

**THE NEXT GREAT DIVERGENCE**  
**WHY AI MAY WIDEN INEQUALITY BETWEEN COUNTRIES**



# AI and the Climate Crisis

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## AI AND THE CLIMATE CRISIS

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**Powering AI will require huge quantities of natural resources, from energy to water to minerals. This chapter assesses the potential opportunities and challenges of AI deployment to support countries' Nationally Determined Contributions. It considers AI's dual role as both an enabler of climate action and a contributor to resource depletion. It also addresses the implications of uneven AI readiness across countries, showing how disparities in technological capacities can exacerbate existing inequalities in climate mitigation and adaptation capability. Through case studies, the chapter zooms in on climate change areas that have a high priority across Asia and the Pacific: net-zero transitions, climate adaptation, and risk reduction.**

Climate change is one of the most pressing and complex global challenges of our time. While it is a shared threat, countries and regions differ significantly in both their contributions to climate change and their capacity to mitigate emissions or adapt to its impacts. These disparities are particularly pronounced in Asia and the Pacific, where countries face markedly different climate risk exposures, institutional capacities and financial resources.<sup>1</sup>

Asia and the Pacific, home to over half the world's population and a number of large and rapidly growing economies, accounts for more than 50 percent of global CO<sub>2</sub> emissions and is among the regions most vulnerable to climate change. Over the past 60 years, temperatures in Asia and the Pacific have risen faster than the global average, with devastating consequences for food systems, economies, and social structures.<sup>2</sup> Over the period 2000 to 2022, Asia and the Pacific experienced more than 60 percent of global climate disasters, displacing 225 million people and costing \$1.3 trillion.<sup>3</sup> Six of the top ten countries most affected by climate-related disasters are located in this region.<sup>4</sup>

If the world is to achieve the targets of the Paris Agreement, to limit global warming to well below 2°C, and preferably to 1.5°C, the large emitters in the region will need to accelerate decarbonization efforts. At the same time, the socioeconomic impacts of climate change are becoming more severe. More than four out of five

people in the region are exposed to multi-hazard risks associated with both slow-onset and sudden-onset climate events.<sup>5</sup> Under high-emissions scenarios, developing economies in the region could see their GDPs decline by up to 17 percent by 2070, and by as much as 41 percent by 2100.<sup>6</sup> Without urgent and coordinated action, climate change is likely to remain a significant driver of poverty and inequality across the region, with particularly profound impacts on countries facing multiple structural vulnerabilities.

### *The need for digital solutions in climate action*

As the window for meeting climate targets narrows, and the urgency for resilience grows, it is important to understand how advanced digital technologies – particularly AI – can accelerate climate action. This would be part of coordinated and timely action across multiple fronts. Governments and stakeholders need to access up-to-date climate data, build accurate and dynamic models, conduct rapid and high-quality analysis, and translate insights into actionable policies. In addition, policy design and evaluation must reflect the diverse needs of regions, communities, and stakeholder groups – particularly in areas where climate vulnerability is highest.

However, progress is hindered by a number of factors. Many countries have limited access to granular climate data and face constraints in analytical and response

capacities, particularly in remote or under-resourced settings. There is also a shortage of skilled personnel trained in climate science, data analytics, and systems modelling. At the same time, levels of public and private investment in digital solutions vary considerably..

### *The potential of AI to support climate action*

AI technologies – encompassing machine learning, computer vision, natural language processing, and geospatial analytics – are increasingly being applied to fill these gaps. On the mitigation side, AI supports low-carbon transitions through smart grid management, energy efficiency improvements, and real-time emissions monitoring. On the adaptation side, AI powers early warning systems for floods and heatwaves, improves agricultural decision-making, and strengthens food security in the face of rising climate risks. AI technologies also present promising opportunities to improve climate resilience by making climate-related information more accessible, timely, and cost-effective, particularly for marginalized communities.

When designed and implemented in an inclusive way, AI tools can enhance adaptive capacity and even contribute to reducing climate-related inequality. UNESCO has highlighted the potential of AI in forecasting, monitoring, and mitigating climate impacts.<sup>7</sup> One notable example is the Asia-Pacific Risk and Resilience Portal 2.0. This digital platform leverages AI and machine learning to map localized climate vulnerabilities and guide evidence-based adaptation planning.<sup>8</sup> Crucially, it prioritizes capacity building by training rural government officials and community leaders to interpret and apply AI-generated risk data in local preparedness and response planning.

By improving data availability, accelerating analysis, and enabling adaptive decision-making, AI has the potential to transform how climate action is planned, implemented, and evaluated. Innovation is urgently needed across the Asia-Pacific region, from driving low-carbon transitions in major emitting economies to strengthening resilience in climate-vulnerable countries.

### *The limitations and risks of using AI*

While AI holds significant promise for accelerating climate action, its deployment also comes with environmental costs. At the core of AI operations are data centers whose energy intensity far exceeds that of conventional buildings – consuming 10 to 50 times more energy per square foot than typical commercial spaces. Currently, data centers are estimated to account for 1–2 percent of global electricity consumption. In the Asia-Pacific region, according to IEA, data center energy use in 2024 reached 105–180 TWh – led by China (70–130 TWh), Japan (10–20 TWh), and Australia (8–12 TWh). In Singapore in 2023, data centers consumed approximately 9 percent of national electricity.<sup>9</sup>

These facilities also require vast amounts of water for cooling. Global water consumption for data centers is currently estimated at around 560 billion litres per year and could rise to about 1,200 billion litres per year by 2030, further straining natural resources, particularly in water-scarce regions.<sup>10</sup>

At the same time, the production and disposal of AI hardware also brings serious ecological risks. Mining for metals such as cobalt and silicon, essential for the manufacturing of servers and high-performance processors, can lead to soil erosion, habitat destruction, and contamination of water sources. At the other end of the product lifecycle, the improper disposal of e-waste poses additional threats to both ecosystems and public health – a problem being exacerbated by the pace of technological advancement in AI which is shortening hardware lifecycles.

Sustainability principles need to be embedded into the full lifecycle of AI systems – from design and deployment to decommissioning. Without proactive measures, broader climate benefits may be compromised by the environmental externalities, particularly in the Asia-Pacific region where digital expansion and climate vulnerability are accelerating in parallel.

Beyond the climate and environmental costs of AI, there are potential social costs. Uneven access to AI infrastructure, limited data availability, and unequal digital literacy across gender and urban-rural lines will exacerbate existing disparities and exclude the populations most vulnerable to climate change – especially in remote or under-resourced areas.

