clear data-sharing agreements between governments, businesses, and communities are essential for effective collaboration. Financial sustainability should be ensured through blended funding models, including government grants, private investment, and community crowdfunding. Additionally, capacity-building programs should train communities in data collection and interpretation to enhance the quality and impact of the data.

Thailand's smart water management system exemplifies how PPPs can support climate action. In 2019, the country approved a long-term water management plan [21] to address challenges like drought, flooding, and wastewater management. Recognizing the need for sustainable financing, Thailand's Ministry of Interior partnered with the International Finance Corporation in 2023, signing a Memorandum of Understanding to enhance subnational financing and promote PPP-driven projects focused on sustainability [22]. One such initiative is the Smart Dam Operation System [23, 24], which uses AI to predict reservoir inflow, helping mitigate water shortages and improve drought response. This system integrates over 40 databases and 30,000+ sensors [23, 24], showcasing how PPPs enable advanced technologies for community-based climate data collection.

P I

Establish data collection infrastructure (e.g. community data platforms, sensors, IoT, satellite monitoring)

Lead: Government, academia, multilateral organisations
Beneficiaries: The public, local communities

This action focuses on deploying and integrating climate data collection technologies, such as IoT-based weather sensors, satellite monitoring, and community-driven data platforms. Developing local infrastructure is crucial for accurately recording climate data at the community level and addressing the lack of hyperlocal climate data in Southeast Asia. These technologies will enhance real-time climate monitoring and support AI-driven forecasting, enabling more precise and localised climate insights. According to research [37], there is a correlation between the density of personal weather stations and levels of deprivation, highlighting underlying socio-economic and environmental inequalities. As a result, climate data in these areas tends to be less reliable, which can hinder climate adaptation efforts and empowerment within these communities.

An example of local data collection infrastructure established is the Mekong Delta Integrated Climate Resilience and Sustainable Livelihoods Project [25] funded by the World Bank. This project plays a crucial role in establishing data collection infrastructure to enhance climate-smart planning and adaptive water management in Vietnam's Mekong Delta. **Case studies Jejakin and AIMVIE on page 140 and 142** have leveraged data collection from multiple sources (e.g., IoT sensors, satellite and drone).

This project developed an extensive network of sensors, IoT-enabled monitoring stations and satellite-based remote sensing to collect real-time data on groundwater levels, salinity intrusion, river flows and coastal erosion. .

By integrating IoT-enabled water monitoring stations, automated flood forecasting systems, and cloud-based data management platforms, the project enhanced the community's capacity to respond to climate change, extreme weather events, and water resource challenges. This data-driven approach, ensures that policymakers, farmers and local communities have access to-real-time, high-resolution environmental data, enabling more effective and resilient water and land management strategies.

However, it is important to note that the women and marginalised groups often have limited access to climate data and decision-making platforms, as mentioned in the State of Gender Equality and Climate Change in ASEAN Report [26]. To ensure equitable access to climate information, local climate data infrastructure must be designed to be inclusive, ensuring that women, low-income communities, and indigenous groups can access, interpret, and use climate data for decision-making.

Beyond establishing new infrastructure, there is a critical opportunity to enhance existing climate-related technology platforms in the region. Strengthening platforms like SIMONTANA (Indonesia's forest monitoring system) and the ASEAN Haze Portal can accelerate knowledge-sharing, improve data accessibility, and foster cross-border collaboration.

SIMONTANA, managed by Indonesia's Ministry of Environment and Forestry, provides real-time forest resource data. Expanding its capabilities to include AI-driven climate forecasting based on local climate data and transboundary data-sharing would enhance its role in regional climate resilience. Similarly, the ASEAN Haze Portal, focused on peatland and haze management, could integrate IoT-based climate data, predictive analytics, and community-driven reporting, strengthening early warning systems.

Policy alignment with frameworks like the ASEAN Agreement on Transboundary Haze Pollution can enhance regional cooperation. Ensuring inclusive access—through multilingual, mobile-friendly platforms—will empower women, low-income communities, and indigenous groups in climate decision-making.

By strengthening and integrating existing platforms, ASEAN nations can maximize climate-tech investments, enhance resilience, and foster equitable access to climate information.

5. Increase access to historical climate data

Action Rationale

Access to historical climate data is essential for AI-driven climate modelling, disaster risk reduction, and long-term sustainability planning. However, ASEAN countries face significant barriers in collecting, standardizing and sharing historical climate records. Many climate datasets remain fragmented, inaccessible, making it difficult for policymakers, researchers and businesses to develop data-driven climate resilience strategies.

By increasing access to historical climate data, ASEAN nations can improve AI-powered forecasting, enabling better predictions of extreme weather events and long-term climate trends. Additionally, historical data is crucial for enhancing disaster preparedness, as it allows governments to analyze past disaster and develop proactive mitigation strategies. Access to well-documented climate records also support climate adaptation policies, helping countries identify long-term shifts in temperature, precipitation, and sea levels. Moreover, a standardized and open-access climate data system would foster regional collaboration, strengthening ASEAN's collective response to climate change.

Action Description

P I R

Establish a Climate Data Hub in ASEAN as a platform to centralise, verify and standardise historical climate records

Lead: National governments, ASEAN Secretariat
Beneficiaries: The public

One of the key barriers to AI-driven climate resilience is the lack of a centralised, standardised historical climate database. Currently, climate records are scattered across multiple national agencies, universities and private organisations, making it difficult to access comprehensive datasets for regional climate modelling. Additionally, linguistic diversity across Southeast Asian countries presents a significant challenge, as many historical climate records are stored in local languages and may not be easily accessible.

To address these challenges, ASEAN nations should work together to establish a regional Climate Data Hub, which will act as an open-access platform for aggregating, verifying and standardising historical climate records. ASEAN nations must ensure data standardisation and interoperability, as well as establish quality control and verification protocols of historical climate records. A crucial aspect of this initiative is ensuring multilingual support, allowing users to access and interpret climate data in their native languages, thereby promoting inclusivity and ease of use. Collaboration with global climate data organisations such as the World Meteorological Organisation, NASA and MOAA will also further strengthen ASEAN's climate data infrastructure.

Several ASEAN countries have already made progress in digital climate data accessibility. Singapore's National Climate Data Repository [28] managed by Metrological Service Singapore, offers open Access to its daily historical climate datasets dating back to 1980.

Thailand's Thai Meteorological Department Historical Climate Data Hub Portal [29] has digitised over 50 years of climate records, particularly for monthly tropical cyclone data, making them available for research and disaster planning. A proposed regional initiative, the ASEAN Climate Data Hub, could integrate historical climate records from all ASEAN countries, ensuring interoperability, multilingual access and data consistency.

UK Expertise: The UK has extensive experience in climate data management, open-access platforms and AI-driven climate research.

Relevant UK Organisations: UK MET Office, Centre of Environmental Data Analysis, British Geological Survey

Research Prompt: What is required for ASEAN nations to successfully develop an interoperable, multilingual and AI-ready open-access climate data platform?

P

Incentivise digitisation and sharing of historical climate data

Lead: National governments
Beneficiaries: Government, academia

Many ASEAN countries have valuable historical climate records stored in non-digital formats (e.g. paper archives, handwritten weather logs). These records hold critical insights into long-term climate trends, but they remain largely inaccessible due to lack of digitalisation efforts. To address this issue, governments should provide financial incentives, grants and technical support to local government bodies, meteorological agencies, and research institutions to digitise and share historical climate data.

A notable example of such an initiative is the Climate Data Rescue project for Vietnam, Cambodia and Laos, led by DataSuds [30, 31], which is the institutional repository established by French National Research Institute for Sustainable Development (IRD). This initiative focuses on recovering, digitising and standardising historical climate data from national meteorological agencies in these three countries, particularly for the colonised periods in 19th / 20th century, many of which still store weather records in paper-based archives.

To make these efforts effective, governments should provide funding and research grants to institutions willing to digitalize and share climate records. Promoting regional collaboration by establishing data-sharing agreements between ASEAN countries will further enhance access to historical climate data. Additionally, ensuring data privacy and security measures while keeping climate data open access will be crucial for long-term success.

P R

Digitise and incorporate Traditional Ecological Knowledge (TEK) into AI systems

Lead: Government, local communities
Beneficiaries: Local communities

In Southeast Asia, Traditional Ecological Knowledge (TEK) plays a vital role in sustainable resource management. An example of TEK is exemplified through Thailand's "Monkey Cheek" project, which uses traditional knowledge to manage water resources by mimicking the natural water storage function of "monkey cheeks" (natural depressions in the landscape). This approach helps in flood control and drought mitigation [32].

To advance ethical and inclusive AI for climate action, it is crucial to incorporate TEK into AI systems, ensuring that historical local expertise and cultural perspectives are respected and integrated into data frameworks. This integration can enhance the effectiveness of climate solutions by leveraging both traditional wisdom and modern technology.

To incorporate TEK into AI systems, governments and local communities should establish collaborative partnerships with indigenous communities to document and digitise TEK, ensuring proper consent and data ownership protocols are in place. This process should also involve creating user-friendly interfaces and multilingual outputs for AI systems, making the integrated knowledge accessible to local communities for decision-making and adaptation strategies.

UK Expertise: The UK has developed significant expertise in integrating traditional knowledge with AI-driven climate solutions, particularly through frameworks that promote participatory design and community engagement, ensuring that AI systems respect and incorporate local expertise and cultural perspectives.

Relevant UK Organisations: Alan Turing Institute, Oxford Insights

What frameworks or methodologies can be developed to integrate AI and traditional ecological knowledge, ensuring that AI systems respect and support cultural perspectives and local language nuances?

6. Enhance AI-based climate risk assessments

Action Rationale

As climate change intensifies, Southeast Asian countries face increasing risks from extreme weather events, rising sea levels, floods, droughts and heatwaves. Traditional climate risk assessment methods, which rely primarily on historical climate data and manual modelling, often lack the speed and accuracy needed for real-time decision-making. To enhance climate resilience, Southeast Asian nations must adopt AI-driven climate risk assessment methods that can process vast amounts of climate data, detect patterns and generate highly accurate, real-time climate risk predictions.

AI-based climate risk assessment offers several advantages. Machine learning models can analyse historical climate records, real-time weather data, satellite imagery, and IoT sensor inputs to generate more precise climate forecasts. AI can also identify localised climate risks at a granular level, enabling policymakers, business and communities to proactively mitigate climate-related threats. Additionally, AI models can continuously improve their accuracy by learning from new climate data, making them more adaptable and reliable than traditional forecasting method.

To accelerate AI-driven climate risk assessment, Southeast Asian countries must develop national AI models tailored to their specific climate challenges. These models should be trained on local climate data, incorporate regional risk factors, and be integrated into national disaster response systems. By doing so, Southeast Asian nations can enhance early warning systems, improve climate adaptation policies and strengthen disaster preparedness.

Action Description

P R

Develop national AI models for climate risk assessment

Lead: Government, academia
Beneficiaries: The public

To effectively predict and mitigate climate risks, ASEAN nations should develop national AI-driven climate risk assessment models tailored to their specific geographic, environmental and socio-economic conditions. These AI models should be trained on local climate data, historical weather patterns, satellite imagery and real-time sensor inputs to ensure high accuracy and relevance. Additionally, they should be integrated into national disaster risk management systems, enabling real-time decision-making for government agencies, business and local communities.

One notable example is BencanaBot [33], an AI-powered disaster response chatbot developed in Indonesia to improve disaster preparedness, early warning systems, and emergency communication (see page 141). Utilising machine learning and natural language processing, BencanaBot delivers real-time disaster alerts, emergency response guidance, and localised risk updates by enabling residents to submit disaster reports which are then mapped in real time on PetaBencana.id, a free, open-source platform [34, 35].

UK Expertise: The UK has been at the forefront of AI-driven climate risk assessment, leveraging machine learning, geospatial analysis and big data to enhance disaster preparedness and resilience planning.

Relevant UK Organisations: UK Met Office, Alan Turing Institute, Centre for AI & Climate

Research Prompt: How can Southeast Asia develop climate risk assessment models that are tailored to the local environmental and socio-economic conditions with AI ethics, geospatial modelling and real-time climate data integration?

Computing

Key Actions for *Computing*

1. Enhance the energy efficiency of data centre operations

Action Rationale

The increasing demand for AI has significantly impacted the environment, particularly through the extensive use of data centres and other digital infrastructure such as network infrastructure and IoT devices. Among all digital infrastructure, data centres are the most energy-intensive, estimated to account for up to 21% of global energy demand by 2030 [1]. This is a concern especially for countries Indonesia, Thailand, Malaysia, and Vietnam who are experiencing a rapid growth in data centre investments and developments [2] (see pages 26, 42, 51, and 58). Malaysia, one of the fastest growing Southeast Asian data centre markets, is increasingly facing energy consumption concerns, with projections indicating that their energy use could exceed 5,000 MW by 2035 [3]. As the demand for data centers continues to grow regionally, so does the need for innovative solutions to enhance its energy efficiency and sustainability.

The governments of Indonesia, Thailand, Malaysia, and Vietnam could collaborate to provide tax breaks and other incentives to encourage the adoption of energy-efficient technologies and practices. The private sector could facilitate knowledge sharing and collaboration among data centre operators to disseminate best practices and innovative solutions. For example, Singapore has been exploring the use of AI technologies to optimise energy use and reduce carbon footprints [8].

Action Description

R

Improve energy efficiency of data centers through more advanced AI algorithms

Lead: Government, research institutions

Beneficiaries: AI tech providers, data centre operators, the environment

Data centres host the operations of many high-performance servers and provide cloud computing access to clients globally. Traditionally, to ensure the robustness and reliability of AI systems, scientists tend to use more sophisticated AI algorithms with more hyperparameters, which compromises energy efficiency. For example, GPT-4, a frequently used Large Language Model with approximately 1.8 trillion parameters, requires more time and power consumption than a lighter AI model. In early 2025, the newly released DeepSeek R1 uses lighter and smaller models, which are only 10% the size of GPT-4, without compromising the AI system's robustness and accountability [4]. Therefore, technological breakthroughs could vastly improve the energy efficiency of data centres and move towards a safer and more ethical AI.

