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Revised draft policy brief on opportunities, risks and challenges of AI for climate action

Cover note

A. Background

1. As per activity A.4.1. of its rolling workplan (2023-2027), the TEC is exploring the role of artificial intelligence (AI) and applied machine learning as enablers of climate solutions.

2. At TEC 32, the TEC considered the draft policy brief on opportunities, risks and challenges of AI for climate action and provided guidance to the open-ended activity group on finalizing both draft documents after the meeting, ensuring that they reflect oral comments made and written inputs provided by TEC members during the meeting, for unanimous approval by TEC members via email.

3. Following TEC 32, a TEC member requested clarification from the secretariat on the legal and procedural implications of requiring unanimity for electronic decision-making. The secretariat clarified that, in accordance with paragraphs 43 and 56 of the TEC rules of procedure, decisions by the TEC are taken by consensus.

4. Given that the revised draft policy brief was not finalized by consensus via electronic means, it is to be considered further by the TEC at TEC 33.

B. Scope of the note

5. The annex to this note contains the revised draft policy brief on opportunities, risks and challenges of AI for climate action.

C. Possible actions by the Technology Executive Committee

6. The TEC will be invited to consider the revised draft policy brief contained in the annex and provide guidance to the activity group with a view to finalizing the draft after TEC 33.

Annex

Revised draft policy brief on opportunities, risks and challenges of artificial intelligence for climate action

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Abbreviations and acronyms

AI	Artificial Intelligence
AMAP	AI-based Mangrove Adaptive Mapping
CNN	Convolutional Neural Network
CTCN	Climate Technology Centre and Network
DL	Deep Learning
DPG	Digital Public Good
EW4All	Early Warnings for All
EO	Earth Observation
FPIC	Free, Prior, and Informed Consent
GenAI	Generative AI
GHG	Greenhouse Gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (German Corporation for International Cooperation)
GPU	Graphics Processing Unit
HASTE	High-speed Assessment and Satellite Tracking for Emergencies
HCS	High Carbon Stock
IFRC	International Federation of Red Cross and Red Crescent Societies
IKS	Indigenous Knowledge Systems
IoT	Internet of Things
ITU	International Telecommunication Union
JWP	Joint Work Programme
LDCs	Least Developed Countries
LDRI	Local Development Research Institute
LLMs	Large Language Models
LSTM	Long Short-Term Memory
ML	Machine Learning
M&E	Monitoring and Evaluation
NDCs	Nationally Determined Contributions
NLP	Natural Language Processing
SAFIR	Smart AI-based Farming and Irrigation for Resilience
SIDS	Small Island Developing States
SLMs	Small Language Models
TEC	Technology Executive Committee
TNA	Technology Needs Assessment
TRiSM	Trust, Risk, and Security Management
UNDP	United Nations Development Programme
UNDRR	United Nations Office for Disaster Risk Reduction
UNFCCC	United Nations Framework Convention on Climate Change
WMO	World Meteorological Organization

Executive Summary

Key Messages

The TEC highlights the following key messages drawn from the findings of the technical paper on *Artificial Intelligence for Climate Action: Advancing Mitigation and Adaptation in Developing Countries*[i]

Opportunities of AI for climate action:

AI can serve as a powerful enabler for climate action in developing countries, accelerating progress in both adaptation and mitigation.

- **For adaptation**, AI enhances early warning systems for extreme weather (e.g., hurricanes, floods), utilizes Earth Observation (EO) for monitoring and analysis, disaster risk reduction, urban resilience, deforestation control and infrastructure planning, and improves resource and ecosystem management through tools like precision agriculture, biodiversity conservation, and supporting climate simulation, projections, and related analytical processes. AI also supports education and community engagement, raising awareness and building local capacity. These benefits are strengthened by open and interoperable data ecosystems that enable local adaptation and contextual relevance of AI tools.
- **For mitigation**, AI enables the efficient usage of resources, optimization of energy consumption and distribution, enhances renewable energy management systems, and supports transport systems through traffic optimization and route planning.