Vulnerability to climate disruptions and the capacity to cope with them are far from uniform, reflecting a complex landscape of socioeconomic, geographic, and institutional inequalities.<sup>10</sup> This diversity is reflected in the ND-GAIN index which measures a country’s exposure, sensitivity and capacity to adapt to the negative effects of

climate change across six sectors – food, water, health, ecosystem services, human habitat, and infrastructure (Table 1). In this index, higher scores indicate greater climate vulnerability and lower readiness to adapt. The Asia-Pacific region has some of the world’s most resilient countries and some of the most vulnerable. For example, New Zealand (0.304) and Australia (0.316) have strong infrastructure, governance, and adaptive systems and thus high levels of resilience. In contrast, Bangladesh (0.568), Myanmar (0.514), and Pakistan (0.515) are much more vulnerable due to their high exposure to climate hazards, limited institutional capacity, and socioeconomic constraints.

**Table 1 – The inequality of climate vulnerability: Ranking by ND-GAIN Vulnerability (2023)**

Asia-Pacific Rank	Global Rank	Country	Income Group	Score
<b>1</b>	10	New Zealand	Upper	0.304
<b>2</b>	18	Australia	Upper	0.316
<b>3</b>	18	Kazakhstan	Upper middle	0.316
<b>4</b>	39	Republic of Korea	Upper	0.357
<b>5</b>	41	Uzbekistan	Lower middle	0.359
<b>6</b>	46	Kuwait	Upper	0.362
<b>7</b>	48	Mongolia	Lower middle	0.365
<b>8</b>	50	Jordan	Lower middle	0.366
<b>9</b>	51	Malaysia	Upper middle	0.367
<b>10</b>	54	Japan	Upper	0.369
<b>11</b>	65	Iran	Lower middle	0.376
<b>12</b>	70	China	Upper middle	0.382
<b>13</b>	71	United Arab Emirates	Upper	0.383
<b>14</b>	75	Singapore	Upper	0.389
<b>15</b>	80	Azerbaijan	Upper middle	0.404
<b>16</b>	80	Brunei Darussalam	Upper	0.404
<b>17</b>	85	Saudi Arabia	Upper	0.408
<b>18</b>	92	Oman	Upper	0.420
<b>19</b>	97	Indonesia	Lower middle	0.430

<b>20</b>	103	Thailand	Upper middle	0.435
<b>21</b>	104	Bahrain	Upper	0.436
<b>22</b>	109	Philippines	Lower middle	0.444
<b>23</b>	116	Fiji	Lower middle	0.453
<b>24</b>	119	Dem. People's Rep. of Korea	NA	0.460
<b>25</b>	122	Viet Nam	Lower middle	0.468
<b>26</b>	125	Sri Lanka	Lower middle	0.475
<b>27</b>	126	Cambodia	Low	0.481
<b>28</b>	128	India	Lower middle	0.485
<b>29</b>	130	Laos	Lower middle	0.486
<b>30</b>	134	Nepal	Low	0.490
<b>31</b>	141	Nauru	Lower middle	0.509
<b>32</b>	143	Palau	Upper middle	0.513
<b>33</b>	143	Samoa	Lower middle	0.513
<b>34</b>	145	Myanmar	Low	0.514
<b>35</b>	146	Bhutan	Lower middle	0.515
<b>36</b>	146	Pakistan	Low	0.515
<b>37</b>	157	Timor-Leste	Lower middle	0.538
<b>38</b>	162	Maldives	Upper middle	0.550
<b>39</b>	162	Papua New Guinea	Low	0.550
<b>40</b>	165	Kiribati	Low	0.557
<b>41</b>	168	Vanuatu	Low	0.563
<b>42</b>	170	Bangladesh	Lower middle	0.568
<b>43</b>	172	Tuvalu	Low	0.576
<b>44</b>	176	Afghanistan	Low	0.588
<b>45</b>	177	Marshall Islands	Lower middle	0.590
<b>46</b>	180	Tonga	Lower middle	0.607
<b>47</b>	184	Micronesia	Low	0.621
<b>48</b>	185	Solomon Islands	Low	0.629