Recently, there have been more Large Language Models (LLMs) designed and used in Southeast Asia, robust algorithms and unbiased data used. For example, SEA-LION and SeaLLMs [5, 6], which have been trained on over eight local languages used in Southeast Asia and making the model inclusive to different regions. SEA-LION has been used in customer service chatbots to enable effective communication across diverse linguistic groups [27].

Yet, these algorithms are built based on GPT-4 and LLaMA which are 'traditional' AI algorithms that has at least 7 billion parameters which is nearly 3 times more than DeepSeek R1 and would consume a lot more energy than light models such as DeepSeek R1 [5, 6].

UK Expertise: UK academics are working on developing computationally efficient AI models and reducing the environmental impact of AI systems [7]. UK organisations are also actively conducting research on ways to enhance sustainable AI, such as the Royal Academy of Engineering. The UK also has a growing startup ecosystem providing smart solutions for operational efficiency of AI data centres, such as SmartCT.

Relevant UK Organisations: University of Oxford, Royal Academy of Engineering, Institution of Engineering and Technology, BCS, the Chartered Institute of IT.

Research Prompt: What novel approaches can be developed to improve the computational efficiency and reduce the environmental impact of AI data centres in growing Southeast Asian markets?

M I

Use smarter building control systems (such as AI enabled systems) to monitor energy usage in real-time, identify inefficiencies, and optimise operations

Lead: Data centre operators
Beneficiaries: Local communities, government, AI tech providers, startups

Integrating a real-time IoT sensing system with AI to create a smart Building Automation System (BAS) is a crucial step toward reducing the carbon footprint of AI data centres. Smart BAS systems control and monitor building functions such as heating, ventilation, air conditioning, lighting, and security. In Southeast Asia, AI-driven energy efficiency in data centres is still in its early stages, with a pilot project in Singapore between ABB and ST Telemedia Global Data Centres exploring the potential of AI modelling to optimise energy use.

By incorporating AI into the BAS, data centre managers can gain better visibility, be more proactive in facility operations, optimise energy consumption, and reduce carbon emissions. For example, a smart BAS can monitor cooling system performance, allowing managers to adjust cooling capacity based on actual data center needs, which, in return, reduce energy consumption and carbon emissions while maintaining optimal operating conditions for IT equipment.

UK Expertise: UK has developed significant expertise in implementing smarter building control systems. A few tech startups in the UK have also established mature markets (such as OpenBlue and Cube Controls) and proved its cost reduction in utility and maintenance bills.

OpenBlue offers smart building solutions to create smart, autonomous buildings that are more efficient, secure, and sustainable [28]. Cube Controls specialises in smart HVAC control to improve energy efficiency and sustainability [29].

Yet, such smart applications are less recorded in Southeast Asia. Singapore is the leading country in implementing AI enabled smart building control. ST Telemedia Global Data Centre In Singapore has been exploring how to use AI technologies to optimise energy use and reduce carbon footprint [8].

Relevant UK Organisations: Alan Turing Institute, InnovateUK

Research Prompt: How can smart building control systems be implemented in AI data centres in Southeast Asia? What would be the costs and potential savings?

M I

Deploy innovative data centre cooling measures

Lead: Data centre operators
Beneficiaries: Data centre operators, the environment

Given Southeast Asia's tropical climate, cooling remains a significant challenge. Data centers in the region could benefit from adopting advanced cooling techniques to reduce energy consumption, which currently accounts for up to 40% of a data center's energy use [9]. Liquid cooling offers significant energy savings compared to traditional air cooling, with potential reductions of up to 40% and a PUE as low as 1.05, far surpassing the typical 1.5-2.0 PUE of air-cooled systems [10]. This efficiency presents an opportunity for Southeast Asia to collaborate with global leaders developing advanced thermal management solutions for data centers. One such partnership in Malaysia between PETRONAS Lubricants International in Malaysia and UK-based Iceotope served to develop advanced thermal management solutions for data centers, facilitating knowledge sharing and transfer (refer to page 125 for more detail).

M I

Deploy renewable energy sources to power data centres

Lead: Government, data centre operators, investors
Beneficiaries: Energy providers, data centre operators, the environment

Southeast Asia has significant renewable energy potential, with over 220 GW of documented prospective utility-scale solar and wind capacity [11]. Globally, leading technology companies have spearheaded the use of renewable energy in data centre operations. For example, Google uses a combination of solar, wind, and battery storage to power its data centres, significantly reducing its carbon footprint [12].

Malaysia has also made strides in renewable energy usage for data centres, with the new green data centre irix in Santubong, Sarawak becoming the first in the country to receive Tier IV certification thanks to its sustainability and renewable energy implementation [13]. To capitalise on this potential, Southeast Asian countries can accelerate the deployment of renewable energy sources for data centres by implementing supportive policies and incentives. For example, following Google's model of co-locating data centres with renewable energy sources, governments and data centre operators can collaborate to develop industrial parks that integrate data centre capacity with dedicated clean energy plants [14].

2. Establish governance of green digital infrastructure and adapt sustainable practices

Action Rationale

The expanding digital economy in Southeast Asia has surged the demand for data centres and cloud computing. In 2023, the Southeast Asia region's data centre market attracted $10.23 billion in investments, with projections reaching $17.73 billion by 2029. The data center construction market is expected to reach $5.29 billion by 2029 [15]. Given the rapidly growing business opportunities in digitalisation and the energy demands of data centres, it is crucial to establish governance for green digital infrastructure and adopt sustainable practices throughout the lifecycle of data centres. However, such practice is missing among all countries in Southeast Asia, apart for Singapore [16].

For this action, governments within the region could develop a regional framework under ASEAN to harmonize green infrastructure standards and practices across member states. The private sector, academia, and governments are encouraged to undertake joint initiatives and projects to address common challenges and leverage regional strengths.

Action Description

P

Enforce the implementation of green standards in AI data centre design and adaptive use

Lead: Government, data centre operators
Beneficiaries: The environment, government, data centre operators

In Singapore, the Green Mark for Data Centres is a rating system that encourages the adoption of energy-efficient design, operation, and management of data centers [17, 18] **(See pages 133 – 135 for the case study on green data centre development)**. Other Southeast Asia countries have committed to enhancing the development of energy-efficient and sustainable data centers, such as Malaysia. In essence, Southeast Asia still need some time on the journey to create sustainable AI data centres.

Additionally, as the rapid growth of AI and investments, some traditional data centres in Southeast Asia are looking opportunities to repurpose to be AI data centres which consume significantly more energy [19]. Most of the building design code across the world assess the sustainability of new design and overlook adaptive use. Therefore, implementing green standards in AI data centre adaptive use is also important.

P

Enforce circular economy practices to reuse and recycle electronic waste

Lead: Government, private sector
Beneficiaries: Local communities, government
The rapid growth of AI technologies increases hardware demand and shorten equipment lifespan [20]. The AI industry could produce between 1.2 to 5.0 million metric tons of e-waste by 2030 [21]. In ASEAN, e-waste increased by 19.8% from 2015 to 2019, with some countries experiencing even steeper increases: Cambodia (46.2%), Lao PDR (70.0%), Myanmar (51.9%), and Vietnam (49.4%) [22].

By 2021, Southeast Asia's e-waste generation had surged to 12.3 million metric tons, yet as of 2022, only about 12% of e-waste generated in Asia was documented as collected for recycling, highlighting the region's need for proper e-waste management.

Implementing such circular economy practices can also create new business opportunities and revenue streams, such as selling refurbished equipment. For example, Google has successfully implemented circular economy practices in its data centres, achieving an 86% landfill diversion rate globally [23].

A few reports have highlighted that AI technologies could optimise waste sorting and recycling processes using computer vision techniques to separate different types of waste more efficiently, increasing recycling rates and reducing landfill use [24, 25].

UK Expertise: The UK government and industry initiatives have effectively helped the country to reduce the carbon footprint of data centres. The UK Green Building Council provides guidelines and support to implement green building standards and promote sustainable practices in the construction and operation of data centres [30]. It supports the use of AI technologies to optimise HVAC systems in buildings and adjusts HVAC operations to reduce energy consumption and carbon footprint while improving occupant comfort [31].

The private sector has issued green bonds to fund sustainable projects, including data centres. These bonds ensure that sustainability is integral to the growth of the data centre industry [26]. Such experiences could help Southeast Asia uplift the sustainability of data centres.

Relevant UK Organisations: UK Green Building Council

Research Prompt: How can Southeast Asian countries develop and implement an effective regulatory framework that enforces energy efficiency standards in AI data centres?

Talent & Skills

Key Actions for *Talent & Skills*

1. Encourage the use of AI innovations among smallholder farmers

Action Rationale

The agricultural sector in Southeast Asia is dominated by smallholder farmers, with over 100 million in the region [1]. Despite the potential of digital technologies to support sustainable agricultural practices, the adoption of AI innovations among farmers remains low. The development and application of new technologies, such as robotics, automation, and digital applications, are playing an increasing role in promoting climate-smart agriculture. As such, it is essential for farmers to enhance their technical skills.

This is especially urgent in countries where agricultural productivity has declined over time, as reported in Thailand, Indonesia, the Philippines, Lao PDR and Vietnam. Thailand's agriculture sector generates the lowest value added per worker in the economy [2], slowing the country's overall labour productivity growth. Smallholder farming households contribute to this, with 50% of households producing yields below the sector average [2]. This issue has been further exacerbated by climate vulnerabilities such as flooding and typhoons, which threaten crop yields and increase economic instability.

Introducing modern technology can help improve productivity and resource efficiency. In Thailand, 9 out of 10 agricultural labourers have access to mobile phones [3], and in Vietnam, 90% of farmers own one [4]. Although internet connectivity may be limited in rural areas, this digital access serves as an opportunity to introduce AI-driven agricultural solutions that can support farmers in increasing their productivity and climate resilience **(see Dokter Tania case study from Indonesia on page 145)**.

However, it is crucial to address the gender gap pervasive in technology adoption. Women play a vital role in Southeast Asian agriculture, often forming the backbone of farming communities, yet they frequently face barriers in accessing technology and resources. Research indicates that in 11 of 12 surveyed countries, women working in agriculture were between 5% and 40% less likely than men to own a mobile phone [5]. In developing regions such as Africa, this disparity extends to digital agriculture solutions, where only 25% of registered users are women, with field evidence suggesting the gender gap could be even wider when considering actual usage [5]. As such, targeted actions are required to improve female farmers' uptake of AI-driven agricultural tools.

Action Description

P R

Support agritech startups to create equitable AI-enhanced solutions

Lead: Government
Beneficiaries: Agritech startups, farmers

Southeast Asia's agritech sector faces high upfront costs and limited financing options to support innovation [6]. Governments should provide targeted financial support, such as grants and low-interest loans, to encourage the development of AI-enabled climate-smart agriculture solutions. Malaysia's Ministry of Agriculture and Food Security has done a successful job of providing grants to agritech startups through its Young Agropreneur Grant package, which provides extended assistance of up to RM 50,000 to develop agrotechnology solutions that utilise technologies like AI or IoT. 9,754 young entrepreneurs have been approved for grants as of September 2024 [7]. However, to ensure the effective adoption of these AI innovations, governments and innovators must also address the varying levels of digital literacy among farmers, to ensure the benefits of innovations reach all segments of the farming community.

UK Expertise: The UK has a strong ecosystem of AI-driven agritech solutions, with research institutions and startups developing precision farming, predictive analytics, and automated monitoring tools. UK-based initiatives have explored AI applications for smallholder farmers, including affordable remote sensing and AI-powered advisory platforms tailored for low-tech environments.

Relevant UK Organisations: Innovate UK, Agrimetrics, Alan Turing Institute

Research Prompt: How can AI-driven agricultural solutions be designed and implemented to be accessible for smallholder farmers of varying digital literacy levels?

P

Strengthen public sector agricultural extension services

Lead: Government
Beneficiaries: Smallholder farmers

Public extension services provide farmers with scientific education and good agricultural practices. Thailand's Department of Agriculture Extension has piloted digital tools to improve water and fertilizer use [8]. Promoting AI-enabled farming through extension agents helps scale implementation. Additionally, agriculture extension agents in Indonesia are teaching technology to farmers and monitoring adoption, especially in rural areas, ensuring social and economic inclusion [9].

P M

Establish public-private partnerships to provide farmers with access to emerging AI technologies

Lead: Government, AI technology providers
Beneficiaries: AI technology providers, farmers

Governments should collaborate with the private sector to scale AI adoption in agriculture. Private firms can provide AI expertise, while the public sector facilitates farmer outreach and implementation. For example, Vietnam's Department of Plant Protection under the Ministry of Agriculture and Rural Development and CropLife Vietnam committed to a five-year partnership, in which CropLife provides farmers with access to advanced plant protection technologies and sustainable farming practices [10].

P

Ensure gender-inclusive access to agritech solutions

Lead: Government, multilateral organisations, private agricultural businesses
Beneficiaries: Female farmers

When carrying out distribution of AI-enabled farming tools to farmers, relevant government bodies, multilateral organisations and/or agricultural businesses should develop engagement strategies that cater specifically to female farmers' needs. This could include recruiting and training female agents to interact with female farmers, and scheduling meetings at convenient times and locations to provide them hands-on experience with agritech tools. A successful example of gender-inclusive capacity building is the ASEAN Green Recovery through Equity and Empowerment Project, funded by the International Development Research Centre and implemented in Cambodia, Vietnam and the Philippines, which equipped women farmers with knowledge on farm planning, intercropping, and digital tools for agripreneurship [11]. The female farmers also received a technology package which included a smartphone, pocket WiFi, and prepaid cards to provide access to AI technologies and boost their livelihoods [11].

UK Expertise: The UK has a strong track record in integrating AI into agritech while ensuring technology remains accessible and inclusive. The Women in Agriculture Task Force, established by the Scottish government in 2019 [12], promotes gender equality in farming, including improving access to AI tools for female farmers.

Relevant UK Organisations: Women in Agriculture Task Force, Agri-Tech East, Innovate UK

Research Prompt: How can AI-enabled agritech innovations be designed to address the specific needs of female farmers in Southeast Asia, while overcoming barriers to access and usage to prevent bias in agritech uptake?

2. Build foundational AI literacy necessary to advance climate action

Action Rationale

Southeast Asia's population faces a significant digital skills gap. Projections indicate that by 2030, up to 80% of jobs in the region will require basic digital literacy and applied ICT skills [15]. However, in a report published by Deloitte, fewer than 67% of respondents in Southeast Asia believe that employees in their organisations have the level of skills required to use AI solutions responsibly [16].