Challenges, impacts, and risks of AI adoption:

The development and deployment of AI-powered climate solution is challenged by several factors in developing countries, particularly LDCs and SIDS:

- The **digital divide** or "compute divide" and **equitable access to AI** is a fundamental barrier, stemming from **digital infrastructure limitations** (electricity, internet, computing power) in many vulnerable regions. **Data scarcity and poor-quality data** further hinder the development and deployment of reliable AI models, as many developing countries lack the comprehensive, localized, and representative climate datasets needed for effective, context-aware decision-making.
- The **high energy and water consumption** and resulting carbon footprint of advanced AI models, particularly Deep Learning (DL) and Generative AI (GenAI), pose a significant concern. The resource-intensive nature of training and deploying these models, including direct, indirect, rebound, and systemic effects, requires careful management to ensure AI's climate benefits are not offset by its own environmental costs.

- **Ethical risks, algorithmic biases** can perpetuate social disparities, data security and privacy risks, associated with handling vast datasets. These issues are compounded by **limited regulatory preparedness** and the lack of robust governance frameworks needed to ensure transparency and accountability. Moreover, AI misuse poses a critical threat to information integrity on climate change, including its potential to **spread misinformation and disinformation in the form of AI hallucinations and false claims,** or promote unsustainable practices.

Context-specific measures are therefore required to mitigate these risks, which will be outlined alongside practical policy responses in the brief to ensure a responsible and equitable adoption of AI for climate action.

Recommendations:

AI offers opportunities for climate change adaptation and mitigation in developing countries, despite inherent risks and challenges, which can accelerate progress towards the UNFCCC objective and its **Paris Agreement** goals. To unlock this potential, coordinated, inclusive, and ethical global effort is required, underpinned by respect for the digital sovereignty of all countries and their right to choose their own paths of technological development, focusing on key priority actions:

1. Promote the use of open-source AI applications, as appropriate, in climate change mitigation and adaptation strategies in developing countries, ensuring they are deployed and are the most suitable tool for the task.
2. Encourage the use of AI for climate action by promoting supportive policies, local training, and resources to empower stakeholders to use AI to reduce GHG emissions and build climate-resilience.
3. Integrate AI technologies into national and regional climate strategies where they can enhance areas such as early warning systems, optimization of resource allocation, and data-driven decision-making, as appropriate, in climate adaptation and mitigation efforts.
4. Strengthen global partnerships and knowledge sharing by fostering international cooperation and developing capacity-building programmes to enhance the skills and capabilities of local stakeholders, promoting knowledge-sharing and collaboration to maximize AI’s potential in climate strategies.
5. Develop inclusive and sustainable policies and establish governance approaches, enabling data-driven decision-making, as appropriate, and access to climate regulatory frameworks and state-of-the-art research.
6. Reduce the energy consumption and carbon footprint of AI by implementing energy-efficient algorithms and computing infrastructure and promoting the use of Small Language Models.

7. Strengthen data security and ethical governance by developing robust data governance frameworks to ensure privacy, security, and ethical use of data, protecting against unauthorized access and breaches.
8. Address gender bias by applying inclusive design practices, generating and using diverse datasets, and establishing gender-responsive policies, particularly in climate-related applications.
9. Bridge the digital divide by investing in infrastructure development and capacity-building initiatives in developing countries to promote equitable access to AI technology and resources.
10. Invest in AI research, development, and innovation tailored to local contexts and priorities.
11. Enable AI deployment for climate action in developing countries with a focus on SIDS and LDCs by facilitating relevant infrastructure and skills development, financial support and the establishment of governance and policy frameworks.
12. Integrate, as relevant to local contexts, Indigenous and local knowledge into AI-powered solutions.
13. Ensure gender-responsive approaches in AI development.
14. Institute AI risk management and regulatory framework to minimise challenges related to AI application for climate actions
15. Enhance the role and participation of the youth in the development, deployment and maintenance of AI for climate change

1. Why this TEC brief?

The escalating global climate crisis and its severe impacts on developing countries, particularly LDCs and SIDS, underscore the urgent need for transformative climate solutions. Leveraging AI and applied ML for climate action is increasingly recognised as both an enabling and a catalysing condition for supporting low-emission, climate-resilient development pathways and risk-informed decision-making.