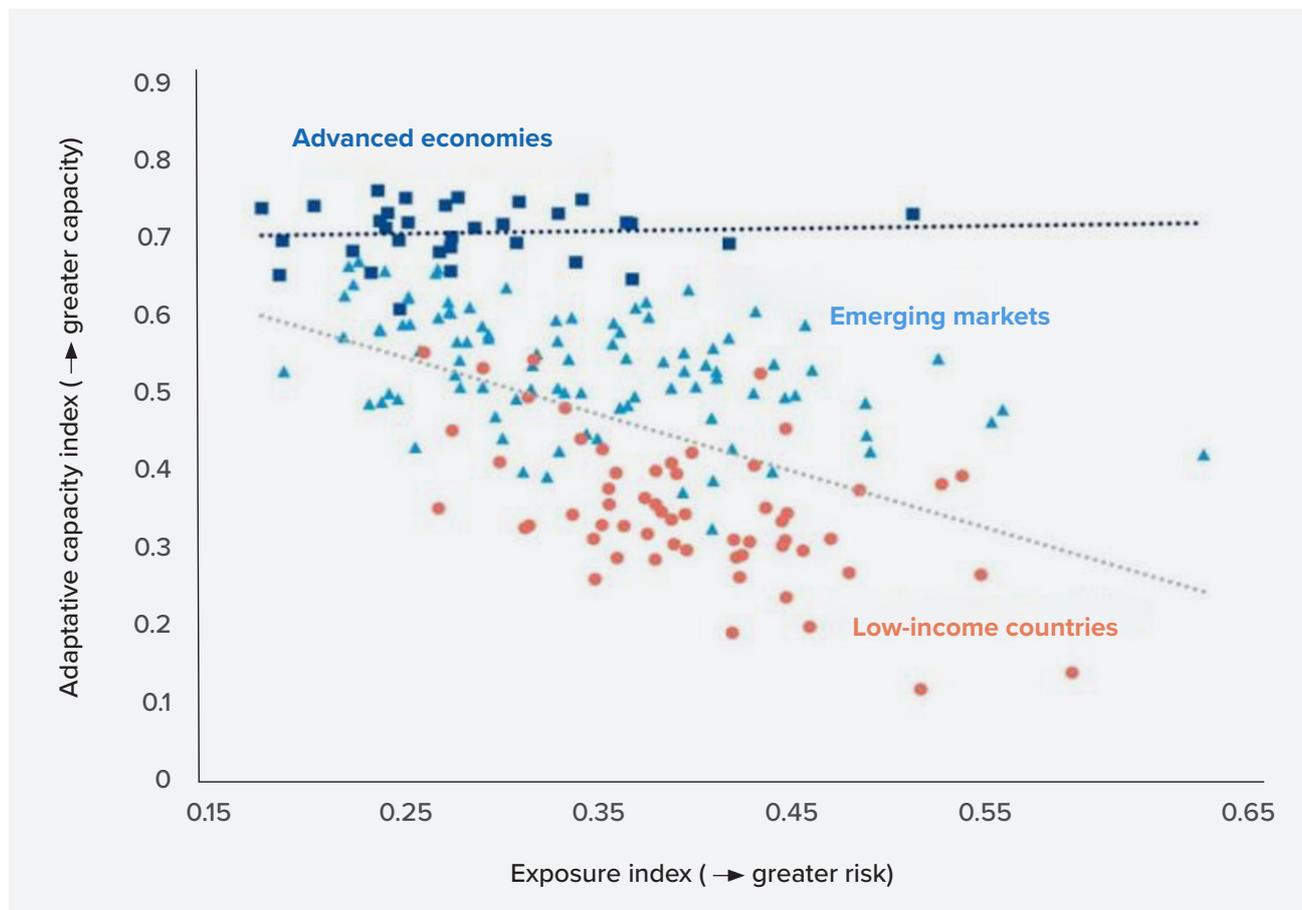
Source: ND-GAIN, 2025<sup>12</sup>

There are similar disparities in adaptive capacities. Typically, there is a negative correlation between climate risk exposure and adaptive capacity – and one which is stronger in low-income countries (Figure 1)). Similar patterns of inequality emerge at the micro level. For example, sea-level rise is likely to intensify socioeconomic disparities in already unequal coastal areas: wealthier individuals may relocate to safer, higher ground, increasing land values and displacing poorer populations to more hazardous zones.<sup>13</sup>

This chapter examines the dual role of AI in the climate crisis in Asia and the Pacific, and asks the following questions:

- **Distributional impacts** – How might the benefits and risks of AI-driven climate action be distributed across countries, sectors, and communities, and what are the implications for equity and justice?
- **Effectiveness and trade-offs** – In what ways can AI accelerate the implementation of NDCs, while managing its own energy and emissions footprint?
- **Sustainability and system integration** – What are the integrated strategies that can align AI deployment with low-carbon development goals – such as those involving green computing, renewable-powered data infrastructure, and lifecycle-conscious design.

**Figure 1 – Unequal costs of climate change**



Notes: This figure is based on IMF staff calculations using 2015–2018 data from the European Commission, the United Nations University Institute for Environment and Human Security, the University of Notre Dame, and the April 2020 World Economic Outlook. Dotted lines represent the estimated linear relationships for advanced economies and for emerging-market and low-income countries combined, respectively.

Source: IMF<sup>14</sup>

- **Policy and inclusion** – What targeted policy interventions are needed to ensure that the most climate-vulnerable and digitally underserved populations can access and benefit from AI applications, such as early warning systems, adaptive planning tools, and clean energy access?

## AI's role in addressing climate challenges

AI can contribute to climate change mitigation in many ways, in particular through energy optimization, climate modelling, and sustainable agriculture.

- **Energy optimization and renewable energy integration** – AI facilitates demand-side management, predictive maintenance, and grid optimization. Machine learning algorithms forecast energy demand and renewable energy output, enhancing the integration of solar and wind resources. Reinforcement learning optimizes energy storage and distribution systems. AI-driven smart grids minimize energy wastage, with studies indicating up to 15 percent reduction in energy efficiency in optimized systems.<sup>14</sup> By improving energy efficiency and accelerating the transition to renewables, AI technology can help reduce greenhouse gas emissions and enhance the economic viability of renewable energy through cost-effective load balancing.
- **Climate modelling and prediction** – AI deep-learning techniques enhance the resolution and accuracy of climate models. Neural networks process vast datasets from satellites, sensors, and historical records to predict climate trends, extreme weather events, and long-term shifts, helping to reduce economic and human losses. Sophisticated models can compare multiple projections and scenarios and refine the predictive capabilities and granularity of climate models – providing precise projections and enabling early warning systems for extreme weather. For instance, AI-improved models have enhanced hurricane path predictions, decreasing evacuation costs.<sup>15</sup>
- **Disaster response and risk assessment** – AI can integrate computer vision and natural language processing to analyse real-time data from drones, social media, and satellite imagery. Predictive models assess risks of floods, wildfires, and droughts, while AI-powered chatbots streamline disaster communication and resource distribution. These applications can reduce vulnerability in high-risk regions, for example through early wildfire-detection systems that achieve up to 90 percent accuracy in identifying ignition points based on explainable machine-learning models. In doing so, AI technologies can help optimise humanitarian aid delivery and support more rapid, resilient recovery.<sup>16 17</sup>
- **Sustainable agriculture and land use** – AI optimizes crop yields through precision agriculture, utilizing IoT sensors and machine learning to monitor soil health, water usage, and pest activity. Computer vision identifies deforestation and land degradation, while predictive analytics guide reforestation efforts. FAO's AIM4Forests program, for example, uses AI to improve forest monitoring and carbon verification, aiding governments in deforestation risk assessment.<sup>18</sup> A case study from Australia showcased the effectiveness of intelligent irrigation systems, which led to a 40 percent decrease in water losses during rice cultivation through optimized canal management.<sup>19</sup> Thus, AI could promote food security and reduce land-based emissions and enhance adaptive capacity in agriculture-dependent communities.
- **Carbon capture and emissions monitoring** – AI optimizes carbon capture and storage processes by modelling geological reservoirs and predicting capture efficiency. Machine learning tracks emissions through satellite data and industrial sensors, identifying leakage and monitoring compliance with emissions regulations in real time. AI-enhanced monitoring systems have detected methane leaks with up to 95 percent accuracy.<sup>20</sup>

**Table 2 – Summary of AI applications in climate change**

Domain	AI techniques	Key applications	Benefits
<b>Energy optimization</b>	Machine learning, reinforcement learning	Smart grids, renewable integration, energy forecasting	Reduces emissions, enhances energy efficiency, supports renewable energy adoption
<b>Climate modelling</b>	Deep Learning, generative adversarial networks	Climate trend prediction, extreme weather forecasting	Informs policy, enables early warnings, optimizes adaptation strategies
<b>Disaster response</b>	Computer vision, natural language processing	Risk assessment, real-time disaster monitoring	Enhances resilience, reduces losses, optimizes aid delivery
<b>Sustainable agriculture</b>	IoT, machine learning, computer vision	Precision agriculture, deforestation monitoring	Promotes food security, reduces emissions, supports sustainable land use
<b>Carbon capture &amp; monitoring</b>	Machine learning, predictive analytics	CCS optimization, emissions tracking	Accelerates decarbonization, ensures regulatory compliance, mitigates greenhouse gases

*AI-driven smart grid systems*

Through smart grid systems AI can orchestrate dynamic energy distribution and facilitate seamless integration of renewable energy sources, addressing critical inefficiencies in traditional energy infrastructure. By employing machine learning and predictive analytics, AI mitigates systemic challenges such as energy wastage, grid instability, and over-reliance on fossil fuels, enabling real-time demand forecasting and load balancing. These capabilities resolve some of the challenges related to intermittent renewable energy supply and peak load management, contributing to more resilient energy ecosystems. This could substantially reduce greenhouse gas emissions, enhance grid reliability, and optimize resource utilization – though there are still many implementation barriers.