There is a huge influx of AI-powered solutions from large-scale technology providers and startups aimed at addressing climate change. In 2022 alone, Southeast Asian agrifoodtech startups received US$1.7 billion across 192 recorded deals [17], demonstrating the rapid development of tech-driven innovative solutions to solve specific climate issues. Despite the rising presence of AI-enabled climate tools, implementation is limited by the skills gap present in local populations in Southeast Asia.

If the skills gap in Southeast Asia for AI literacy and AI skills is not addressed, it will exacerbate existing digital divides, particularly among rural communities and within climate sectors. A reported challenge in Southeast Asia is the lack of skills among farmers to effectively adopt digital technology, limiting their ability to increase productivity and growth [18].

Moreover, the lack of AI skills among rural communities will hinder their ability to leverage digital technologies for critical climate applications like AI-powered disaster reporting or early warning systems. As a result, there is a critical need to close the AI skills gap to alleviate socio-economic inequalities as well as achieve positive climate outcomes in the region.

Action Description

P R

Integrate AI skills and its climate applications into classrooms

Lead: Education institutions
Beneficiaries: Students

Introducing AI and climate change education into curricula is crucial for empowering Southeast Asia's next generation to address rapidly developing climate challenges. Students can develop a foundational understanding of AI's potential and its role in combating climate change. However, this may be challenging action to take forward in Southeast Asia, where significant educational gaps persist. UNESCO reports that climate change education alone "has not emerged as an independent field" and is "still very much in its infancy" in the region [19]. There is a need for more research to understand best approach to integrate these topics effectively considering Southeast Asia's unique context.

International Expertise: AI is increasingly integrated into classrooms worldwide, both as a teaching tool and a subject of study. Countries like the UAE, USA, and UK have begun introducing or studying ways to incorporate AI and climate change into their curricula. For example, ReadyAI, a US-based organisation, develops hands-on AI education programmes for elementary and middle school students to teach them how AI can be harnessed for social good [20].

Relevant International Organisations: UK Department for Education, the Incubator for Artificial Intelligence, ReadyAI, MIT OpenLearning

Research Prompt: How can Southeast Asian countries effectively integrate AI and climate change education into existing curricula to address the digital skills gap and prepare youth for future environmental challenges, given the region's varying educational levels and resource constraints?

P M

Foster multi-stakeholder partnerships to create AI-for-climate training, leveraging on existing expertise

Lead: Private sector such as AI technology providers, government, academia
Beneficiaries: Workers, local communities

Establishing public-private partnerships between AI technology providers, governments, and academic institutions can leverage collective expertise and create AI upskilling programs tailored to climate action. For example, Google collaborated with the Vietnam Farmer's Union from 2017 to 2020 to provide digital skills training to over 30,000 farmers in Vietnam, teaching them how to use agricultural apps and digital tools to improve productivity and adapt to changing environmental conditions [21]. Similar training programmes can equip workers with practical AI skills necessary to address climate challenges, improving their employability as well as enhancing the local talent pool available for employers.

P

Create a consolidated knowledge sharing platform to centralise information regarding AI-for-climate resources

Lead: Government
Beneficiaries: The public

Despite the growing availability of courses on AI applications such as climate data analysis, satellite-based monitoring, and machine learning for climate modelling offered by institutions like the Asian Disaster Preparedness Centre, the Asian Institute of Technology, Asia-Pacific Network for Global Change Research, a study by Amazon Web Services and Access Partnership found that 74% of workers were not aware of training opportunities available to them, thus limiting their participation [22]. To address this, governments should increase the visibility of AI-for-climate training through centralised platforms. SkillsFuture, implemented by the Singaporean government, is a successful example of a one-stop, user-friendly portal for training opportunities across all ages. It provides Singaporeans with seamless access to training courses, including those focused on digital and green upskilling [23]. National governments in Southeast Asia should develop a platform that can centralise all AI-for-climate resources, including training courses, events, conferences and publications.

P

Provide financial support to employers and employees to enhance participation of AI-for-climate upskilling courses

Lead: Government, employers
Beneficiaries: Workers, employers

Many workers in Southeast Asia face financial barriers to AI and climate-related upskilling. To encourage workforce participation in upskilling courses, governments should provide financial support through subsidies, grants or other measures to both employers and employees. In Thailand, the government offered 10,000 free slots for the course 'Unlock AI with Prompt Engineering', led by the Big Data Institute, to encourage its population to develop essential AI skills [24]. Similarly, Malaysia's Ministry of Human Resources, through the Human Resources Development Fund, implemented the Skim Bantuan Latihan, which supports employers by covering expenses such as course fees or external training providers [25]. Similar initiatives could be implemented by governments across Southeast Asia, specifically providing support for initiatives focused on AI upskilling to drive climate action. Lastly, employers in climate-related sectors also have a role to play by covering training expenses to encourage their employees to upskill in AI.

3. Nurture talent pool to develop cross-domain expertise in AI and climate change

Action Rationale

Southeast Asia faces a critical AI talent shortage. According to a study by Amazon Web Services, in Asia-Pacific, 79% of employers prioritise AI-skilled hiring but 75% struggle to find qualified candidates. This gap is particularly acute in specialised domains like climate applications, where the talent pool is narrow and nascent. The scarcity of high-tech expertise can cause the region to lag globally, potentially exacerbating brain drain. In Southeast Asia, brain drain has become a significant concern, with countries like Malaysia experiencing a brain drain rate of 5.5% of its population, significantly higher than the global average of 3.3% in 2023 [29].

Developing cross-domain expertise in AI and climate change is crucial for Southeast Asia. Combining AI capabilities with climate expertise leads to more accurate models and predictions, such as enhanced AI-powered weather forecasting in flood-prone areas [30]. This integration can also accelerate climate-related research and breakthroughs. Without cross-domain expertise, there comes a risk of creating technologically advanced yet environmentally ineffective AI solutions, potentially undermining climate efforts.

P M

Develop specialised apprenticeships and traineeships

Lead: Technology companies, government
Beneficiaries: Students, professionals

Develop apprenticeships to cultivate cross-domain expertise in AI and climate change, leveraging on private sector expertise. These programmes should combine intensive training with real-world project experience. For example, AI Singapore's Apprenticeship Programme has successfully trained 300 Singaporean AI Apprentices. The programme offers a 3-month intensive deep-skilling training followed by a 6-month real-world AI project [31]. Similar programmes could be developed focusing on enhancing cross-domain knowledge in AI and climate-related sectors such as agriculture, disaster relief, energy and water management, depending on each country's climate goals and needs.

P R

Increase access to specialised tertiary courses

Lead: Institutes of higher learning (IHL), research institutions, government
Beneficiaries: Students, IHLs

There is an opportunity to create AI and climate change-focused curricula at universities and polytechnics, as well as offer short-duration courses and deeper modules. University of Philippines Diliman offers a doctorate degree in AI, taking the lead as the first institution to do so across the region [32]. Additionally, partnerships with overseas renowned institutions like University of Oxford and University of Reading, which offer highly sought after AI and Climate Change courses, can provide valuable exposure and learning opportunities for Southeast Asian talent (refer to page 125 for more detail). Such courses shall provide accessible and easy-to-read learning materials to accommodate diverse learners. **Case study Kartu Prakerja (on page 146) engaged underrepresented population groups, such as women and the disabled, to ensure sufficient training opportunities are provided to these groups [27].**

P M

Offer competitive compensation packages to attract and retain talent

Lead: Government, private sector
Beneficiaries: Professionals, private sector

Offer competitive salaries and employment packages to highly-skilled local talent with domain expertise in AI and climate change. Governments can provide subsidies and financial support, while companies need to offer attractive compensation. The Malaysian government's MyDigitalWorkForce Work in Tech (MYWiT) initiative exemplifies this approach, providing a total of RM100 million in training and salary incentives for jobs in the technology sector. This programme aims to create 6,000 job opportunities and produce at least 1,000 quality tech talents [33]. MYWiT offers incentives between US$2,375 and US$4,980 per employee for companies hiring digital business service roles [33]. Employers also recognise the need for competitive rates, with a study by Amazon Web Services finding that employers are willing to pay 44% more for IT workers with AI skills on average across the Asia-Pacific region [22].

P M

Nurture female talent and leadership in AI for climate action

Lead: Government, private sector, multilateral organisations
Beneficiaries: Female leaders, employees and students

The gender gap in Southeast Asia's technology sector remains a pressing issue, with women representing only 32% of the workforce in the technology sector [34]. Globally, women comprise just 29% of the total AI workforce, as reported in the World Economic Forum's Global Gender Gap Index [34]. This underrepresentation not only limits diversity in problem-solving approaches but also hinders the development of inclusive AI solutions for climate challenges.

To address this gap, there is a critical need for upskilling and leadership development initiatives tailored for women in technology. Cambodia's AI Landscape study emphasises the importance of boosting female representation in STEM, including AI, to foster more inclusive innovation. Similarly, Malaysia's National Artificial Intelligence Roadmap (2021-2025) prioritises gender inclusivity by addressing barriers to women's leadership in technology fields [35].

Key actions to nurture female talent and leadership in AI for climate action include implementing targeted mentorship programmes and developing inclusive AI education. For example, mentorship schemes like the Women4Climate Mentorship Programme by C40 provide women with training, networking opportunities, and guidance from leaders in climate action [36]. Additionally, inclusive AI education and training programmes can be developed to combine climate science with AI skills, ensuring equal access and representation for female students. Such actions are essential for equipping women with the skills needed to lead in the development of AI-driven climate solutions.

Responsible Governance

Key Actions for *Responsible Governance*

1. Mandate AI governance frameworks to guide responsible AI use and enhance inclusion

Action Rationale

Mandating AI governance frameworks through national legislation is critical to ensuring the responsible, transparent, and ethical deployment of AI in climate risk assessment, and disaster management. As AI plays an increasing role in policy decisions, emergency response and resources allocation, a legal foundation is essential to standardising AI practices, ensuring accountability and preventing algorithmic biases.

By integrating AI governance into national laws, governments can enhance public trust, foster cross-sector collaboration, and safeguard human rights while ensuring AI-driven climate solutions are inclusive, equitable and aligned with sustainable development goals. In Southeast Asia, where climate risks are intensifying, a strong legal framework will help ensure AI applications in disaster response and climate adaptation remain transparent, fair and reliable.

Social inclusion must also be a core principle of AI governance. Climate change impacts are not experienced equally, with vulnerabilities shaped by factors such as gender, socioeconomic status, geography, and access to technology. According to the State of Gender Equality and Climate Change in ASEAN (2022) [2] report, women and marginalised communities in Southeast Asia often face disproportionate climate risks due to existing social and economic inequalities. Furthermore, disparities in data access and AI development resources between large corporations and smaller enterprises, including startups and local innovators, can exacerbate power imbalances, limiting equitable participation in AI-driven climate solutions. Without inclusive and accountable AI policies, algorithmic biases may reinforce these inequalities, restricting access to climate adaptation tools, early warning systems, and disaster relief efforts for vulnerable populations and underrepresented stakeholders.

Action Description

P

Establish national AI governance, which should include the governance of AI applications for climate change

Lead: Government, academia
Beneficiaries: Government, private sector

Currently, Lao PDR, Myanmar, Cambodia and Timor-Leste do not have established national AI governance.

Developing national AI guidelines, regulations and strategies is the foundational step toward structured AI governance. This involves creating a comprehensive regulatory framework that outlines ethical principles, risk mitigation strategies, and best practices for AI applications in disaster management and climate resilience.

AI can play a transformative role in climate action, from predicting extreme weather to optimising renewable energy and enhancing carbon monitoring. However, without robust governance, AI solutions risk exacerbating biases, privacy concerns, and accountability gaps. National AI guidelines should ensure data privacy, fairness, and transparency in climate decision-making.

For instance, ethical AI frameworks can prevent biases in climate forecasting, wildfire detection, and carbon tracking, ensuring vulnerable communities have access to critical information. AI-driven climate risk assessments should incorporate equity-focused approaches, protecting low-income communities, women, and indigenous groups from disproportionate impacts.

A relevant model is the EU AI Act, which classifies AI by risk level and emphasizes transparency in high-risk applications, including environmental monitoring (European Commission, 2023). ASEAN nations can adapt similar principles to make AI-driven climate solutions ethical, inclusive, and effective.

By integrating AI governance into national climate policies, governments can maximize AI's potential for climate resilience while ensuring fair, transparent, and accountable AI development.

Key Actions for *Responsible Governance*

P

Enact existing national AI governance related to AI applications for climate change, ensuring compliance and enforcement

Lead: Government
Beneficiaries: Government, private sector

The Philippines, Indonesia, Malaysia, Vietnam and Thailand have established AI governance, be it in the form of a national strategy or guideline. The next step for these national governments is to enforce AI governance through legally binding regulation and laws. This involves legislating AI accountability, defining compliance mechanisms and establishing regulatory bodies to monitor AI applications in climate risk management and disaster response. These laws should ensure that AI used in public safety and environmental monitoring undergo regular audits, impact assessments, and human oversight, to prevent misuse or unintended harm.

A notable example is the European Union's AI Act [2], which classifies AI applications based on risk levels and enforce strict transparency, accountability, and safety requirements for high-risk AI systems, including those used in disaster forecasting.

P

Develop AI fairness audits standard

Lead: Government
Beneficiaries: Government, private sector

Developing and mandating fairness audits in AI-driven climate adaptation and disaster response is crucial for ensuring equity, transparency, and accountability. According to Landers & Behrend (2023) [3], fairness audits help evaluate bias in AI models, particularly in high-stakes applications such as disaster prediction and resource allocation. Their framework emphasises three key perspectives: individual attitudes, ethical and legal standards, and technical fairness, ensuring AI decisions do not disproportionately disadvantage marginalised communities. In Southeast Asia, where countries such as Indonesia, the Philippines, and Vietnam frequently face climate disasters, fairness audits can prevent urban-centric biases in AI-driven early warning and relief systems.

In climate action-related data, fairness audits help identify and mitigate biases in satellite-based climate monitoring, carbon credit assessments, and predictive models for extreme weather events. For example, AI models forecasting floods or wildfires must be tested for geographic and socio-economic biases, ensuring equitable resource distribution.