Yet, globally, access to and effective applications of AI-powered climate solutions suffer from significant shortcomings, particularly in LDCs and SIDS, creating the risk of exacerbating existing inequalities. Key barriers include the compute divide (including inadequate computing power and unreliable internet connectivity) due to the lack of access to reliable and affordable energy, data scarcity (lack of comprehensive, reliable, and localized datasets), capacity constraints (a shortage of skilled professionals and end users), and systemic risks (environmental impacts, data security concerns, and algorithmic biases).

Produced by the TEC to foster policy discussions on climate technology and innovation, and building on the expertise of partners in the digital and climate technology community, as well as the TEC Technical Paper, *Artificial Intelligence for Climate Action: Advancing Mitigation and Adaptation in Developing Countries*, this policy brief provides policy insights and concise, actionable recommendations to:

- Support inclusive, sustainable, and ethical AI development and deployment for climate action.
- Enable national determined efforts through targeted capacity building and equitable access, allowing vulnerable countries to leapfrog development stages.
- Translate technical findings into practical guidance to accelerate climate adaptation and mitigation progress in alignment with the UNFCCC and the Paris Agreement objectives, and respecting national sovereignty and circumstances.
- Guide the developing countries to cautiously embrace AI for climate action while taking into consideration the related barriers and risks.

Drawing from the latest available information and insights, this brief is designed to inform a broad range of stakeholders, particularly policymakers and development agencies involved in the formulation and implementation of AI for climate adaptation, mitigation, and climate AI policies and actions.

2. Introduction: The Enabling Role of AI in Climate Action

AI and applied ML are rapidly emerging as powerful technological enablers to accelerate global progress towards the UNFCCC objectives and the Paris Agreement goals. AI's ability to process vast, complex datasets, enhance predictive accuracy, and optimize intricate systems, position it as a strategic tool for both adaptation and mitigation efforts. Policymakers are increasingly recognizing this potential and countries have already included the application of digital technologies to support their NDCs, with some explicitly mentioning AI[ii].

This **policy brief aims** to translate the comprehensive findings and detailed evidence from the **TEC technical paper, *Artificial Intelligence for Climate Action: Advancing Mitigation and Adaptation in Developing Countries***, into **concise, actionable policy recommendations for the effective integration of AI into national climate policies and strategies**. The paper explores AI's opportunities across adaptation (e.g., improving Early Warning Systems and precision agriculture) and mitigation (e.g., optimizing energy grids and reducing transport emissions). At the same time, the brief addresses **key barriers and risks** faced by developing countries, including the digital divide, data scarcity, capacity gaps, high energy and water demands of advanced AI models (Deep Learning, Generative AI), and the need for inclusive and ethical governance to mitigate algorithmic bias, security, and privacy concerns.

The **methodology** for this brief builds on the TEC Technical Paper, which synthesizes peer-reviewed literature, real-world case studies from developing countries, and expert insights to ensure the recommendations are robust, contextually relevant, and aligned with operational realities faced by developing countries.

Definition and Concepts of AI

In this brief, the term AI is used broadly to refer to both Artificial Intelligence and applied Machine Learning methods. The following definitions and structural breakdown categorize the models and methods most relevant to climate action (for details see TEC report Section 1.2)[iii]:

- **Artificial Intelligence (AI)** is the discipline focused on the research and development of mechanisms and applications of system that generate outputs such as content, projections, recommendations, or decisions for a given set of human-defined objectives (ISO/IEC 22989:2022).
- **Machine Learning (ML)** is a sub-field of AI defined as the process of optimizing model parameters through computational techniques, such that the model's behaviour reflects the data or experience. In the context of climate action, applied ML is used to analyse large and complex climate-related datasets to support mitigation and adaptation efforts.

- **Deep Learning (DL)** is a subset of ML that uses **Artificial Neural Networks (ANNs)** with multiple layers. ANNs provide the underlying structure for DL and are foundational to advanced predictive analytics in the climate space.
- **Generative AI (GenAI)** is a subset of DL powered by foundation models (transformer architecture) designed to generate new synthetic data, such as text via **Large Language Models (LLMs)**, by learning the underlying statistical distributions of vast datasets. Due to the immense computational power required for training and inference, GenAI is often discussed in the context of high energy and water consumption risks and its immense carbon footprint. For instance, the training phase of a single large-scale model of the size of GPT-4 is estimated to emit as much carbon as several gas-powered cars over their entire lifespans (see TEC report Section 1.2 for detailed metrics).