CASE IN CHINA, AI-DRIVEN SMART GRID SYSTEMS<sup>21</sup>

The rapid increase in China’s renewable energy capacity embeds a fundamental shift, moving its power grid from a traditional, single-function system toward a smarter, greener, and more adaptive energy model. China Southern Power Grid has been actively applying AI technologies to accelerate the construction of a new-type of power system and a clean, low-carbon energy structure. It launched China’s first AI-based, system-wide load forecasting platform, improving forecast accuracy from 97.6 to 98.3 percent. In parallel, by combining AI with meteorological data, the company has achieved second-level supply–demand matching across more than one million square kilometers. Since 2025, its renewable energy utilization rate has remained around 97 percent. Beyond grid operation, the company is

also expanding AI applications in virtual power plants, spot market trading, microgrid energy management, carbon monitoring and tracking, and electric vehicle charging infrastructure planning. Through large-scale AI models and reinforcement learning, the company is addressing the “energy trilemma” – achieving a system that is clean and low-carbon, secure and reliable, and economically efficient.

### *AI-driven smart manufacturing*

AI transforms smart manufacturing by optimizing production workflows and energy-intensive processes and tackling inefficiencies inherent in industrial operations. Utilizing predictive maintenance, reinforcement learning, and real-time monitoring, AI addresses systemic challenges such as high energy consumption, equipment downtime, and carbon emissions. These interventions enhance operational precision and reduce resource waste, aligning industrial activities with environmental imperatives. The positive impacts encompass diminished industrial carbon emissions, increased production efficiency, and reduced operational costs, fostering sustainable industrial practices and reinforcing the viability of low-carbon manufacturing paradigms.

### *AI-driven smart buildings*

In the realm of smart buildings, AI can optimize control systems, including heating, ventilation, and lighting. Through advanced data analytics and adaptive algorithms, AI addresses key operational inefficiencies by dynamically adjusting resource allocation based on occupancy and environmental variables. This alleviates the carbon-intensive nature of building operations and mitigates urban heat-island effects. The positive outcomes include significant reductions in energy demand, lower carbon footprints, and improved occupant well-being, contributing to sustainable urban development and scalable frameworks for energy-efficient infrastructure.

## CASE IN HONG KONG (SPECIAL ADMINISTRATIVE REGION OF CHINA) – AI-DRIVEN SMART BUILDINGS

In Hong Kong (Special Administrative Region of China), AI-driven smart buildings are pivotal for mitigating climate change and reducing carbon footprints by optimizing energy consumption and enhancing operational efficiency.<sup>22</sup> Buildings are the dominant source of carbon emissions in Hong Kong, responsible for approximately 90 percent of the city's total electricity consumption. The electricity generation required to power these buildings consequently accounts for over 60 percent of Hong Kong's total carbon emissions. This significant share substantially exceeds the global average, where buildings contribute about 39 percent of energy-related carbon emissions, highlighting the acute challenge faced by high-density urban centers like Hong Kong.<sup>23</sup>

Traditional building management systems (BMS) lack the intelligence to effectively balance computational demands with energy efficiency, resulting in performance degradation and excessive cooling costs. A next-generation, AI-powered building-management platform harnesses an integrated framework of semantic models, digital twins, the internet of things, and mixed reality to offer scalable solutions for energy efficiency, supporting emissions-reduction planning and helping to avoid carbon-intensive system lock-in. Empirical data from long-term pilot studies confirm average energy savings of over 20 percent.<sup>24</sup>

### *Climate resilience: applications in disaster adaptation and agricultural sustainability*

AI can support Asia-Pacific countries in managing climate-related disasters – such as floods and typhoons – by improving the accuracy of predictive models, strengthening coordination across emergency-response systems, and expanding access to climate-smart advice for farmers. In this context, AI can enable:

- Enhanced forecasting – machine-learning and real-time data analytics enable earlier, more precise disaster predictions.

- Smarter resource allocation – AI optimizes evacuation planning and helps ensure that aid reaches the right places faster.
- Data-driven decision-making – by analysing vast datasets, AI improves risk assessment and enables timely interventions.
- Lower human and economic losses.
- More resilient communities and ecosystems.”

#### CASE IN INDIA: AI FOR FLOOD FORECASTING AND WATER MANAGEMENT

India, which is highly susceptible to monsoon-driven floods, has leveraged AI to bolster disaster preparedness and water management.<sup>25</sup> The Indian Meteorological Department, for example, is using AI-based flood forecasting models that integrate real-time data on rainfall, river levels, and soil moisture to deliver early warnings. Approximately 66 percent of India's population is at risk of extreme flood events, yet only one-third of those exposed are covered by flood early warning systems. In response, India is actively strengthening its Early Warning Dissemination Systems (EWDS) by leveraging new-era technologies such as the IoT, cloud computing, and artificial intelligence, enhancing EWS by enabling the sensing, cleansing, processing, and analysis of environmental data, thereby improving capabilities in monitoring, forecasting, and alert generation. Several states – including Andhra Pradesh, Odisha, Goa, Karnataka, Kerala, and West Bengal – have taken the lead in establishing cyclone warning systems, positioning themselves at the forefront of building disaster resilience.<sup>26</sup>

#### CASE IN THE PHILIPPINES: AI-DRIVEN DISASTER ADAPTATION

To enhance disaster preparedness and response, the Philippines has increasingly adopted big data and AI to gather and analyze localized vulnerability information for local government units.<sup>27</sup> One notable application involves mobile big data, such as call detail records and mobile positioning data, which can be used to track

population movements and inform evacuation planning and resource allocation strategies.

The Philippine Atmospheric, Geophysical and Astronomical Services Administration operates the Flood Information and Warning System (FIWS), a web-based platform integrating multiple data streams, including rainfall and river-level monitoring, satellite imagery, and even social media content.<sup>28</sup> The system produces real-time flood forecasts and warnings during typhoon events. Using machine-learning models, FIWS analyzes historical flood patterns and post-disaster assessments to support rapid resource mobilization and relief coordination. For example, it can identify areas at highest risk of severe flooding and prioritize the deployment of rescue operations and aid supplies accordingly. To address these technical bottlenecks and enhance the role of AI in building disaster-resilient communities, increased international cooperation and policy support are essential.<sup>29</sup>

#### *AI-driven agricultural sustainability*

Adaptive agricultural strategies can support food security and long-term ecological stability in climate-vulnerable regions. Leveraging predictive analytics, IoT integration, and automated decision-making, AI addresses weaknesses of conventional farming practices such as inefficient water and fertilizer use and yield variability. AI is, for example, being harnessed to optimize resource management and bolster crop resilience, countering climate change-induced challenges such as erratic precipitation and soil degradation.