Landers & Behrend (2023) propose a 12-component audit framework to ensure fairness, transparency, and data diversity in AI systems. Their framework covers three key areas: (1) AI model evaluation, which assesses data representativeness, model design, and bias mitigation; (2) Information transparency, ensuring clear communication of AI decisions to affected communities and stakeholders; and (3) Ethical and cultural considerations, addressing how AI impacts different populations and aligns with fairness principles [3].

AI fairness audits shall ensure the alignment of AI practices with human rights principles, the implementation of ongoing monitoring to detect and address biases or unfair outcomes as the AI system operates, as well as assess the AI training data for biases and ensure it represents diverse populations. Such ensures AI systems operate fairly, especially for rural, indigenous, and low-income communities.

Governments should adopt regulatory frameworks similar to the EU AI Act (2023), requiring pre-deployment fairness audits to mitigate systemic biases. As Landers & Behrend highlight, fairness audits should be proactive and interdisciplinary, integrating psychological principles, machine learning validation, and ethical AI governance. By mandating fairness audits, ASEAN can enhance trust and inclusivity in AI-driven climate solutions, ensuring equitable disaster preparedness. This research provides a valuable reference for ASEAN countries to establish fairness audits in AI-driven climate adaptation, ensuring equitable, transparent, and accountable AI systems for disaster response.

Key Action for *Responsible Governance*

UK Expertise: The UK has strong expertise in AI governance, climate resilience, and sustainable technology, making it a valuable partner for ASEAN countries. Institutions like the Alan Turing Institute, UK AI Council, and Centre for Data Ethics and Innovation (CDEI) have developed frameworks for ethical AI deployment, ensuring transparency, accountability, and fairness. The UK also leads in AI-driven climate solutions, with Imperial College London and DeepMind advancing AI for climate modeling, disaster forecasting, and energy efficiency.

Relevant UK Organisations: Centre for Data Ethics and Innovations, Alan Turing Institute

Research Prompt: In the context of AI systems making autonomous decisions for climate crisis management, what legal and ethical frameworks should be established to determine liability and ensure accountability when AI-driven decisions lead to unintended negative consequences?

2. Create specialised government bodies at the intersection of AI and climate change

Action Rationale

AI has immense potential to enhance climate resilience, disaster management, and sustainable development. However, without dedicated government oversight and structured coordination, AI initiatives risk being fragmented, underutilised, or misaligned with national priorities. Establishing specialised AI governance bodies ensure that AI policies and applications are strategically developed, ethically implemented and effectively scaled.

These bodies will facilitate collaboration between government agencies, research institutions, private sector innovators and local communities, ensuring that AI solutions are tailored to national and regional climate challenges. By integrating scientific research, policy expertise and public engagement, these institutions can help bridge the gap between AI advancements and real-world climate action, fostering trust, inclusivity and accountability.

Action Description

P

Establish an AI taskforce for streamlined governance

Lead: Government, academia
Beneficiaries: Government, private sector

A national AI Taskforce will be responsible for developing, coordinating, and which shall be overseeing AI -driven climate resilience initiatives in responding sustainable development goals or national targets. This taskforce will serve as the central authority for AI applications in climate monitoring, disaster preparedness and sustainability planning. It will also be responsible for developing national AI standards, ethical guidelines, and risk assessment frameworks for AI deployment in climate-related domains.

For example, Singapore's National AI Group under Ministry of Digital Development and Information established one of the first National AI strategies in the world, which provides a roadmap to enable widespread, responsible adoption of AI. [1, 4]. Setting up a centralised National AI Group helped to ensure a streamlined and coordinated governance of AI initiatives across Singapore. Malaysia also set up National AI Office in 2024, which aims at transforming Malaysia from an AI consumer into AI producer by building robust AI ecosystem, starting from preparing datasets related to AI technology to creating future action plans for incorporation. [5]

P

Establish multi-stakeholder AI advisory councils to ensure diverse representation in AI policy development

Lead: Government
Beneficiaries: Government, private sector

AI governance must be inclusive and representative of various societal interests. A multi-stakeholder AI advisory council will bring together government leaders, AI researchers, private sector innovators, environmental organisations, and civil society groups to shape ethical AI policies for climate resilience. This council will ensure that AI policies are equitable, sustainable and aligned with public interests.

Key responsibilities of the multi-stakeholder AI advisory councils include providing policy recommendations, on AI ethics and regulations, ensuring AI driven solutions prioritize social equity and encouraging responsible AI innovation by setting guidelines for AI fairness, bias mitigation and environmental sustainability.

For example, Singapore's Model AI Governance Framework [6] for Generative AI by AI Verify was developed through consultation with multiple stakeholders, including academia, industries and public sector stakeholders, which ensures the framework are socially responsible and widely accepted.

Key Action for *Responsible Governance*

UK Expertise: The UK has a well-developed AI governance ecosystem, with dedicated institutions ensuring AI is deployed ethically and strategically for climate resilience. The Alan Turing Institute, UK AI Council, and Centre for Data Ethics and Innovation (CDEI) provide models for national AI taskforces, developing AI policies, risk assessment frameworks, and ethical guidelines.

Relevant UK Organisations: . The Alan Turing Institute, Centre for Data Ethics and Innovations

Research Prompt: What governance frameworks and ethical guidelines can be developed to mitigate the risks of dual-use AI technologies in climate monitoring, particularly to prevent their misuse for unauthorised surveillance or military purposes?

Innovation

Key Actions for *Innovation*

1. Foster AI innovation for climate action

Action Rationale

Southeast Asia's innovation landscape is dynamic, driven by rapid digital transformation, a thriving startup ecosystem, and increasing investment in emerging technologies. The region's digital economy has grown significantly, with profitability increasing 2.5 times from US$4 billion to US$11 billion between 2022 and 2024 [1]. This expansion is fueled by a young, tech-savvy population, rising internet penetration, and a strong entrepreneurial culture. Countries such as Indonesia and Vietnam are positioning themselves as regional hubs for innovation, attracting venture capital and fostering AI-driven solutions [2].

The region's innovation ecosystem is highly startup-driven. Compared to sectors such as finance or retail, AI-driven climate innovation remains relatively underfunded and fragmented. Existing climate-tech startups often struggle with limited access to capital, regulatory barriers, and a lack of cross-sector collaboration. The challenge lies in bridging this gap by fostering targeted investments and stronger cross-stakeholder collaboration.

Action Description

P M

Enhance research and development (R&D) of AI-powered climate change solutions

Lead: Government and tech companies
Beneficiaries: Local AI developers, climate researchers, and environmental organisations

To harness R&D to develop safe, trustworthy and ethical AI-powered solutions to local climate change challenges in Southeast Asia, there is a need for increased government and private sector investment to establish dedicated and relevant research initiatives. These initiatives should encourage cross-border partnerships between research institutions and private companies, focusing on sector-specific initiatives such as renewable energy optimisation, sustainable agriculture, and/or disaster preparedness, depending on country context. Governments should also provide grants, tax exemptions, tax credits and/or subsidies to encourage such R&D activities. For example, Thailand offers complete tax relief on qualifying R&D expenses to incentivise research in focus areas such as science and technology [3]. Global grant initiatives such as the Climate Change AI Innovation Grants programme, which has already provided 22 grants across 22 countries, also serves as an example of support provided for driving cutting-edge R&D at the intersection of AI and climate change [4].

P M

Implement regulatory sandboxes to spur climate tech innovation

Lead: Government, private sector
Beneficiaries: Green technology innovators, startups and incubators

Implementing regulatory sandboxes is crucial for fostering innovation in climate tech by providing a controlled environment where new ideas can be tested without the constraints of traditional regulations, as shared during an interview with the Tech for Good Institute. Key considerations for governments include establishing clear sandbox guidelines ensuring safe, trustworthy and ethical AI principles are fulfilled, coordinating cross-border testing corridors, and establishing platforms to share lessons learnt [5]. The private sector should also actively participate and be open to sharing data for testing purposes.

Countries in Southeast Asia have existing experience implementing sandboxes tailored to addressing country-specific needs. For example, the Philippines has an agricultural insurance sandbox to protect farmers, while Malaysia has a drone sandbox to solidify its position as a regional drone hub [5]. In Singapore, sandboxes to test green AI technologies such as green data centre innovations and carbon accounting technologies (see **Unravel Carbon on page 147**) will be established to bridge gaps between research and practical application [6]. This can be leveraged to create future sandboxes focused on AI applications addressing pressing climate challenges unique to each country's context.

Key Actions for *Innovation*

UK Expertise: The UK has a strong track record in AI ethics, responsible technology deployment, and climate-focused AI innovations. Institutions like the Alan Turing Institute have advanced research on mitigating biases in AI and ensuring equitable technology access, while UK-based Centre for AI & Climate supports innovative, responsible AI applications to address the global climate crisis [7].

Relevant UK Organisations: FCDO's Research and Evidence Directorate (RED), UK Research & Innovation (UKRI), Alan Turing Institute, Centre for AI & Climate

Research Prompt: How can the innovation inequality between more technologically advanced countries and developing countries be addressed, to ensure AI-driven climate solutions bring equitable access to and benefits from these technologies?

Scaling

Key Actions for *Scaling*

1. Attract private investment and involvement to scale AI-driven climate innovation

Action Rationale

Southeast Asia faces a significant climate investment gap, requiring an estimated US$1.5 trillion by 2030 to fund the region's green transition [1]. While the region is uniquely positioned as an emerging hub for climate innovation, with climate tech deals growing from 3.2% of all venture funding in 2019 to 9.5% in 2023 [2], it faces substantial challenges in scaling these solutions. High costs, fragmented regulation and limited access to growth-stage funding impede the commercialisation of promising innovations, despite strong momentum in early-stage development.

Furthermore, the climate tech investment landscape in Southeast Asia is imbalanced, with a disproportionate share concentrated in Singapore and Indonesia. These two countries alone accounted for over 90% of the total deal value in the region's climate tech sector in 2023 [2]. This concentration of capital poses a significant challenge, as underfunded countries risk falling behind in developing and implementing crucial climate solutions. As such, scaling solutions will also need to be inclusive to countries across the region to ensure benefits are widespread.

Action Description

P M

Increase access to early-stage funding to catalyse development of AI-driven climate tech innovation

Lead: Government, private sector (angel investors, venture capital firms, large tech providers)
Beneficiaries: Startups, investors

Climate tech investment is rapidly on the rise in Southeast Asia. Early-stage venture rounds (before Series B) dominate the landscape, accounting for about 85% of deal volume in recent years [3], indicating strong potential for growth. The funding landscape for climate tech is also increasingly diverse, with interest rising in clean energy and carbon management from major players like Temasek Holdings, Breakthrough Energy Ventures, and BlackRock [4].

The early-stage funding ecosystem typically begins with seed funding, where companies raise capital from angel investors, seed venture funds, or accelerators. Pre-Series A funding serves as a bridge for start-ups showing traction but not yet prepared for a full Series A round. Series A funding is sought by startups with a minimum viable product ready to scale, such as **Qarbotech in Malaysia (refer to page 148)** and **EasyRice in Thailand (refer to page 149).**

Offering tax incentives to angel investors and venture capital firms to stimulate investment in climate tech is one approach. Additionally, governments can create opportunities for start-ups to connect with potential investors. For instance, Indonesia's NextICorn platform promotes and links promising local start-ups with global investors and provides scaling resources [5]. Such initiatives foster a more robust early-stage funding ecosystem by facilitating investor connections and providing startups with essential resources. There are numerous private-led funding streams being made available in the region. For example, the APAC Sustainability Seed Fund 2.0 led by AVPN, Asia's largest network of social investors, has a US$5 million allocation for technology-led climate solutions in the Asia Pacific region [6].

Governments can also strategically use public funds to catalyse private investment in climate tech. The Monetary Authority of Singapore is spearheading the Financing Asia's Transition Partnership (FAST-P), an initiative aimed at mobilising up to US$5 billion for climate projects in Southeast Asia [7]. FAST-P uses blended finance to reduce risk for private investors, bridging funding gaps for climate tech startups, including those developing AI-driven solutions [7]. This approach, which combines public, private, and philanthropic capital, aligns with ASEAN's broader climate finance strategy. Singapore has committed US$500 million in matching concessional funding to support this initiative [8]. Similar initiatives could be replicated across Southeast Asia to support the scaling of promising climate AI innovations.

P M

Foster partnerships between climate-tech startups and larger private sector companies to attract commercial capital and leverage established distribution channels

Lead: Private sector
Beneficiaries: Climate-tech startups

Fostering partnerships between climate-tech startups and larger private sector companies is crucial for scaling AI-driven climate solutions in Southeast Asia. This action leverages the innovative capabilities of startups with the resources and established networks of larger corporations.

Several successful examples of such partnerships have emerged in the region. Energy corporates like Banpu and Schneider Electric have been actively investing in climate startups through their venture arms, focusing on distributed solar, carbon markets, and automated energy trading across Southeast Asia [9]. These partnerships have not only provided startups with funding but also enabled them to scale their solutions more rapidly by tapping into the networks and expertise of larger companies. Similar types of partnerships with a specific focus on the funding of safe, trustworthy and/or ethical AI-for-climate applications should also be established.

2. Leverage stakeholder networks and funding to scale AI-driven climate innovation

Action Rationale

There is a significant investment gap to fund Southeast Asia's green transition. An estimated $1.5 trillion is needed until 2030, with only $45 billion made across dedicated green investments since 2021 [1]. To bridge this gap, leveraging stakeholder networks and funding sources is crucial. Southeast Asia benefits from a robust ecosystem of multilateral organizations, aid agencies, and regional partnerships that can be tapped into.

Action Description

P

Tap on existing cross-border climate networks and partnerships to scale climate tech innovations

Lead:	Government, multilateral organisations
Beneficiaries:	Startups, SMEs, researchers

Strengthening regional and bilateral partnerships is key to unlocking cross-border market expansion. Such partnerships can help scale innovations by streamlining market entry and reducing regulatory barriers to neighbouring markets in Southeast Asia. Such regional cooperation can help accelerate the deployment and adoption of climate tech innovations.