The following models and architectures are commonly applied to address specific climate challenges:

- **Computer Vision (CV)** techniques like **Convolutional Neural Networks (CNNs)** process visual data from satellite and aerial imagery for detecting deforestation, monitoring coastal erosion, assessing disaster damage, flood mapping in urban areas, and generating synthetic tropical cyclones for resilience planning.
- **Sequential & Predictive modelling** including **Recurrent Neural Networks (RNNs)** and **Long Short-Term Memory (LSTMs)** for high-accuracy weather forecasting, water resource management, and enhanced sea-level predictions.
- **Natural Language Processing (NLP**) and **LLMs** to interpret and generate human language, enhancing climate communication, providing personalized climate education. **Small Language Models (SMLs)** serve as an energy-efficient and context-aware alternative to LLMs to reduce the carbon footprint of AI infrastructure and improve accessibility in local languages.

3. Strategic Opportunities: Harnessing AI for Climate Action

This section details specific, actionable strategic opportunities where AI can be effectively deployed to build climate resilience, improve projections, optimize resource management, and advance decarbonisation efforts, enhance knowledge and engagement, as well as the role of the Technology Mechanism activities across the most vulnerable regions.

Improving Forecast Accuracy

AI-driven predictive analytics for extreme weather events, such as floods, hurricanes, and droughts, can substantially improve forecast accuracy and extend lead times, enabling anticipatory action and more effective disaster risk management. By integrating climate models, satellite imagery, historical climate data, and real-time observations, AI systems enhance the ability to estimate exposure and identify populations at risk, supporting timely and targeted interventions.

Initiatives such as the UN **Early Warning for All (EW4All)**[iv] demonstrate the transformative potential of AI-enabled early warning systems. Implemented in countries including Ethiopia and India and co-led by the World Meteorological Organisation (WMO) and the United Nations Office for Disaster Risk Reduction (UNDRR), EW4All uses AI, high-resolution satellite imagery and predictive modelling through partnerships with organizations like Microsoft and Planet Labs to accurately map vulnerable populations and identify high-risk areas. These AI-driven insights enable governments and organizations like the International Federation of Red Cross and Red Crescent Societies (IFRC) to transition from reactive disaster response to anticipatory actions (e.g., pre-distributing aid), ensuring that resources reach the most at-risk communities before disaster strikes. **Google's Flood Hub**[v], which supports the EW4All, has set a new global benchmark for lead times in data-scarce regions with riverine flood forecasts up to 7 days in advance, and in regions like Bihar, India, this window has led to a 30% reduction in medical costs for affected families, as they have enough time to evacuate with clean water, medicine, and livestock[vi].

The **EMPIRIC AI** [vii] project addresses the lack of robust climate-specific data and limited representation of small islands in global climate models for Pacific Island Countries, which are highly susceptible to tropical cyclones. The project uses new statistical modelling and AI techniques (specifically CNNs) to generate thousands of synthetic tropical cyclones and emulate their pan-Pacific impacts. This allows for rapid sampling of future storm states and provides site-specific projections of potential landfalls, wind, and rainfall at different hospital sites in Pacific Island Countries like Fiji, Tonga, Vanuatu, and the Solomon Islands. These insights empower health governing bodies for future healthcare infrastructure planning, identifying high-risk hospital sites to guide long-term adaptation measures, such as preparation for flooding or potential relocation, to ensure healthcare facilities remain resilient over multi-decade climate horizons.

The **MAZU AI-powered Early Warning System**[viii] supports developing countries in addressing limited access to advanced forecasting infrastructure and technical capacity for responding to extreme weather and climate risks. The system combines satellite and radar observations with AI-based forecasting to provide cloud-based early warning services, currently used by meteorological agencies in more than 40 countries. In parallel, customized systems have been developed for several countries, complemented by joint research, technical training and expert exchanges. This combination of shared digital infrastructure, tailored deployment and capacity-building enables countries to access advanced AI capabilities while strengthening local capacity and long-term ownership of climate early warning systems.