#### CASE IN VIET NAM: AI-DRIVEN AGRICULTURAL SUSTAINABILITY

In Viet Nam's Mekong Delta, with support from international donors, the deployment of cutting-edge technologies – such as integrating AI for carbon-farming applications, leveraging geospatial systems to deliver real-time crop data, and establishing digital traceability and certification platforms – supports nearly 40 million smallholder farmers.<sup>30 31</sup> Positive impacts include lower greenhouse gas emissions from reduced fertilizer use

and enhanced food security in a region critical to global rice supply. Positive impacts include lower greenhouse gas emissions from reduced fertilizer use and enhanced food security in a region critical to global rice supply.

These initiatives can generate economic gains for farmers, but they represent only one technical pathway within a broader enabling architecture for sustainable agriculture and long-term climate resilience. Their effectiveness depends on supportive governance arrangements, clear policy and legislative frameworks, institutional capacity, enforceable standards, long-term financing, and coordination among farmers, cooperatives, agribusinesses, and public agencies. Replication in other contexts – particularly in small or resource-constrained economies – will require adaptation to local conditions, regulatory and policy readiness, robust data-governance mechanisms, and institutional ownership anchored in national systems.

## **AI's environmental load**

AI can bring many benefits through advancements in smart grids, climate modelling, and sustainable agriculture. Yet these gains could be offset by its resource intensity. The ecological impacts of AI include the energy and water demands of data centers, greenhouse gas emissions, mineral extraction, and electronic waste generation.<sup>32</sup>

If unmanaged, these energy and other demands could pose challenges for countries seeking to advance their Paris Agreement commitments.<sup>33</sup> Strategic and context-appropriate measures may help align AI deployment with the Sustainable Development Goals and countries' Nationally Determined Contributions.

### *Energy consumption*

AI systems, particularly training and operating large-scale models, can be energy-intensive. The computational intensity of AI, particularly in training and operating large-scale models. A single query to a GenAI model can consume ten times the electricity of a standard internet search.<sup>34</sup>

Globally, AI alongside cryptocurrency and data-center operations is projected to account for around 4 percent of electricity use by 2026, equivalent to the annual demand of a major industrialised nation. The Asia–Pacific region is expected to account for roughly 28 percent of this global total, driven primarily by hyperscale facilities in India, Japan, the Republic of Korea, and Australia.<sup>35</sup>

In 2023, data centers in the Asia-Pacific region consumed an estimated 55 TWh of the 200 TWh global total. Between 2023 and 2028, the rapid proliferation of AI infrastructure, is projected to drive a 30 percent increase in data centers and by 2030 to add roughly 15 GW of computing capacity in Asia and the Pacific – 8 percent of regional electricity demand.<sup>36</sup> Environmental impacts are higher in contexts where the electricity grid relies heavily on coal.

### *Water consumption*

Although public debate has focused mainly on AI's energy consumption, its significant water consumption has received far less scrutiny. The operation and maintenance of AI infrastructure require large quantities of water for chip production, server cooling, and non-renewable electricity generation.<sup>37</sup> As AI deployment accelerates, the associated water demand risks intensifying competition over limited freshwater supplies and exacerbating water stress in vulnerable regions. By 2027, AI-driven data-center water consumption could reach between 4.2 billion and 6.6 billion cubic metres, equivalent to four to six times the total annual water consumption of Denmark, or roughly half that of the United Kingdom.<sup>38</sup>

### *Mineral resources*

The environmental costs are compounded by the manufacture of AI hardware. AI systems rely on critical minerals, including rare earth elements, copper, aluminum, and silicon, which are essential for manufacturing semiconductors, magnets, and other components. The extraction of these minerals often results in deforestation, water pollution, and habitat loss.

The problem is intensified by the rapid obsolescence of AI hardware, driven by accelerating technological advances, generating electronic waste that is growing five times faster than recycling systems can absorb. This expanding e-waste stream presents long-term ecological risks as hazardous materials leach into surrounding ecosystems.”

To reconcile AI’s resource consumption with climate objectives, a multifaceted approach is required. Beyond transitioning data centers to renewable energy sources, it is equally critical to implement sustainable mining practices and enhance waste management strategies for the minerals essential to AI infrastructure. Addressing these interconnected challenges will reduce environmental degradation and support the broader climate commitments outlined in NDCs.<sup>40</sup>