Southeast Asia has an existing ecosystem of networks and initiatives focused increasing funding for climate action and AI, which can be leveraged on. Utilising existing platforms like the ASEAN Climate Change Initiative (ACCI) and the ASEAN Working Group on Climate Change (AWGCC) can help identify high-impact areas for collective action and facilitate knowledge transfer across the region [10]. These existing networks provide a strong foundation for collaboration and knowledge-sharing in the climate tech and AI space.

P

Leverage international funding and grants focused on scaling AI-driven climate tech innovation

Lead:	Government, international organisations
Beneficiaries:	Local communities, startups, SMEs

Governments should collaborate with international organisations such as multilateral development banks and aid agencies to create more targeted financing opportunities for AI-driven climate solutions, ensuring a robust ecosystem of financial support is established. This could involve establishing dedicated funds or expanding existing programmes with international bodies to specifically support startups and SMEs developing AI applications for climate action. For instance, Mercy Corps Ventures' initiative, which commits up to US$1 million to grant partners for testing first-of-a-kind AI solutions to increase climate resilience in vulnerable communities across Africa, Asia, and Latin America, provides a blueprint for such targeted support [11].

Existing regional funding initiatives like the ASEAN Green Investment Catalyst [12] and the ASEAN-UK Green Transition Fund have also been successfully channelling investment into strategic green sectors in Southeast Asia. By tapping into these established funds and partnerships, innovators can accelerate the deployment of AI-powered climate solutions.

3. Close the gender gap in climate tech investment

Action Rationale

Despite progress in climate tech innovation most notably in Indonesia, Thailand, the Philippines, Malaysia and Vietnam, there remains a significant gender gap in this sector. Women-led startups receive only 7% of venture capital funding in emerging markets, with just 10% invested globally into women-led climate tech ventures [13]. This disparity highlights the need for targeted financing to support women innovators in climate tech.

Action Description

P

Support women-led climate tech projects through targeted financing support

Lead: Government, international organisations
Beneficiaries: Local communities, women-led startups and entrepreneurs

Governments, international organisations, and private investors should lead efforts to create gender-specific funding opportunities for AI applications in climate action. For instance, the UN Women Climate Tech Accelerator aims to empower women-led climate tech startups in ASEAN countries [14]. Similarly, the Climate Investment Funds and Asian Development Bank have prioritized gender inclusion in climate tech projects, providing initial capital to attract additional investment [15]. These initiatives demonstrate the potential for dedicated financing to address gender inequity and unlock innovative AI-driven climate solutions driven by women with diverse perspectives.

M

Raise equity for women-led climate tech innovations to catalyse growth

Lead: Private sector, investors
Beneficiaries: Investors, local communities, women-led startups and entrepreneurs

To promote gender diversity in climate tech investment portfolios, investors can implement several strategies. Incorporating gender diversity questions into due diligence questionnaires can help prioritise this aspect during the evaluation process. Additionally, investors can actively seek out and support women-led startups, provide mentorship opportunities, and create networking platforms specifically for female founders in the climate tech sector. For example, Amazon's commitment to invest over US$50 million from its Climate Pledge Fund into women-founded and women-led climate companies [16] exemplifies a step that the private sector can take towards addressing this gender gap in climate tech funding.

Key Actions for *Scaling*

UK Expertise: The UK has established itself as a global leader in AI-driven climate solutions, with significant investments and expertise in this field. UK-based AI climate tech firms saw a remarkable 128% increase in investment, from £440 million in 2023 to £1.01 billion in 2024 [17].

Relevant UK Initiatives: Climate Adaptation and Resilience (CLARE) – ASEAN Project [18], Net Zero Innovation Portfolio

Research Prompt: How can financing mechanisms for scaling AI-driven climate innovations be designed to ensure inclusivity for local startups and communities?

04

Collaboration Opportunities

Collaboration Opportunities

This section identifies key collaboration opportunities between the UK and Southeast Asia, identifying specific countries within the region where each collaboration can create the most impact for advancing safe, ethical and trustworthy AI for climate action. These collaborations provide a foundation for meaningful cross-border engagements.

The opportunities were selected based on the following criteria:

- Alignment with Southeast Asia's AI, technology, and development priorities.
- The UK's expertise and leadership in AI topics.
- Strategic distribution across the six enabling pillars to ensure comprehensive impact.
- Integration of GEDSI principles to drive inclusive benefits for communities such as women, low-income groups and rural populations.

Talent exchange

Establishing talent exchange programmes between the UK and Southeast Asia can facilitate knowledge transfer and nurture talent through developing specialised cross-domain knowledge in AI and climate change (refer to page 107), leveraging UK universities' offer of climate data sciences courses involving AI and machine learning to bridge the region's AI skills gaps (refer to page 16). Candidates suitable for talent exchanges include local students enrolled in courses about climate change available in Malaysia, Thailand, Vietnam, the Philippines, Indonesia and Cambodia, who would benefit from exposure to AI applications. For example, Thailand's Chulalongkorn University's MA in Environment, Development and Sustainability [1] teaches key concepts of climate change but does not explicitly mention intersections with AI and technology. As such, students can enhance their learnings by gaining experience with AI applications in climate change from relevant UK universities.

Promising university courses in the UK to facilitate such talent exchanges include the University of Reading's MSc in Climate Change and Artificial Intelligence [2], Imperial College London's MSc in Environmental Data Science and Machine Learning [3], and the University of Cambridge's AI for Environmental Risk research community [4]. These courses mostly focus on climate data science, which includes modelling and analysis of environmental datasets such as climate data and biodiversity data.

Innovation of energy-efficient computing infrastructure

Lending AI expertise for green innovation presents a significant opportunity for collaboration between the UK and Southeast Asia, more specifically Malaysia and Indonesia, home to some of the largest data centre markets in the region. A key area for collaboration is in developing energy-efficient computing infrastructure suited to tropical environments, which is a growing concern for data centre operations in Malaysia and Indonesia (refer to page 98). This partnership can leverage the UK's leadership in green data centres – specifically its renewable energy integration, advanced cooling systems, and usage of AI, IoT and ML for forecasting energy use – to address the unique environmental challenges of data centres in the region [5]. Such collaborations can replicate or build off existing partnerships such as the one between Malaysia's PETRONAS Lubricants International and the UK's Iceotope, which focuses on creating advanced thermal management solutions to reduce emissions and water usage in data centres (refer to page 98).

Such collaboration offers UK data centre operators the opportunity to tailor its innovations to the unique Southeast Asian context and expand its technologies to new markets. Meanwhile, Southeast Asia can gain positive environmental impact from the innovation of energy-efficient AI solutions.

Funding for priority areas in AI-driven climate action

The UK supports Southeast Asia's green transition through initiatives like the ASEAN-UK Green Transition Fund [6], providing financial and technical assistance to accelerate green economic growth. The GSMA Innovation Fund for Impactful AI [7], funded by UK International Development, offers grants and venture building support to small enterprises leveraging AI for transformative impacts in low- and middle-income countries, including Southeast Asia, except Myanmar. While existing UK-led funding mechanisms support AI applications in climate action, a dedicated funding stream for AI-driven climate solutions in Southeast Asia could accelerate innovation in growing climate tech ecosystems like Malaysia, Indonesia, Vietnam, the Philippines, and Thailand. It could also target lower-income economies where AI applications are nascent, such as Lao PDR, Myanmar, Timor-Leste, and Cambodia.

One key area for targeted funding is green mobility, leveraging UK leadership in the sector, particularly in the adoption of electric vehicles (EV) as Europe's largest EV market in 2024 [8]. Indonesia, Thailand, Malaysia and Vietnam have set ambitious goals for green transport including EV adoption, and are exploring AI applications for green transport (refer to pages 22, 38, 46, and 54 respectively). As such, expanding UK-ASEAN financial and technical support can advance AI-driven climate solutions, particularly in priority areas such as green transport.

Additionally, the integration of AI for urban heat mitigation in Southeast Asia remains underdeveloped, presenting a ripe opportunity for funding to catalyse the development of AI tools specifically designed to address the pressing issue of urban heat islands.

Knowledge transfer partnerships

A systematic approach to transferring research and knowledge in AI-based climate action to products or services in Southeast Asia, modelled after Innovate UK's Knowledge Transfer Partnership (KTP) scheme, can drive the progress of safe, trustworthy, and ethical AI development in the region. Innovate UK's KTPs connect businesses and organisations with academic experts to turn innovative ideas into reality, with £50 million invested annually by Innovate UK and over 800 live projects currently underway. Southeast Asia would greatly benefit from being part of such knowledge transfer schemes with UK experts, leveraging the UK's expertise and research outcomes to accelerate the innovation of AI solutions for climate action [9].

For example, the UK has been leading research on computationally efficient AI models, with organisations like the National Engineering Policy Centre conducting projects aimed at creating environmentally sustainable AI systems [10]. Southeast Asian countries, such as Malaysia, Indonesia, Vietnam, Thailand, and the Philippines, with rapidly increasing AI adoption, are seeking novel approaches to enhance AI energy efficiency, which could be applied to increasingly used LLMs (refer to page 97). Overall, knowledge transfer from research bodies from the UK to Southeast Asian AI practitioners can strengthen the region's AI capabilities in climate action but also provide the UK with access to a broader market and talent pool.

Bridging the gender gap in climate tech leadership and funding

Southeast Asia faces a significant gender gap in climate tech funding as well as leadership representation within the climate tech startup ecosystem (refer to page 122), mirroring challenges the UK has been actively working to overcome. The UK has made strides in nurturing female leadership in climate tech through initiatives such as Women in Cleantech (WiCT), a Mayor of London-funded project [11]. WiCT supports female founders and innovators by facilitating collaboration and providing tailored resources to strengthen women's participation in the sector. There is a strong opportunity for the UK to extend its expertise to Southeast Asia by developing similar programmes providing mentorship and resource sharing for female climate tech entrepreneurs. Countries such as Thailand, Malaysia, Indonesia, Vietnam, and the Philippines, where climate innovation is rapidly growing yet women remain underrepresented in leadership roles, would particularly benefit from structured UK-SEA collaboration.

In addition, there is significant opportunity to provide targeted funding for female entrepreneurs in climate tech. While organisations like GSMA offer funding for Southeast Asian climate tech startups [7], there is a lack of funding tailored to women-led startups in Southeast Asia. A dedicated funding portfolio that supports female-led, AI-driven climate tech ventures in the region can help empower female entrepreneurs and bridge the gender gap.

Development of local climate data infrastructure

To address the disparities in climate data collection and accessibility in Southeast Asia, particularly in flood-prone regions with limited meteorological coverage such as the Philippines (Mindanao), Vietnam (Mekong Delta), and Myanmar (Irrawaddy Delta), there is an opportunity to build local climate data collection infrastructure through the deployment of low-cost IoT climate sensors (refer to pages 91 and 92).

The UK can play a key role in this effort by leveraging its expertise in climate data and digital infrastructure. Climate research institutions such as the UK Met Office have extensive experience in climate data analysis, modelling, and forecasting, which would support the development of a localised climate data network in Southeast Asia. Southeast Asian telecom providers, such as Viettel, can establish the connectivity infrastructure necessary for real-time data transmission. Additionally, IoT sensor manufacturers can provide cost-effective, scalable sensor solutions for the pilot deployment of IoT sensor networks in Southeast Asia's most vulnerable areas. This initiative can also be supported by funding sources such as UK PACT [12], which focus on climate resilience, digital infrastructure, and fostering international collaboration between the UK and Southeast Asia.

05

Best Practices in the Region

Case Studies

Case Studies

Overview

The selected case studies deep-dive into best practices of safe, trustworthy, and ethical AI deployment for climate action across Southeast Asia. The selection process was guided by several factors to ensure a comprehensive spread of examples:

- Geographical diversity was considered to include examples from different countries in Southeast Asia, reflecting varying levels of readiness and development across the region.
- Alignment with enabling pillars such as computing, data, talent, and governance was prioritised.
- The availability and reliability of information of case studies were also evaluated, focusing on examples which are well-evidenced and can clearly demonstrate positive impacts and outcomes.

Case Study 1: Enhancing Reliable Flood Forecasts with AI

Case Study 2: Green Data Centres for AI Development

Case Study 3: High Carbon Stock Approach in Indonesia

Case Study 1: Enhancing Reliable Flood Forecasts with AI

Background

As one of the most common natural disasters, floods disrupt the lives of many and cause significant losses worldwide every year. Climate change, alongside dense urban settlements and socioeconomic in exposed areas, amplifies the adverse impacts of flood [1].

In view of the urgent need for flood forecasting, Google has launched a flood forecasting initiative to improve global preparedness, developing a real-time system that provides alerts via Google Search, Maps, Android notifications, and the its Flood Hub since 2017. Over the years, Google showcased how machine learning significantly improves flood forecasting in data-scarce areas [2].

Successes

Traditionally, extensive streamflow data records are required to calibrate hydrological simulation models for flood assessments. The use of AI in this initiative has helped to make available early warnings up to five days ahead for floods in countries and areas that lack dense streamflow gauge networks, where reliable flood forecasts were lacking. This AI-based forecasting system has also shown similar or better accuracies relative to the existing global flood system based on conventional modelling approach for the more impactful flood events with a return period of five years [3].

Enablers & Opportunities

This case study highlights how one enabling pillar (innovation) could help to bridge the gaps in another enabling pillar (data), i.e. the application of machine learning algorithms helped solve the streamflow data gaps in the less developed areas.

Such a model could also be adapted for other use cases in early warning systems and crisis management for climate change adaptation beyond the flood hazards, such as for the prediction of wildfires and heatwaves that have severely impacted the Southeast Asian region under the changing climate.

Safe, Trustworthy and Ethical AI

Safe: In the development of this forecasting systems, robust evaluation was conducted by Google in collaboration with the European Centre for Medium-Range Weather Forecasts (ECMWF) in its role of CEMS Hydrological Forecast Centre – Computation, to benchmark the AI system against the state-of-the-art flood modelling system to ensure its reliability and accuracy of the output [3].

Trustworthy: A high-level of transparency is noted in this initiative, with all the results of the model evaluation being published on scientific journal such as Nature, allowing room for challenge by the modelling and scientific community. Besides, data sources used in the AI model are also made publicly accessible on its Google Flood Hub platform online [4].

Ethical: This AI development supports the World Meteorological Organisation (WMO) Early Warnings for All initiative, which aims to provide early warnings on climate hazards to everyone, including the vulnerable communities regardless of economic status, race and gender, and disability via warning dissemination via Google and Android services [5].