Optimizing Resource Management

AI also plays a critical role in supporting sustainable resource use and ecosystem management under changing climate conditions. In agriculture, AI-powered precision farming systems combine data from weather stations, satellite imagery, and soil sensors to generate localized crop yield projections and early warnings of climate stress. These tools help smallholder farmers reduce losses due to climate variability and improve food and nutrition security.

For example, in Kenya the **Early Warnings System for Crop Phenotyping and Food and Nutrition Security** project[ix], in collaboration between the Local Development Research Institute (LDRI) and the German Corporation for International Cooperation (GIZ) FAIR Forward initiative[x] uses AI to provide smallholder farmers, in particular women, with timely crop yield predictions by integrating data from local weather stations, satellite imagery, and soil sensors across 400 farms across 6 agro-ecological zones. Accessible in local languages such as Kiembu, Luhya, Kikuyu, and Kiswahili, the system enables proactive climate adaptation, improved resource management, and more informed agricultural decision-making.

Similarly, **AI-generated indicative High Carbon Stock Maps**[xi] in Indonesia, India, and Senegal use remote sensing and ML techniques to identify and classify High Carbon Stock (HCS) forests, supporting more accurate carbon accounting and targeted conservation planning. These initiatives integrate local forest inventory data, consent-based approaches such as Free, Prior, and Informed Consent (FPIC), and participatory mapping to improve biomass estimates and ensure that local and Indigenous knowledge and rights are reflected in land-use decisions. By combining advanced analytics with inclusive governance practices, the projects strengthen national climate mitigation strategies and provide open-source tools[xii] for forest fire detection, long-term forest monitoring, and evidence-based, sustainable ecosystem management.

The PrevisIA Project[xiii] in the Brazilian legal Amazon uses AI and satellite imagery to detect the emergence of unofficial roads, which are strong predictors of deforestation and fires. Since 2024, the AI model annually detects these roads, allowing authorities to take targeted enforcement action[xiv]. The project involves a working group led by the Pará State Prosecutor's Office that monitors deforestation and takes action based on the AI-generated alerts. This demonstrates a scalable model for integrating AI into legal action, forest governance, and climate mitigation.

Coastal conservation efforts are increasingly strengthened through advanced digital tools such as **AI-based Mangrove Adaptive Mapping (AMAP)**[xv], which has been implemented in the Solomon Islands to improve the monitoring and management of mangrove ecosystems. By combining satellite imagery with ML algorithms and climate data, AMAP produces high-resolution maps that offer detailed information on mangrove distribution, health, and changes over time. This enhanced spatial knowledge allows decision-makers to identify vulnerable or degraded areas, prioritize zones for protection or restoration, and guide more effective allocation of conservation resources.

Advancing Decarbonisation

In key areas like energy management and transport systems, AI can significantly advance decarbonization efforts. In the energy sector, AI-driven systems are crucial for mitigation by reducing energy loss, optimising consumption and distribution, and improving the overall efficiency and reliability of power grids. Through advanced data analytics and predictive modelling, AI supports accurate forecasting of electricity demand and renewable energy generation, enabling better integration of variable renewable sources such as solar and wind, improved energy storage management, and more resilient grid operations. These capabilities are essential for scaling clean energy while maintaining grid stability.

For example, the **Lamwo Electrification App**[xvi] developed by Sunbird AI, uses ML, satellite imagery, and geospatial data to identify suitable renewable energy sites in Uganda. This approach enables more effective rural electrification planning, supports evidence-based investment decisions, and improves reliable electricity access for rural households and small businesses, contributing directly to low-carbon energy transitions.

In the transport sector, AI tools analyse traffic patterns, mobility data, and route efficiency to optimise traffic flow and transport planning, directly reducing fuel consumption, congestion, and associated emissions. In India, the **Vayu/Open Air project**[xvii], supported by UNDP India and the Lacuna Fund for Climate[xviii], used AI alongside citizen participation and Internet of Things (IoT) sensor deployment across two cities to generate real-time, hyperlocal data for improved air quality management. This data helped identify neighbourhoods most affected by poor air quality, guiding local authorities in targeted interventions such as optimizing traffic routes, reducing the carbon intensity of existing transport systems, monitoring construction dust, and planning green spaces.