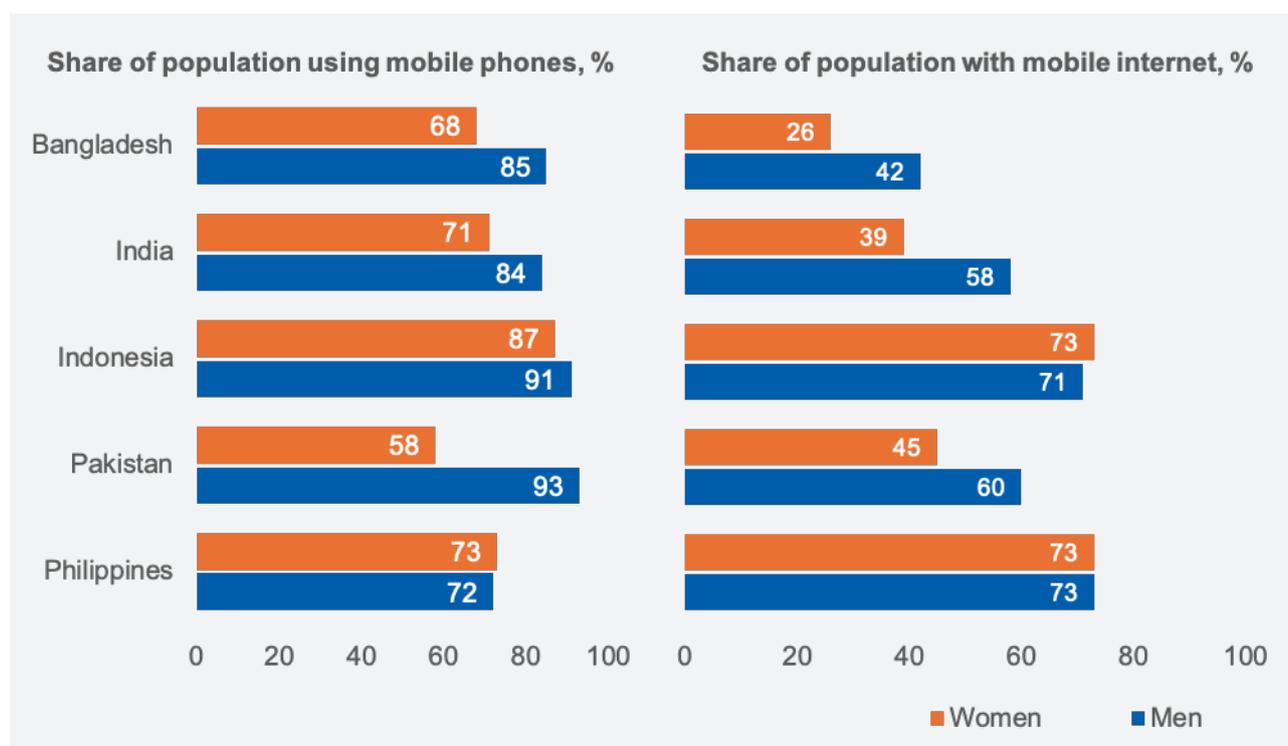
## Inequality within countries

Climate impacts disproportionately affect women and marginalized groups like indigenous peoples, further deepening societal inequalities.<sup>40</sup> The ways in which different social groups cope with climate change are now also being shaped by deep disparities in AI access. Women, rural populations, and low-income communities may face systemic barriers to technology access and climate information, which can limit their ability to fully benefit from digital tools for resilience.

### Gender gaps: women’s unequal access to AI and information

In many contexts, gendered social norms, affordability barriers, and unequal access to technology can limit women’s ability to benefit from climate information

**Figure 2 – Mobile ownership, smartphone ownership and mobile internet adoption among men and women**



Source: GSMA, *The Mobile Gender Gap Report 2025 –GSMA Consumer Survey (2024)*, country estimates for Bangladesh, India, Indonesia, Pakistan and the Philippines

services. The extent of gender disparities in 2024 has been analyzed by GSMA for five Asia-Pacific countries: Bangladesh, India, Indonesia, Pakistan, and the Philippines.<sup>42</sup> Mobile internet gender gaps are widest in India, Bangladesh and Pakistan – and they are still widening. Across South Asia, the smartphone ownership gap increased from 34 to 40 percent between 2023 and 2024. In India, this widening gap reflects a modest rise in men’s smartphone ownership while women’s ownership levels remained largely unchanged over the same period. In Indonesia and the Philippines on the other hand, the gaps were narrower: women were as likely as men to use mobile internet and smartphones.

Multiple factors drive this gendered digital divide. According to GSMA, the principal barriers for women include weak literacy and digital skills and high handset/data costs, along with concerns for safety, information security and the risks of scams and fraud. Research confirms that women often lack timely warnings of hazards "through a lack of equal access to technology, communication, and services", especially in rural or isolated areas.<sup>42</sup> Climate information delivered via smartphone apps, SMS alerts, or online platforms is thus far less likely to reach women. Social norms and safety concerns also play a role – in some communities, technology is seen as "for men," and women face greater online harassment, creating additional barriers to digital access.<sup>43</sup>

### *Rural communities: the climate-tech divide*

Rural populations often find themselves on the wrong side of the digital divide. In Asia and the Pacific, rural areas are frequently more exposed to climate hazards yet less served by the information and telecommunication infrastructure that could help protect them.

Without connectivity, farmers cannot receive up-to-the-minute weather forecasts or pest outbreak alerts on their phones.<sup>45</sup> Villagers cannot participate in online climate training or access digital platforms that share drought-resistant farming techniques. "As climate

patterns grow increasingly erratic, the isolation of many rural communities underscores the need for more timely, accessible, and actionable climate information to complement and strengthen traditional knowledge systems. AI-powered climate apps or early-warning SMS services that reach city dwellers may otherwise never reach a remote farming village.

Households with access to digital connectivity and financial services may find it easier to mobilize resources and recover in the aftermath of disasters. Regional data indicates that rural individuals without internet access or higher levels of education report greater challenges in raising emergency funds during crises; in one survey, around 8 percent of respondents in this group were able to mobilize resources quickly, compared with nearly 60 percent of men with higher education and internet access.<sup>46</sup> Communities with limited connectivity or financial access may depend more heavily on informal networks, existing savings, or external support during emergencies. Improving rural access to AI and digital tools is not a luxury but a necessity for equitable resilience. As the UNFCCC warns, without deliberate efforts to bridge these gaps, emerging climate tech could deepen existing social divides.<sup>47</sup>

### CASE STUDIES: BRIDGING THE URBAN-RURAL DIVIDE FOR CLIMATE RESILIENCE

**China** – AI is helping farmers adapt to climate change by improving precision in agriculture. Using AI, drones can detect plant issues early and reduce excessive use of water and chemicals. Since 2017, AI-powered drones from XAG, a Chinese smart agriculture technology company, have helped save over 5 million tonnes of water and cut more than 368,000 tonnes of CO<sub>2</sub> emissions. In Sichuan’s Ruergai grasslands, AI-guided drones have been reseeding and restoring 700 hectares of degraded land, supporting climate resilience and sustainable farming.<sup>47</sup>

**India** – AI weather forecasting has been applied as the first initiative of the Agriculture Innovation Mechanism

for Scale (AIM for Scale), a partnership launched in 2024 by the United Arab Emirates and the Gates Foundation. Such services have helped thousands of smallholder farmers make more informed decisions about planting and harvesting schedules. The benefits are tangible: some communities have cut their debts in half and increased their household savings by up to 10 percent as a result of using AI-generated climate insights.<sup>48</sup> These gains are particularly significant given the high debt burden and climate sensitivity of small-scale agriculture in the region.

### **Inequality between countries**

AI can also contribute to inequality between countries. The hubs of AI and climate research are primarily in the United States, China, and a few countries in Europe. This concentration can contribute to talent migration patterns and may affect the ability of some countries to participate fully in AI-driven innovation.

As a result, these dynamics may result in uneven distribution of benefits, particularly for countries facing barriers to digital transformation. The benefits of AI are unevenly distributed, and many developing countries remain on the periphery of technological advancement. In this section, we analyze cross-country inequality from two key perspectives: the divide in AI infrastructure and the disproportionate environmental impacts of AI deployment, which may place greater strain on countries with constrained resources or limited digital infrastructure.

Low-income regions, particularly the least developed countries (LDCs) and Small Island Developing States (SIDS) in the Asia Pacific region, face significant infrastructural barriers that hinder the deployment of AI for climate adaptation. Many of these countries lack the foundational systems required for advanced climate analytics – such as widespread weather stations, reliable electricity grids, and adequate computing capacity. Without these enabling conditions, AI forecasting tools may depend on regional or incomplete datasets in contexts where localized, high-resolution data is

limited. AI tools often rely on coarse, non-localized data, limiting their relevance and effectiveness in addressing local climate risks.