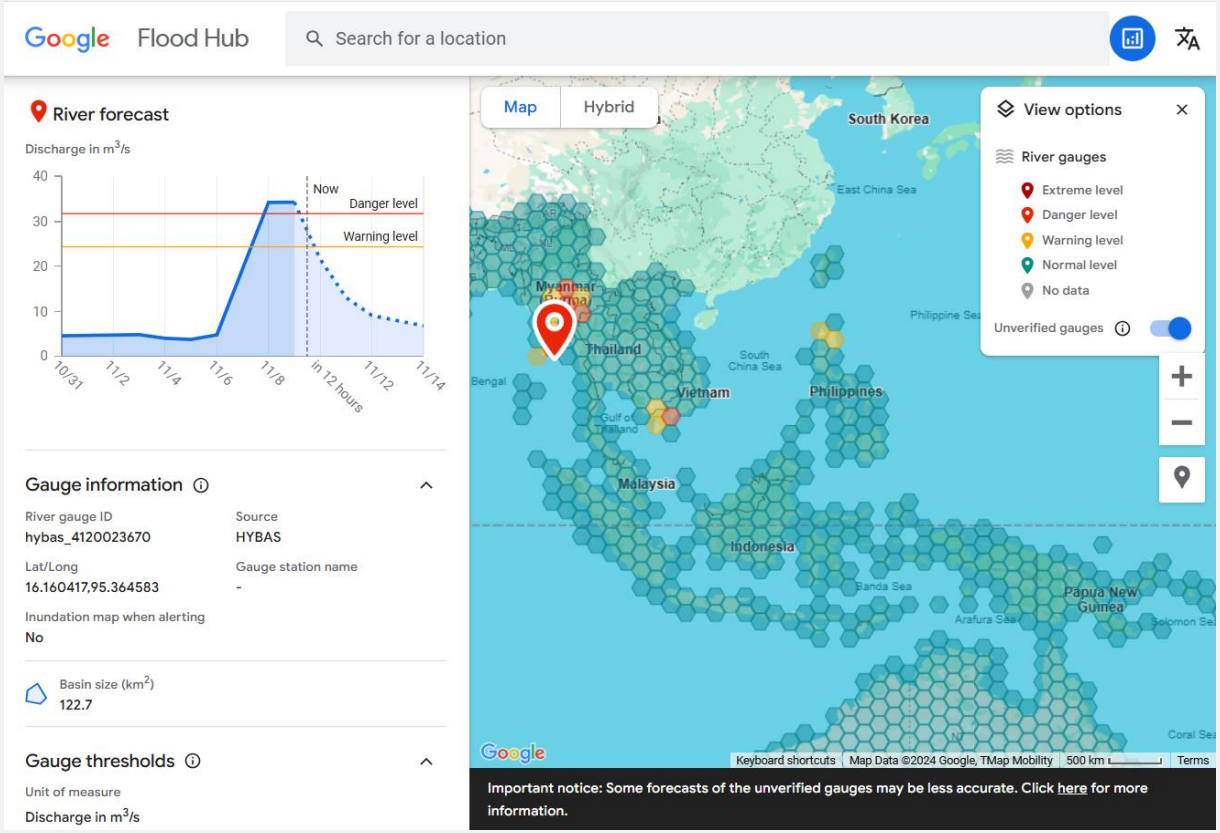
Other AI Applications In Weather Forecasting and Disaster Management

Globally, several other initiatives in the application of AI in weather forecasting, such as Huawei's Pangu-Weather and Google's DeepMind have also demonstrated satisfactory performance when compared with the state-of-the-art conventional weather prediction system [6]. In Southeast Asia, numerous initiatives have explored the use of artificial intelligence (AI) in weather forecasting and disaster management.

For example, in Bali, Indonesia, an AI-based early warning system has been implemented to detect seismic activity and provide valuable early alerts for earthquakes. . A study conducted on the island found that the system successfully detected the initial tremors of an earthquake before stronger seismic waves arrived, providing more than a minute of additional warning time [7].

In Vietnam, the Vietnam Meteorological and Hydrological Administration (VNMHA) has adopted AI and big data analytics to improve predictions of tropical cyclones. By analysing historical data and identifying patterns in previous storms, VNMHA can simulate potential future impacts and refine its forecasting models [8].

In the Philippines, a collaboration between the Department of Science and Technology (DOST) and Atmo, a company pioneering AI in meteorology, has led to the development of AI4RP (AI for Resilient Philippines). The second version of this AI model is tailored to the Philippines' local weather conditions, providing a level of detail and precision that generic global models cannot achieve. [27]



Case Study 2: Green Data Centres for AI Development

AI And Data Centres In Southeast Asia

Data centres are a vital component of Southeast Asia's digital economy, providing essential infrastructure for sectors such as finance, e-commerce, and social platforms. As AI technologies advance and digital services continue to expand, these facilities are under increasing pressure to meet rising demands. AI applications, in particular, require significant computational power, which has led to a surge in demand for data centres. These centres not only store vast amounts of data but also handle intensive real-time processing workloads that are crucial for powering AI technologies. As a result, Southeast Asia's data centre market is expected to grow from $10.23 billion in 2023 to $17.73 billion by 2029, emphasizing the need for greater efficiency, scalability, and sustainability in these facilities [1].

Global cloud service providers, including Amazon Web Services, Google, Microsoft, and Tencent Cloud, have already made substantial investments in Southeast Asia by establishing cloud regions in countries like Singapore and Indonesia. Now, these companies are continuing their expansion with plans to launch new cloud regions in Malaysia, Thailand, and other countries across the region. This ongoing growth reflects the increasing demand for cloud infrastructure and services as the region's digital economy continues to evolve. [1]

Climate and Environmental Concerns

Conventional data centres are known for their significant energy consumption. For example, training a single natural language processing AI model—used in applications like Siri, Alexa, Google Translate, and ChatGPT—can generate as much carbon dioxide as burning 300,000 pounds of coal. To offset this environmental impact, it would take approximately 4,500 tree seedlings growing for 10 years. Additionally, generating a single AI-generated image consumes as much electricity as charging a smartphone halfway. While this might seem less impactful than the energy used in training AI models, the enormous volume of images produced amplifies the overall environmental footprint, highlighting the need for more responsible usage of the technology. [2]

Data centres also face challenges in terms of energy efficiency, especially regarding their cooling systems, which are essential for keeping servers running continuously. In tropical regions like Southeast Asia, where the climate is hotter, the costs associated with cooling are even higher than in temperate areas. This, coupled with the ethical concerns of responsible AI deployment and its contributions to climate change, underscores the urgent need for sustainable practices in the sector.

Green Data Centres

A potential solution to mitigating the climate impact of traditional data centres is the adoption of green data centres. Green data centres are designed to minimize their environmental impact by focusing on energy efficiency, renewable energy sources, and innovative cooling solutions. They incorporate several key elements to achieve sustainability [3]:

- Energy-efficient infrastructure: Green data centres use energy-efficient servers, storage, and networking equipment to reduce overall energy consumption. Techniques like virtualisation also enhance resource utilisation, enabling multiple virtual servers to run on a single physical machine, further reducing energy needs. Renewable energy integration: These facilities rely on renewable energy sources such as solar, wind, and hydroelectric power, helping to decrease dependence on fossil fuels and mitigate carbon emissions associated with traditional energy consumption.
- Innovative cooling technologies: Advanced cooling methods, including liquid cooling, immersion cooling, and free-air cooling, are employed to minimize the energy required to maintain optimal server temperatures.
- Energy reuse: Waste heat generated by data centres is captured and reused in nearby industrial processes or district heating systems, further enhancing energy efficiency.
- Sustainable building design: Green data centres are constructed using eco-friendly materials and are designed to optimise natural light and airflow, which not only improves energy efficiency but also promotes a healthier working environment [6].

- Waste management: These facilities prioritize responsible disposal and recycling of outdated equipment, minimizing electronic waste and ensuring sustainability in their operations.

Challenges

Several challenges hinder the widespread adoption of green data centres in Southeast Asia:

- High initial costs: The construction of green data centres often requires significant upfront investments in technology and infrastructure. Renewable energy integration and advanced cooling systems are more expensive than conventional solutions.
- Energy infrastructure: Many countries in Southeast Asia still rely on fossil fuels as their primary energy source. While efforts are being made to increase renewable energy capacity, the overall energy grid may not yet be sustainable enough to support green data centres on a large scale. Given the rising demand for renewable energy, data centres are also competing with other sectors for green energy access.
- Regulatory barriers: Regulatory frameworks in some Southeast Asian countries may not yet fully support the development of green data centres. Land use policies, energy regulations, and incentives for green energy adoption are still evolving.

Green Data Centre Frameworks in Southeast Asia

Singapore

Singapore has recently launched its Green Data Centre Roadmap in May 2024. The roadmap is strategic framework developed by the Infocomm Media Development Authority (IMDA) and focuses on fostering sustainable growth in the data centre sector. Building on the Digital Connectivity Blueprint, the roadmap aims to provide at least 300 megawatts (MW) of additional capacity in the short term, with greater expansion driven by green energy solutions. It emphasizes innovative approaches to enhancing energy efficiency and unlocking additional capacity through hybrid green energy strategies.

The roadmap envisions creating an ecosystem that unites key catalysts and partners to accelerate sustainability in data centres across two areas:

- Improving energy efficiency at both hardware and software levels.
- Expanding capacity through increased adoption of green energy.

The data centre ecosystem involves a wide range of stakeholders, including suppliers of systems and equipment, sustainability solution providers, enterprise end-users, energy suppliers, and academia. Data centre operators are recognised as the key catalysts for fostering partnerships across this diverse ecosystem.

As part of the efforts under the roadmap, the IMDA has jointly developed with the Building and Construction Authority the Green Mark for Data Centres (GMDC) certification scheme designed to assess data centres' performances in energy efficiency, sustainable design and construction, use of digital tools and maintainability.

Malaysia

In 2015, the Malaysian Communications and Multimedia Commission (MCMC) introduced the Technical Code for the Specification of Green Data Centres to outline the minimum standards for green data centres. The aim was to guide the development of policies, systems, and processes that enhance energy efficiency while reducing the industry's carbon footprint.

Currently, certification is optional, allowing organisations the choice to pursue certification voluntarily. As the code is about 10 year-old, revision is underway to take into account current technologies and industrial standards. In addition, the Ministry of Energy Transition and Water Transformation (Petra) and the Ministry of Investment, Trade and Industry (Miti) have announced a robust framework on energy and water efficiency can be expected [5].

Indonesia

The Indonesian Data Center Organizers Association (IDPRO) has developed a green data centre standard for the country's data centre industry. This standard includes five key metrics for assessing carbon usage effectiveness (CUE), energy reuse effectiveness (ERE), water usage effectiveness (WUE), water efficiency (WET), and sustainable design (SUS) in data centres.

The Greenship Data Center, a comprehensive evaluation tool for green data centres, was also created through a collaboration between the Green Building Council Indonesia (GBC Indonesia) and IPUSTAH-ID (Ikatan Profesional Pusat Data Hijau Indonesia – Association of Indonesia Green Data Center Professionals). The Greenship Data Center certification program was launched to officially recognise data centres that meet these established

Other Countries

Despite the increasing recognition of sustainability in Southeast Asia, other countries in the region, while implementing energy efficiency policies and green building codes, still lack dedicated standards for green data centres. The data centre sector in these countries remains under-regulated in terms of environmental and climate impact. This absence of targeted standards leaves a gap in ensuring that data centres, which are energy-intensive by nature, are designed, built, and operated in an environmentally responsible manner.

Case Study 3: High Carbon Stock Approach in Indonesia

Background

Indonesia faces significant challenges due to climate change and deforestation, with over 70% of its forests lost or degraded in the past 50 years due to increasing demand for agricultural land use [1]. This loss threatens not only biodiversity but also the livelihoods of local and indigenous communities who rely on forests for survival.

To combat these issues, the FAIR Forward initiative, a GIZ program aimed at promoting the open and sustainable use of AI, collaborated with local participatory mapping groups Ekologika and Indonesian Community Mapping Network (JKPP), as well as the High Carbon Stock Foundation to identify Indonesian forests with high carbon storage that should be prioritised for protection, also known as ‘high-value forests’. The High Carbon Stock Approach (HCS) was utilised for this project to analyse and prioritise forests with high carbon storage potential. The HCS methodology helps farmers identify and avoid high-value forests when looking for new areas to expand into. This helps ensure that any development does not violate protected or high-value areas [1].

Leveraging AI, the data collected through this initiative has been used to enhance accuracy of forest classification. AI positively contributed to climate mitigation action, by enhancing data-driven forest mapping and monitoring. The project has empowered local stakeholders to make informed decisions that promote sustainable land use.

Picture source: FAIR Forward

Successes

The collaboration between GIZ and local community groups has led to several notable successes:

- Active community engagement: Over 40 participants from various regions of Indonesia were trained in data collection methods [1], ensuring that local knowledge and perspectives were integrated into forest mapping efforts.
- Improved data accuracy and access: This project will make available anonymized data and forest maps to relevant ministries and decision-makers, providing essential tools to inform local sustainable land use planning.
- Free, Prior, and Informed Consent (FPIC): The project emphasizes FPIC as a critical component of its success, ensuring that local communities are informed about the data collection process and have a say in how their information is used. FPIC prioritizes the active involvement of local and indigenous communities, safeguarding the rights of vulnerable groups to ensure their land and resources are used only with their informed and voluntary consent [2].

Enablers & Opportunities

Several key enablers have facilitated the success of this initiative:

- Governance: Effective governance structures enable collaboration among stakeholders, ensuring that community voices are heard in decision-making processes.
- Talent: Training over 40 community members in data collection techniques helped to build capacity and empower them to utilize these environmental monitoring meaningfully [1].
- Data: The initiative relies on high-quality data which was collected through participatory methods, ensuring accurate forest mapping and classification.
- GEDSI: The project prioritised the inclusion of FPIC, ensuring local and indigenous groups were fully informed and their data rights safeguarded.

Safe, Trustworthy, and Ethical AI

The project has ensured that AI is deployed responsibly, aligning with the needs and rights of local communities in Indonesia.