Building Resilience and Transforming Urban Planning

AI- and ML-driven tools are playing an increasingly vital role in strengthening urban resilience by enhancing infrastructure planning, optimizing land use, protecting ecosystems, and enabling rapid post-disaster assessment. By analysing data from critical infrastructure, such as buildings, roads, and energy systems, AI-assisted vulnerability assessments can identify potential weaknesses and support proactive adaptation and disaster-preparedness measures. At the same time, AI simulations help guide the design of climate-resilient buildings and transportation networks, improving their capacity to withstand extreme weather events and future climate impacts.

For example, the open-source project **High-speed Assessment and Satellite Tracking for Emergencies (HASTE)**[xix], as part of the **EW4ALL** initiative, was developed to simplify the use of AI models for rapid post-disaster assessment by a broader range of users, addressing the complexity challenge highlighted by catastrophic events. Under the Digital Earth for Resilient Housing and Infrastructure in the Caribbean, the project leverages CV models to automate the generation of exposure data maps and facilitate the accurate mapping of building footprints and roof material classification in post-disaster scenarios, enabling government agencies in Dominica, Saint Lucia, and Grenada[xx] to swiftly and cost-effectively identify damaged or at-risk structures to improve the climate resilience of the housing sector.

AI also supports disaster-resilient energy systems by integrating IoT and sensor data to optimize grid performance, ensuring critical infrastructure remains operational during extreme weather events. A study in **Viet Nam** utilized an AI (specifically a CNN architecture) to improve coastal forest cover change detection, which is crucial for monitoring and protecting these natural barriers that enhance community resilience against climate impacts like storms and erosion. Similarly, the **Community Innovation Labs for Climate Resilience (CO_LABS Project)**[xxi] in Indonesia integrates AI and frugal IoT[xxii] with local traditional knowledge to develop sustainable practices, including mangrove planting for coastal protection and using IoT sensors to optimize fish farming operations.

Finally, AI-powered urban planning tools help identify high-risk areas, optimize land use, and inform long-term strategies to increase climate resilience, ensuring cities are prepared for both present and future climate impacts. For example, the **ITU Global Initiative on Resilience to Natural Hazards through AI Solutions** leverages ML and geospatial data to map hazard exposure and vulnerability, enabling cities to anticipate floods, landslides, and other climate-related risks and prioritize mitigation measures. In the **Philippines**, researchers have developed AI-driven flood mapping models (also using CNNs) that process satellite data with minimal human input to rapidly delineate flood-prone urban areas, helping local planners identify vulnerable neighbourhoods, guide infrastructure investments, and integrate climate risk information into long-term urban planning and disaster preparedness strategies[xxiii].

Enhancing Knowledge and Engagement

AI is increasingly bridging the gap between climate science and society by enhancing access to climate information, supporting participatory decision-making, and strengthening community engagement. By processing, synthesizing, and contextualizing complex data. Projects like the **Artificial Intelligence for Small Island Developing States (AI4SIDS)** utilizes LLMs to generate localized alerts and educational tools for communities in SIDS States, while the **Agriculture Exchange Advisory Platform** (AIEP)[xxiv] in India and Kenya delivers timely, localized agricultural and climate advisory services in Swahili, Hindi and English, supporting climate-resilient farming practices for smallholder farmers, particularly women.

AI also can support participatory approaches by analysing community inputs and integrating them into policy and planning. Open-source platforms such as **Ushahidi**, originally developed in Kenya and a certified Digital Public Good (DPG)[xxv], showcase the importance of inclusivity and language accessibility: by allowing communities to collect, translate, and map climate and hazard-related information in local languages such as Swahili, it empowers marginalized groups to actively participate in decision-making and ensures that local knowledge is integrated into adaptation strategies[xxvi].

In Indonesia, SMLs have been deployed to generate localized climate information and detect misinformation in Bahasa and regional languages, strengthening community engagement and trust in climate science. The **Faktaiklim**[xxvii] initiative**,** implemented by Prosa.ai, has collected localised data in the target languages and uses NLP to detect and counter misleading narratives online, and including evidence-based research, as well as traditional knowledge systems, supporting public trust in climate science and informed civic engagement in languages including Bahasa, Balinese, Buginese, Minangkabau[1].