The problems are exacerbated by financial constraints. Many developing countries lack the resources for crucial elements of climate-resilient AI systems – high-resolution satellite/hyperspectral imagery, geospatial data, or cloud computing infrastructure. Addressing these gaps in infrastructure is a prerequisite for ensuring that the benefits of AI technologies are accessible to the communities most vulnerable to climate change.

The backbone of effective AI applications in climate adaptation and mitigation is high-quality, context-specific data. In many contexts, data collection systems remain under-resourced or unevenly distributed, which can limit the availability of climate-relevant data. Limited data availability can reduce the precision of AI-generated insights, affecting their relevance for local decision-making.

Furthermore, the availability of data can correlate with demographic and socioeconomic status – compounding other sources of bias.<sup>50</sup> When AI models are trained on incomplete or biased datasets, they risk producing outputs that do not reflect the needs of underrepresented communities – particularly in areas such as disaster preparedness, resource allocation, and infrastructure planning. Equally important is the issue of data access and security: climate data must be openly accessible to local governments, communities, and NGOs while ensuring that sensitive information – such as community vulnerability profiles – is protected from misuse. To prevent climate AI from reinforcing existing inequalities and to empower communities with the information needed to adapt and thrive, it is vital to have equitable data governance, inclusive data-sharing mechanisms, and local data ownership.

### **Unequal environmental impacts**

Across Asia and the Pacific, countries experience varied environmental implications from AI infrastructure depending on energy mix, water availability, and

regulatory frameworks. Countries with access to cleaner energy grids, abundant water resources for cooling, and robust environmental governance are better positioned to support the deployment of resource-intensive AI systems in a climate-resilient and environmentally responsible way. In contrast, developing nations – many of which are still navigating the complexities of green transitions and face water scarcity – may bear disproportionate environmental and socioeconomic costs when hosting such facilities. This unequal distribution of environmental impacts underscores the urgent need for coordinated international efforts to promote equitable and sustainable AI deployment.

Most leading AI companies – such as Microsoft, Meta, and Google – are headquartered outside the Asia-Pacific region, but they have established extensive data infrastructure within the region. This can result in environmental impacts occurring in countries that may not directly capture the full economic value of the broader AI ecosystem.

Marked disparities in environmental impact exist across regions. In 2023, Google’s data centers in Finland operated using up to 97 percent carbon-free energy, while comparable facilities in parts of Asia relied on only 4 to 18 percent carbon-free sources. This divergence stems largely from differences in national energy endowments, levels of renewable-energy integration, and the capacity of governments to implement and enforce sustainability measures.<sup>52</sup>

Water consumption is another growing area of concern. In Malaysia in 2025, for example, the National Water Services Commission reported that it had approved fewer than 18 percent of water-usage applications submitted by the 101 data centers operating in the southern peninsula, citing concerns over the risks of treated water intended for public use. As demand for digital infrastructure grows, both governments and industries are under increasing pressure to identify solutions that balance technological advancement with environmental stewardship.<sup>52</sup> Compounding the problems, many data centers tap into underground

aquifers in major urban areas, further stressing fragile hydrological systems and increasing the risks of environmental degradation and water scarcity for surrounding communities.

Despite these risks, halting the expansion of AI and data infrastructure in developing countries is neither feasible nor desirable: digital transformations are increasingly vital for enabling economic diversification, and creating jobs. Recognizing the environmental trade-offs associated with large-scale AI infrastructure, several technology companies have begun implementing measures to influence and accelerate the decarbonization of regional power grids.<sup>53</sup> Similarly, Google has introduced urban greening programs, such as its Urban Forest Plan, as part of its broader strategy to address atmospheric emissions associated with data center construction and operation.<sup>54</sup>

#### CASE STUDY – SINGAPORE: MICROSOFT SOLAR ENERGY INVESTMENT

In 2024, the Portuguese utility company EDP won Phase 8 of Singapore’s SolarNova programme – the country’s largest solar initiative – to install up to 200 MWp of rooftop solar across more than 1,000 public-housing blocks and over 100 government buildings. Microsoft has entered into a 20-year renewable-energy agreement to purchase the electricity generated, supporting both EDP’s decarbonisation goals and Microsoft’s own 100-percent clean-energy target. The company is also collaborating with energy providers to expand access to solar and wind power in under-invested communities and investing in next-generation storage and water-replenishment initiatives.

This example illustrates how large technology firms can help de-risk renewable-energy investments, but it is only one part of the picture. Across Asia and the Pacific, smaller utilities, city governments, and local innovators are also experimenting with AI-enabled renewable-energy projects that are tailored to local grid conditions and financing constraints. From a UNDP perspective, the priority is to embed such technological initiatives

within robust governance and regulatory frameworks, equity-focused policies, and long-term capacity-building so that sustainable AI use advances environmental and social goals rather than depending solely on the actions of a few global corporations.”

## Policy implications and recommendations

### *Embedding sustainability in AI infrastructure*

To mitigate its environmental footprint and align with NDCs emission reduction targets, AI infrastructure must have sustainability embedded as a core principle – addressing specific challenges related to energy, water, mineral resources, and social inequalities. Sustainable AI infrastructure requires significant upfront investment in renewable energy and efficient technologies, which may strain public budgets but yield long-term economic and ecological benefits.

- **Energy** – For their energy-intensive operations, AI data centers must transition to renewable energy sources, such as solar, wind, and hydroelectric power. Policy mechanisms to ensure this can include tax credits, such as 30 percent investment tax credits for renewable-powered data centers. There could also be mandatory renewable energy quotas – such as 50 percent renewable sourcing by 2030 for data centers above 10 MW.
- **Water consumption** – Consumption can be reduced by advanced cooling technologies, such as direct-to-chip or immersion cooling. This can be enforced through regional water usage caps aligned with local hydrological capacities. The necessary investments can be supported by grants covering 20–30 percent of retrofit costs.
- **Critical minerals** – Ethical sourcing of critical minerals, like cobalt and lithium, should be regulated through supply chain transparency laws. Companies should be required to disclose sourcing origins and adhere to international standards, such as the OECD Due Diligence Guidance, with penalties for non-compliance of up to 5 percent of annual revenue.

- **Electronic waste** – Waste management can be strengthened by implementing extended producer responsibility regulations, mandating AI hardware manufacturers to fund recycling programs, and achieving 70 percent recycling rates by 2030.
- **Digital literacy** – Policies should prioritize digital literacy and skill development programs – with targets, for example, for the numbers of women and rural farmers trained in AI tool usage for climate adaptation. These initiatives should be funded through public-private partnerships with a minimum 20 percent private sector contribution.