Informed consent: Adhering to FPIC ensures that local communities are fully aware of how their data will be used and have a say in the process. This builds trust between stakeholders and fosters a sense of ownership among communities [1].

Mitigating bias: Efforts were made to reduce biases in AI algorithms by involving diverse community representatives in data collection and algorithm development. This inclusivity helps ensure that the technology serves all populations equitably.

Cultural sensitivity: By utilising language models tailored to various local languages, the initiative respects cultural diversity while enhancing communication about climate issues within communities [2].

Picture source: FAIR Forward

Locally Led Innovations

Local Innovations

Overview

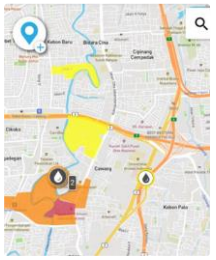
This section introduces local-level innovations in Southeast Asia that leverage AI to drive impactful climate action solutions. The innovations selected have been developed by local startups and organisations from the region, to showcase the huge potential for innovation to address pressing environmental challenges specific to this region. The selection of examples was guided by three main criteria:

- Geographical diversity: Innovations from various Southeast Asian countries were included to reflect the region's diverse levels of readiness and development.
- Alignment with enabling pillars: Priority was given to projects that align with proposed actions outlined earlier, ensuring clear relevance across all pillars.
- Evidence of impact: Well-documented innovations with demonstrable positive outcomes were prioritised.

Data

Jejakin: AI-Powered Carbon Management Platform

Data



PetaBencana.id: Real-time Disaster Info Sharing System

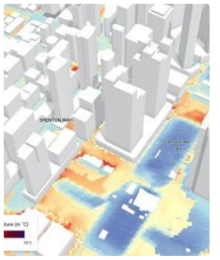
Data

AIMVIE: AI Solutions for Mangrove Blue Carbon

Data

Project NOAH: AI-Driven Disaster Preparedness and Resilience

Data



Cooling Singapore 2.0: AI-powered UHI Mitigation Initiative

Talent & Skills

Dokter Tania: AI Chatbot for Farmers in Indonesia

Talent & Skills

Kartu Prakerja: AI-enabled national training and jobs platform

Innovation

Unravel Carbon: AI-Powered Decarbonisation Platform

Scaling

Qarbotech: Photosynthesis Enhancer Solution using AI and Nanotech

Scaling

EasyRice: AI-Powered Rice Quality Inspection Solution

Local Innovation

Jejakin: AI-Powered Carbon Management Platform

Jejakin is a climate tech company with integrated carbon management platform from Indonesia. Its CarbonAtlas platform supports the monitoring and management of nature-based carbon projects. This includes tracking growth and measuring the impact of reforestation and other biodiversity restoration efforts. The CarbonAPI enables seamless integration of carbon accounting tools into existing systems, making it easier for enterprises to embed sustainability into their workflow. AI, combined with satellite imaging and IoT sensors, is used to monitor and manage reforestation and biodiversity projects. This not only ensures accurate tracking of environmental impacts, but also reflect and server different climatic contexts which ensure fairness and trustworthiness of AI [1].

Key Features

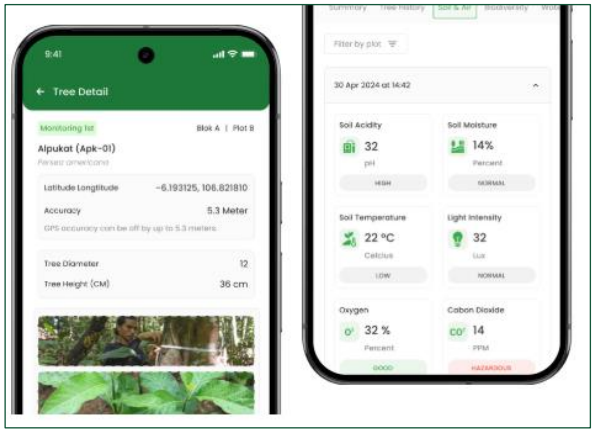
- A mobile app enabling offline data collection and real-time IoT sensor integration for seamless field monitoring.
- High-resolution satellite and drone data processed in-platform for precise environmental analysis.
- Custom sensors measuring water levels, soil quality, bioacoustics, and energy use, ensuring reliable, high-quality data.
- A comprehensive platform for carbon tracking and reforestation monitoring with advanced analytics and dashboards.

Impact

- Monitored around 60,000 hectares of land.
- Planted 1.7 million tree which absorbed almost 14.300 tonnes of carbon emission.

Lessons Learned

- Leveraging a combination of advanced technologies such as IoT sensors, satellite imaging, and AI can significantly improve the monitoring and management of environmental projects, ensuring data reliability and accuracy, and thus responsible deployment of AI.
- Achieving meaningful climate action requires collaboration among businesses, governments, and communities. Jejakin's approach highlights the importance of collective efforts in driving positive change.



Field monitoring app of Jejakin. Source: Jejakin

Local Innovation

PetaBencana.id: Real-time Disaster Information Sharing System

In Indonesia, Yayasan Peta Bencana, a disaster relief non-profit organisation has innovatively used AI to contribute to disaster management efforts, through the development of the PetaBencana.id platform. PetaBencana.id is an open source and free website that provides a comprehensive real-time overview of disaster situations. This is facilitated through BencanaBot, an AI-assisted chatbot which automatically responds to social media posts containing disaster-related keywords, asking users in disaster-affected areas to confirm their situation by submitting a disaster report. Each report will include details regarding location, disaster severity, a photo and description [3]. These reports are then instantly mapped on the PetaBencana.id website. This integration of local knowledge enables residents, humanitarian agencies, and government bodies to make informed and timely decisions during disaster emergencies [2].

Key Features

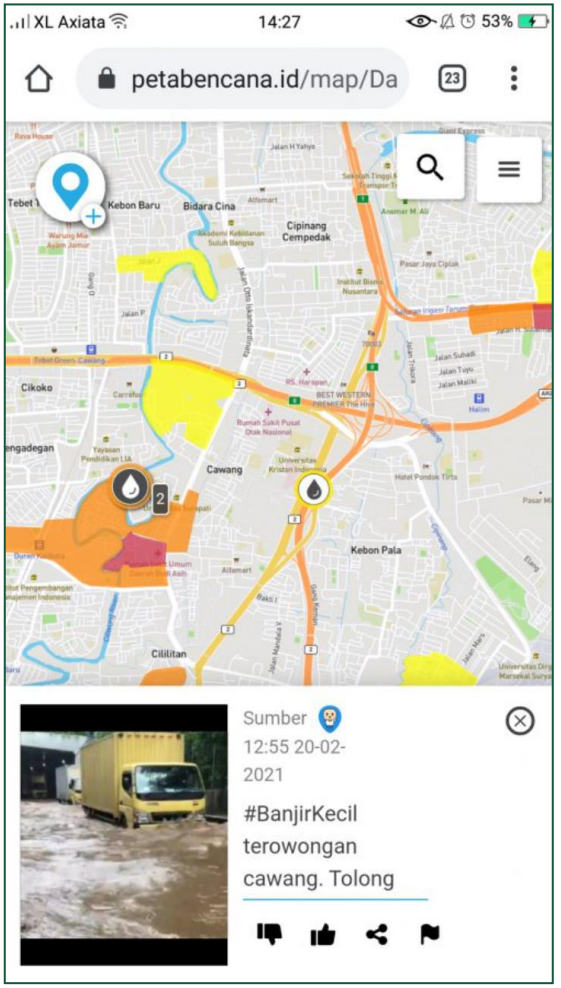
- Integration with messaging platforms: BencanaBot is integrated into popular messaging platforms such as WhatsApp, Twitter, Facebook Messenger, and Telegram, making it widely accessible.
- Anonymity: BencanaBot allows anonymous reporting, enabling engagement from individuals who might be hesitant to disclose their identity or personal information.
- User accessibility: The platform is designed intuitively, making it accessible to users of varying digital proficiency.
- Open source and open data: The platform is built on CogniCity Open Source Software and utilises open APIs to integrate data from various sources, ensuring interoperability and transparency. [3]

Impact

- Over 213 million users engaged the platform in 2024. [3]
- 928 humanitarian organisations in 2024 utilised the data collected to support disaster response. [3]

Lessons Learned

- Transparency in AI decision-making: Transparent data collection processes help to build trust among users, and ensures that AI-driven decisions are explainable and accountable.
- Data privacy: Ensuring that user data is protected is essential for maintaining trust in AI systems, especially in sensitive contexts like disaster response.



Disaster Report on Petabencana.id. Source: Petabencana.id

Local Innovation

AI Solutions for Mangrove Blue Carbon in Vietnam (AIMVIE): AI-Powered Mangrove Monitoring Project in Vietnam

Vietnam, with its extensive coastline, hosts significant mangrove forests, which have massive carbon sequestration potential. However, these ecosystems face substantial threats such as deforestation. Between 1995 and 2019, Vietnam has lost 7.3% of its mangrove forests, with an annual decline rate of 0.3% [4].

AIMVIE seeks to develop AI solutions to monitor mangrove forests and their carbon sequestration in Vietnam. This project is delivered by University College Dublin and Can Tho University, Vietnam, with funding provided by Science Foundation Ireland and Irish Aid [5]. The project is being further developed based on its stakeholder workshop engagements, which have brought together local expertise from Vietnam's Department of Forestry and other local universities.

Key Features

- AI-driven mangrove mapping: AI models that fuse satellite and drone imagery are being developed to accurately map mangrove extent in Vietnam at high resolution and assess the carbon storage capacity of mangrove forests.
- Near real-time mangrove monitoring: The project is implementing a near real-time mangrove monitoring system to provide updated information on forest health and support restoration planning.
- Training provided: A training session was held, bringing participants from government, NGOs, universities and companies together to learn about UAV functionalities and applications, and how to generate digital elevation models for mangrove mapping [6].

Impact

- Enhances Vietnam's climate mitigation efforts by providing accurate data for carbon sequestration assessment and reporting.
- Improves local capacity through training and upskilling, enabling people to use advanced technologies and tools for mangrove monitoring [5].

Lessons Learned

- AI integration: The integration of AI with satellite and drone imagery proves effective in accurately mapping and monitoring mangrove forests at high resolution.
- Academic partnership: Collaboration between local universities and international researchers allows for effective knowledge sharing and brings the benefits of innovation directly to the country.

Source: AIMVIE

Local Innovation

Project NOAH: Enhancing Disaster Preparedness and Resilience using AI

Project NOAH (Nationwide Operational Assessment of Hazards) was launched by the Philippines' Department of Science and Technology as a pioneering disaster risk reduction and management initiative [7]. The project aimed to enhance the country's preparedness and resilience against climate-related disasters such as floods, typhoons, storm surges, and landslides by leveraging advanced technologies, including AI. This project has been into the University of the Philippines as the UP NOAH Center to continue its mission of conducting research, development, and extension services on natural hazards, disaster risk reduction, and climate change actions.

Key Features:

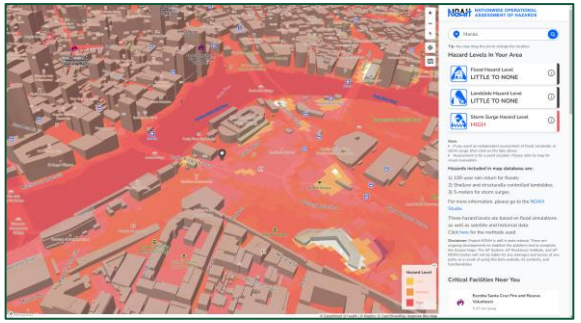
- Real-time weather and flood monitoring: Utilizes Doppler radars, automated rain gauges, and river sensors to track weather conditions and provide timely alerts.
- AI-enhanced hazard mapping: Employs AI algorithms alongside LiDAR technology and computer-assisted analyses to generate high-resolution flood, landslide, and storm surge maps. These AI models analyze historical data and real-time inputs to predict vulnerable areas with unprecedented accuracy [8].
- Web-based and mobile access: Offers an interactive platform (noah.up.edu.ph) for the public, local government units, and disaster agencies, ensuring widespread access to critical information.
- Integrated scenario-based assessment: Translates hazard maps into municipal-level risk assessments using AI to detail the exposure and vulnerability of communities.

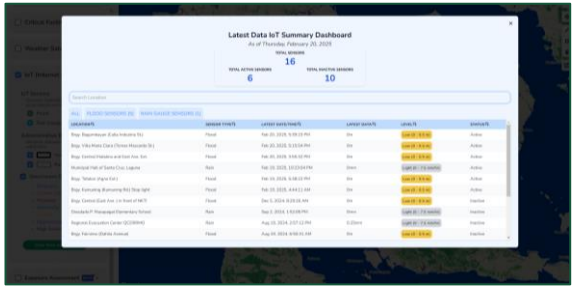
Impact:

- Improved disaster response: Provided up to 6-hour lead-time early warnings to agencies during disaster events which enabled faster and more coordinated actions, empowering local government units with disaster preparedness.
- Informed climate resilience policies and infrastructure: Identified potential locations for evacuation centers, contributing to the development of national and local climate adaptation plans.

Lessons Learned:

- Community engagement is key: Scientific tools and AI-driven solutions must be complemented by local knowledge and community participation to ensure effective implementation.
- Open data and collaboration enhance impact: Partnerships between academia, government, and private sectors strengthen climate action efforts and promote responsible AI use.





IoT Sensor Data Review, Source: Project NOAH, Landslide Hazard Assessment, Source: Project NOAH, Flooding Hazard Assessment, Source: Project NOAH

Local Innovation

Cooling Singapore 2.0: AI-powered urban climate initiative aimed at mitigating the Urban Heat Island (UHI) effect in Singapore

Cooling Singapore 2.0 is an AI-powered initiative designed to combat urban heat in Singapore [9]. Launched in 2021 by the Singapore-ETH Centre, NUS, TUMCREATE, and Agency for Science, Technology and Research, it uses AI, climate modeling, and digital twin technology to analyze and mitigate rising temperatures [10] . The project's Digital Urban Climate Twin (DUCT) integrates sensor data, machine learning, and weather simulations to predict heat distribution and test cooling strategies. AI helps optimise green infrastructure, reflective materials, and urban ventilation to enhance resilience. By providing data-driven insights, Cooling Singapore 2.0 supports policymakers in making science-based urban planning decisions for a cooler, more sustainable city [10].