Beyond public engagement and policymaking, AI-powered tools can also influence individual behaviour by promoting more sustainable consumption. For instance, AI-driven eco-labelling systems and personalized product information can help consumers understand the environmental impacts of their purchases, guiding lower-carbon choices and reducing environmental footprints[xxviii].

Technology Mechanism Activities Supporting the Application of AI for Climate Action in LDCs and SIDS

The UNFCCC Technology Mechanism actively supports developing country Parties in harnessing AI to address climate change through technical assistance projects, capacity-building initiatives, and innovation challenges. These activities align with the Technology Mechanism’s mandate to facilitate the enhanced implementation of the Convention and the Paris Agreement, particularly in technology development, transfer, and innovation. The Technology Mechanism’s work is informed by the Joint Work Programme (JWP), which outlines high-level climate objectives including capacity building, technology transfer, and knowledge sharing, as well as the Technology Needs Assessment (TNA) process, which identifies priority climate-friendly technologies, develops national action plans, informs policy, and mobilizes finance for technology implementation.

Key initiatives of the Technology Mechanism include the **Technology Mechanism Initiative on AI for Climate Action (#AI4ClimateAction Initiative)**[xxix], led by the TEC and the Climate Technology Centre and Network (CTCN), which explores locally-led AI solutions for mitigation and adaptation in LDCs and SIDS with a focus on the TEC and CTCN common areas of work on national systems of innovation, water-energy-food systems, energy systems, buildings and resilient infrastructure, business and industry, and technology needs assessments. The workplan for this initiative (2024-2027)[xxx] is structured around three main workstreams: 1) Supporting the implementation of the Joint Work Programme and TNA outcomes through technical papers, policy briefs, and ongoing capacity-building; 2) Enhancing the capacity of stakeholders from LDCs and SIDS with a focus on gender-responsive solutions, including the AI Innovation Grand Challenge and the development of an AI climate accelerator; and 3) Raising awareness of AI for climate action, including its challenges and risks, through events and contributing expertise to relevant bodies like the UN Secretary-General Advisory Body on AI.

One notable example is the above-mentioned **AI4SIDS**[xxxi], an initiative led by a female leadership from Trinidad and Tobago and the winner of the 2024 AI Innovation Grand Challenge. The project leverages LLMs and ML algorithms, alongside real-time data from IoT sensors, satellite imagery, social media feeds, and weather forecasts to deliver localized, multi-channel early warnings in local languages. By improving accessibility and community engagement, AI4SIDS strengthens climate resilience in vulnerable coastal regions. The initiative provides a scalable and replicable framework for SIDS and other vulnerable areas to optimize the sustainable management of freshwater resources, fisheries, and coral reefs, while running predictive simulations that support climate-resilient infrastructure and urban planning in the face of sea-level rise and increasingly extreme weather events.

Similarly, the AI for Climate Action Award winner in 2025 from Lao People's Democratic Republic, awarded at COP30 for **Smart AI-based Farming and Irrigation for Resilience (SAFIR)**[xxxii], applies open AI models and data tools as a DPG to support groundwater forecasting, soil-moisture prediction using LSTM models, solar irrigation control, and reinforcement-learning-based irrigation scheduling. By making these tools openly accessible, SAFIR enables government agencies, local developers, and researchers to scale climate-smart irrigation solutions, promoting community-driven innovation, and accelerate the adoption of resilient agricultural practices.

These initiatives exemplify how AI projects supported by the Technology Mechanism can be embedded within broader national climate strategies, helping LDCs and SIDS translate cutting-edge technology into actionable policies, strengthen climate adaptation and mitigation planning, and align locally led solutions with long-term sustainable development goals.

4. Navigating the Risks and Challenges of using AI for Climate Action

The effective integration of AI into climate action strategies in developing countries is contingent upon the responsible navigation of significant technological, ethical, and environmental risks (see for details TEC Technical Paper, Section 6). These challenges, if unaddressed, could exacerbate existing inequalities and undermine the overall climate benefits of AI deployment.