### *Promoting open-source AI for cost-effective climate solutions*

Open-source AI models offer a cost-effective and inclusive mechanism for democratizing access to advanced technologies, enabling resource-constrained nations to address climate challenges efficiently while aligning with NDCs. Pilot programs, such as Viet Nam’s AI-driven irrigation systems, demonstrate the scalability of open-source AI solutions.<sup>55</sup> These adaptable models can be tailored for example for optimizing renewable energy integration – aiming to 50 percent renewable energy penetration by 2030. They can also enhance climate modelling accuracy and improve disaster forecasting reliability.

Recognizing the diversity of fiscal and institutional capacities across Asia and the Pacific, one possible avenue would be for interested governments and partners to co-finance the development and maintenance of open-source AI repositories. In some contexts, these could be managed by multi-stakeholder task forces comprising government agencies, technology firms, and academic institutions, with periodic progress reporting to support transparency and learning. Illustrative costings suggest that a regional hub might require on the order of \$50 million over a five-year period, though actual needs would vary.

Open-source AI platforms could also be designed to leverage voluntary private-sector contributions, for example through tax incentives or recognition schemes for firms that share models, datasets, or computing resources for public-interest climate applications. Where appropriate, governments may choose to set targets for e-waste collection and recycling – such as substantially increasing recycling rates for AI-related hardware by 2030 – aligning these efforts with regional initiatives like ASEAN’s Digital Masterplan 2025 to enhance equitable access to climate-focused AI tools across developing nations.<sup>57</sup>

### *Mobilizing public-private cooperation for sustainable AI investment*

To encourage private investment in renewable-powered AI infrastructure and high-impact applications, such as disaster risk reduction and energy optimization, governments can offer financial incentives, such as tax breaks, subsidies, and green bonds. Experience in PPP projects in Japan and India, for example, offers insights and lessons on how disaster and climate risks could be managed under PPPs in emerging markets and developing economies.<sup>57 58</sup>

Corporate accountability can be further heightened by regulatory frameworks that reward energy-efficient and environmentally responsible AI deployment. In China, for example, in June 2025, under the guidance of the Ministry of Industry and Information Technology (MIIT), the Government officially implemented its first national standard titled Green Data center Evaluation. The standard was led and administered by the China Electronics Standardization Institute. Driven by the MIIT and other relevant authorities, China’s data center development is increasingly moving toward high-efficiency, low-carbon, and low-resource intensiveness. As of 2025, a total of 246 national green data centers had been established across sectors such as telecommunications, internet, energy, finance, and intelligent computing.<sup>59</sup>

### *Strengthening regional collaboration for equitable AI deployment*

Regional collaboration is pivotal for ensuring equitable access to climate-focused AI solutions. At present, such cooperation faces a number of barriers due to varying technological capacities and policy priorities. To harmonize governance standards policymakers can prioritize:

- ***Cross-border energy integration*** – Such as through the ASEAN Power Grid, to provide renewable energy for AI infrastructure.
- ***Robust AI governance frameworks*** – Building on initiatives like the ASEAN Guide on AI Governance and Ethics.
- ***Regional knowledge-sharing platforms*** – Supported by institutions such as the Asian Development Bank, these can facilitate technology transfers, capacity building, and the empowerment of marginalized communities. A collaborative framework fosters a cohesive regional strategy, aligning AI deployment with collective Nationally Determined Contributions and promoting inclusive, climate-resilient development.
- ***Regional AI innovation hubs*** – An initial investment of \$50 million per hub could provide low-income countries with access to shared computing resources, open-source AI tools, and high-resolution climate data.

Depending on country context, such measures could be operationalised through national AI task forces coordinated by relevant ministries (for example, environment and technology), with periodic progress reports to support transparency and accountability. By embedding these targeted, enforceable policies across the AI lifecycle – from design and deployment to decommissioning – governments can align technological advancements with low-carbon development objectives, minimize ecological degradation, and promote equitable access to AI-driven climate solutions. This integrated

approach will advance sustainable development and strengthen regional resilience to climate challenges in Asia and the Pacific.

## Conclusion

AI's integration into climate solutions offers significant benefits, including substantial reductions in greenhouse gas emissions, improved resource efficiency, and enhanced resilience to climate-induced disasters. However, these advancements come with considerable costs, such as the high energy, water, and mineral demands of AI infrastructure. Differences in access,

connectivity, and digital readiness mean that AI tools may not benefit all communities equally, and without inclusive approaches, existing digital and socioeconomic inequalities could be reinforced.

To balance AI's transformative potential with its environmental and social costs necessitates a paradigm shift in policy frameworks – with policies that prioritize sustainability, equity, and regional cooperation. Proactive, coordinated policy interventions can ensure that AI serves as a net-positive force in achieving sustainable and equitable climate outcomes, aligning technological innovation with global climate imperatives.

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## END NOTES

1. (ADB, 2024)
2. (UNESCAP, 2023a)
3. (ADB, 2022)
4. (UNESCAP, 2023c)
5. (UNESCAP, 2023b)
6. (ADB, 2024)
7. (UNESCO, 2022)
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11. (UNESCAP, 2024)
12. (NG-GAIN, 2025)
13. (Hsiao, 2024)
14. (IMF, 2022)
15. (Nayyef, Abdulrahman and Kurdi, 2024)
16. (Google DeepMind, 2025)
17. (Shmuel et al., 2025)
18. (FAO, 2025)
19. (Arlanova et al., 2025)
20. (Hasan et al., 2025)
21. (Xioning, 2025)
22. (IEA, 2024)

23. (HK Buildings Department, 2025)
24. (Fu, 2025)
25. (Ghosh, 2023)
26. (Wadhawan, 2023)
27. (Reichstein et al., 2025)
28. (Liu, Lee and Zhou, 2023)
29. (Baltazar et al., 2024)
30. (Thaichon, 2024)
31. (Correia et al., 2025)
32. (Ren and Wierman, 2024)
33. (EPRI, 2024)
34. (IEA, 2024)
35. (U.S. DOE, 2024)
36. (Mytton, 2021)
37. (Li et al., 2025)
38. (UNEP, 2024)
39. (IEA, 2021)
40. (Canpolat and Rahim, 2024)
41. The GSMA is a global organization unifying the mobile ecosystem to discover, develop and deliver innovation foundational to positive business environments and societal change. The GSMA was formed to ease cooperation, uphold standards and support interoperability between those using Global System for Mobile (GSM) technology.
42. (Pudmenzky et al., 2022)
43. (Duffy, 2022)
44. (Burlig et al., 2024)
45. (UNESCAP, 2024)
46. (UNFCCC, 2025)
47. (Aziz Elbehri and Chestnov, 2021)
48. (Nieuwkoop and Nieuwkoop, 2025)
49. (GPAI, 2021)
50. (UNFCCC, 2025)
51. (Google, 2023)
52. (Ming, 2025)
53. (Economist, 2025)
54. (Google, 2023)
55. (Talaviya et al., 2020)
56. (ASEAN, 2021)
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