Key Features

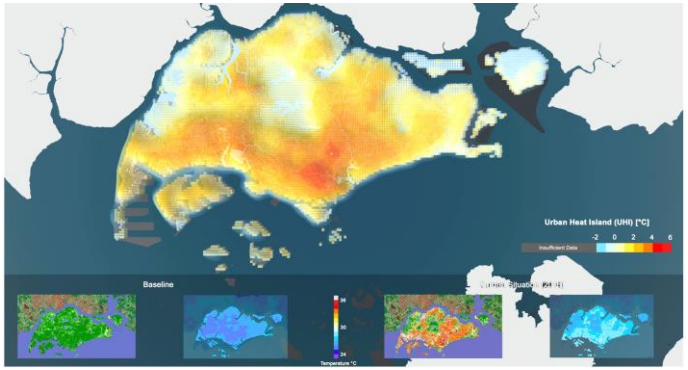
- Digital Urban Climate Twin (DUCT): AI-powered simulation tool that models urban heat scenarios and predicts the effectiveness of cooling strategies [10].
- AI-Based Urban Heat Mapping: Uses machine learning, satellite imagery, and IoT sensors to track real-time temperature variations across Singapore [10].
- Smart Green Infrastructure Planning: AI optimizes the placement of trees, green roofs, and vertical gardens to maximize cooling effects.

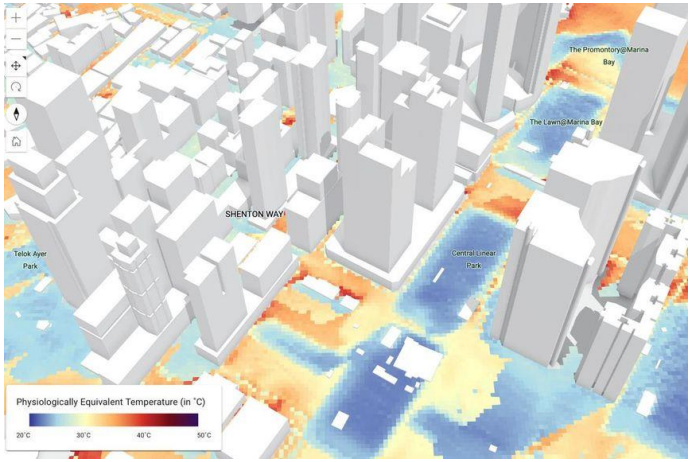
Impact

- Helps Singapore adapt to rising temperatures and climate change using AI-driven insights.
- Provides scientific data for policymakers to implement effective cooling strategies.
- Reduces the need for excessive air conditioning, lowering energy consumption and carbon emissions.
- Scalable for Other Cities: The DUCT model can be adapted for other ASEAN cities facing similar urban heat challenges. [10, 11]

Lessons Learned

- AI is a powerful tool for climate adaptation: Machine learning improves urban heat forecasting and mitigation planning.
- Data-driven decision-making is crucial: Real-time urban heat mapping helps prioritize cooling strategies effectively.
- Interdisciplinary collaboration enhances innovation: Success comes from combining expertise in AI, urban planning, and climate science.





Local Innovation

Dokter Tania: AI Chatbot for Farmers in Indonesia

Agriculture is a crucial sector in Indonesia, contributing around 14% to the nation's GDP, with 93% of the industry being driven by smallholder farmers [12].

Dokter Tania, launched by Neurafarm which is based in Bandung, Indonesia, is an inclusive and innovative AI-powered chatbot-based mobile application that helps farmers to identify crop disease and access information related to farming [14]. Neurafarm receives international and domestic support from technology providers such as Nvidia and Cisco, as well academic institutions such as Institut Teknologi Bandung [13].

Key Features

- Fertilizer Calculator: Helps farmers calculate fertilizer use more efficiently, reducing costs and increasing profits.
- Plant and Pest Identification: Allows farmers to identify plant diseases and pests by simply taking a photo, helping to reduce the risk of crop failure and increase harvests.
- Ask Expert Function: Provides farmers with access to agronomists who can offer expert advice anytime and anywhere, addressing issues directly in the field.
- Languages: Dokter Tania is offered in Bahasa Indonesia to ensure accessibility.

Impact

- Dokter Tania has extended help to 3,718 farmers in Indonesia, who manage a combined land area of 15,000 hectares [13].

Lessons Learned

- Key role of startups and enterprises: Agri-tech startups like Neurafarm play a key role in bridging knowledge gaps by offering farmers practical skills and support through simple, tech-driven solutions.
- Social inclusion: AI tools should be friendly, easy-to-learn and available in local languages like Bahasa Indonesia to ensure accessibility and wider adoption among farmers.

Dokter Tania Application. Source: Neurafarm

Local Innovation

Kartu Prakerja: AI-enabled national training and job-searching platform for Indonesians

In Indonesia, 86% of the workforce has never attended certified training, contributing to a skills mismatch in the labour market [14]. To address this, the Government of Indonesia launched the Kartu Prakerja programme, the country's largest training initiative, aiming to develop competencies and skills among its citizens. Beneficiaries can choose from a variety of training categories, including information technology and agriculture. The programme offers training vouchers to purchase courses. Kartu Prakerja operates through a digital multi-channel Government-to-Person system, integrated with four fintech companies and two conventional banks. This setup allows for large-scale incentive disbursements with high accuracy, speed, and transparency.

Key Features

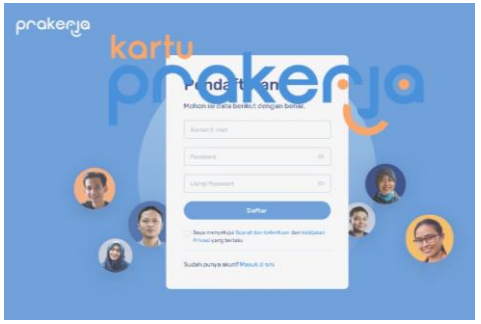
- API integration with four job platforms connects beneficiaries to the labour market through job recommendations and search features. More than 5,500 job vacancies are available on the dashboard, helping users find jobs based on their skills and training [14].
- Machine learning is used to provide personalized training recommendations.
- Upon completion of training, beneficiaries receive a certificate and post-training incentives, which are disbursed through e-wallets or bank accounts.

Impact

- Collaborated with 183 training institutions to provide over 1,000 training modules across various skills, including digital skills, green skills and foreign languages [14].
- A total of 18.9 million people participated in training nationwide over a 5-year period. Of the participants, 52% are women, while 3% are people with disabilities, ensuring training opportunities can benefit these groups [15].

Lessons Learned

- Leveraging digital platforms and AI can significantly enhance the reach and effectiveness of large-scale training programmes, increasing visibility and participation rates.
- Combining AI-powered systems with financial incentives and practical support can drive higher engagement and completion rates in training programmes. Similarly, this could be applied to AI training applied to climate action.
- Incorporating Diversity, Equity, and Inclusion metrics into impact assessments is essential for evaluating the effectiveness of AI and climate training programmes, ultimately ensuring that benefits are accessible to all.



Kartu Prakerja. Source: UMSU [16]

Local Innovation

Unravel Carbon: AI-Powered Decarbonisation Platform from Singapore for Southeast Asia

Unravel Carbon, founded in 2021 and headquartered in Singapore, is an innovative AI-powered decarbonisation platform that helps companies measure, reduce, and report their carbon emissions [17]. The platform leverages AI to convert accounting data into comprehensive supply chain carbon information within seconds, providing detailed emission analytics and generating relevant climate solutions automatically. The platform customises solutions for the Asia-Pacific, driving climate solutions localised to the region [17].

Key features of Unravel Carbon:

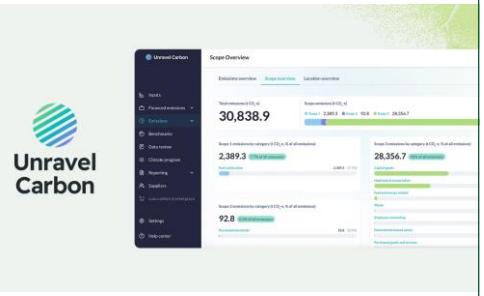
- Local AI-driven carbon insights: Converts accounting information into actionable carbon data using artificial intelligence, providing detailed emission analytics.
- Scalable architecture: Built on AWS serverless architecture, allowing for cost-effective scalability and efficient handling of peak compute demands.
- Global reach: Operates across Australia & New Zealand, Southeast Asia, and Hong Kong, focusing on Asia Pacific's supply chains.
- AI-assisted ISSB reporting: Offers the world's first AI-assisted solution for navigating the International Sustainability Standards Board (ISSB) framework [18].

Impact [1]:

- The serverless architecture enables cost-effective scalability, saving businesses up to $100,000 annually [19].
- Delivers up to 36% reduction in carbon emissions [19].
- Saves 50-60% of project time and manpower by automating much of the carbon emissions reporting process [19].

Lessons Learned

- AI for regulatory compliance: By offering AI-assisted solutions for navigating complex frameworks like ISSB, Unravel Carbon shows how AI can be leveraged responsibly to help businesses comply with evolving sustainability regulations.
- Transparency in AI-driven insights: Unravel Carbon's approach of providing detailed emission analytics and allowing for human review where it matters ensures transparency in its AI-generated insights.



Unravel Carbon software tool. Source: Unravel Carbon

Local Innovation

Qarbotech: Photosynthesis Enhancer Solution using Nanotechnology and AI in Malaysia

Qarbotech, a Malaysian agritech startup founded in 2018, has developed an innovative solution, QarboGrow, which enhances photosynthesis through the development of a biocompatible organic compound similar to chlorophyll, thus boosting agricultural productivity [20]. The company utilises nanotechnology and AI technologies to increase crop yields while reducing environmental impact. Qarbotech aims to expand its product into Singaporean and Indonesian market, fostering partnerships to facilitate product trials [21].

Key Features

- AI-driven photosynthesis enhancement: Qarbotech's patented technology uses machine learning and AI to optimise crucial growth conditions like temperature, humidity, and soil moisture for crops [20].
- Research-backed innovation: Qarbotech's technology originated from research at Universiti Putra Malaysia which then received a market validation grant, demonstrating successful commercialisation of academic research [22].
- Funding success: Qarbotech secured US$700,000 in seed funding and grants in 2023, including innovation grants from Temasek Foundation and Khazanah Nasional [23]. The company has secured US$1.5 million to set up its first manufacturing facility, aiming to produce 100,000 liters of QarboGrow monthly [24].

Impact

- Crop yield increase: QarboGrow has been recorded to boost agricultural productivity by increasing crop yields by 20 – 60% and improving photosynthesis efficiency by 100% [21].
- Extensive farm usage: 800 farms have used the QarboGrow product [20].
- Climate mitigation: The agricultural efficiency from QarboGrow has led to the removal of 3000 tons of additional CO_2 from the atmosphere [20].

Lessons Learned

- Academia-industry collaboration: The startup's origins in university research underscore the value of fostering partnerships between academic institutions and the private sector to commercialise innovative technologies.
- Access to funding mechanisms: Qarbotech's success highlights the importance of having various funding options available for startups, including venture capital, innovation grants, and challenge-based funding.
- Inter-country partnerships are crucial for successful market expansion: Ensuring regional governance and cooperation enables startups to access and expand into neighbouring markets and navigate regulatory environments, accelerating growth across borders [21].

QarboGrow, the photosynthesis enhancer.
Source: Qarbotech

Local Innovation

EasyRice: AI-Powered Rice Quality Inspection Solution in Thailand

EasyRice, a Thai agritech startup founded in 2019, has developed an innovative AI-driven solutions to enhance rice quality inspection as well as inspect paddy varieties, thus improving the efficiency of the rice supply chain in Thailand. In just one year, EasyRice captured a 30% market share of Thai rice exports, inspecting over 6 million tonnes of paddy varieties and rice [25]. EasyRice has also secured total funds worth around $2 million, which include pre-Series A funding [26].

Key Features

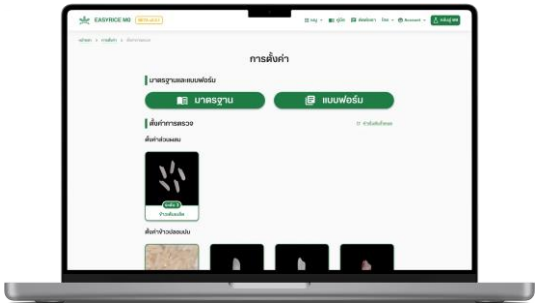
- AI-powered rice quality inspection: EasyRice's models are trained on large datasets of rice images to ensure accurate identification of rice defects and verification of rice quality. Its technology reduces rice inspection time to 3-5 minutes per 25g of rice, compared to 15-20 minutes using traditional methods [3].
- Paddy variety identification: An AI tool for inspecting paddy varieties, featuring a database of up to 84 rice varieties, ensures transparency and fair trade [27].
- Accessibility: EasyRice offers its services through a pay-per-use model, ensuring its technology is as accessible as possible to rice farms [27].

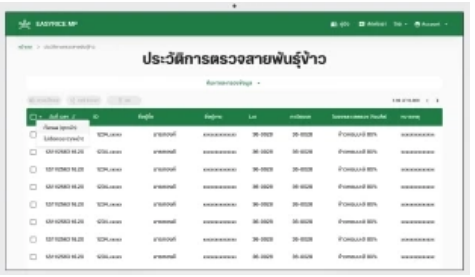
Impact

- Success: Over 10 million tons of rice have been inspected, positively impacting over 200,000 farmers in EasyRice's product ecosystem [25]. 95% of users reported satisfaction with the processing speed, accuracy and convenience of EasyRice's rice inspection services [25].

Lessons Learned

- Accessibility can enable scaling: The pay-per-use model adopted by EasyRice illustrates how making AI technology accessible can drive widespread adoption and scalability amongst users.
- AI enhances rather than replaces human expertise: EasyRice's approach of using AI to assist human inspectors rather than replace them demonstrates how AI can enhance existing processes while alleviating concerns of job displacement (refer to Thailand chapter).





Rice inspection process and results on EasyRice's platform
Source: EasyRice.AI

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01 INTRODUCTION

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02 COUNTRY ASSESSMENTS

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