Address the Digital Divide and Inequality

A fundamental barrier is the vast **digital divide**, often referred to as the “compute divide,” which hinders equitable access to adoption of AI technologies. Many vulnerable regions lack the necessary foundational infrastructure, including reliable electricity, ubiquitous and fast internet connectivity, and local computing power (data centres). This infrastructural deficit is compounded by a severe **data scarcity** problem, specifically lack of localised, representative, high-quality, and reliable climate data (e.g., for localised climate projections and weather forecasts) required for training effective and context-aware AI models. The reliance on large, reliable datasets means that complementing ML models with rule-based, physics-informed, and domain-informed ML approaches is necessary to alleviate data constraints in regions where essential digital data is sparse, such as the localised climate projections and weather forecasts critical for optimizing farming practices [xxxiii] . Furthermore, a shortage of skilled professionals (the **capacity gap**) limits the availability of countries to develop, maintain and ethically govern AI systems and use cases. Policymakers must therefore proactively guard against the risk of AI exacerbating social and economic inequalities. This requires **data sovereignty** and implementing inclusive governance approaches that actively engage civil society, local and Indigenous communities, and underrepresented groups in the design and deployment of AI solutions, ensuring they address local needs rather than imposing external solutions. Furthermore, any efforts to improve data access and sharing must be accompanied by explicit caveats on respect for confidentiality and intellectual property rights, and national sovereignty.

The Environmental Footprint of AI

While AI offers climate benefits as exemplified in previous sections, its development and deployment carry considerable environmental costs, including direct and indirect GHG emissions from the energy supply chain. This environmental footprint requires careful management to avoid unintended consequences (rebound effects) and systemic effects, creating pressure on resources that must be managed. Advanced AI models like DL and GenAI, including LLMs, are notoriously resource-intensive and consume substantial amounts of energy during the training and deployment phases, contributing to direct and indirect GHG emissions. For instance, the training phase of a single large-scale model of the size of GPT-4 is estimated to generate approximately 300 tonnes of carbon (as much carbon as several gas-powered cars over their entire lifespans) for its entire training process, a footprint expected to grow with model complexity[xxxiv]. In addition to the direct energy consumption, there are significant environmental costs linked to the production and operation of AI models; for example, interacting with a model like those powering ChatGPT for 20 to 50 queries could require the equivalent of a 500-millilitre bottle of water[xxxv]. If not effectively managed, this energy and water consumption can offset the potential climate benefits these technologies offer, undermining the goals of the Paris Agreement.

This requires stressing the need for the adoption of energy- and water-efficient models (e.g., SLMs, and efficient, low-energy algorithms, in accordance with national circumstances and development priorities).

A growing body of work is examining the energy and broader environmental footprint of AI, including work by IEA on AI and energy and work by ITU on methodologies and standards for measuring and assessing the environmental impacts of AI.

Governance, Bias, and Human Rights

The rapid growth of AI introduces critical ethical and societal risks. Key concerns include algorithmic biases, including gender and demographic biases, rooted in incomplete or unrepresentative training data, which can perpetuate or deepen existing gender, social, and cultural inequalities. For instance, biased AI used in resource allocation or early warning systems could disproportionately disadvantage vulnerable groups. Furthermore, the misuse of multi-purpose AI systems, in conjunction with dual-use technologies such as drones, poses a grave and systemic risk. Beyond physical threats, the handling of vast datasets raises serious issues related to data security and privacy. As AI systems are vulnerable to cyber-attacks, data breaches, and malicious manipulation of algorithms, it is essential to implement robust security measures and protocols, such as the Trust, Risk, and Security Management (TRiSM) framework[xxxvi], to safeguard data integrity and privacy, including encryption and regular audits[xxxvii].

Promoting Transparency, Accountability, and Technology Development and Transfer

To build trust and ensure beneficial outcomes, there is a strong need for transparency regarding how AI models function and how decisions are made (explainability). This is critical for accountability, especially in high-stakes climate applications like disaster risk reduction. Robust frameworks are needed to assess the full impact of AI deployment, promoting continuous learning and adaptation through appropriate regulatory support. Finally, facilitating genuine technology development and transfer is crucial to enhance local ownership, customize solutions to local contexts, and encourage market diversification, and promote AI cooperation through technology collaboration, innovation incentives, joint research, and local capacity-building, among other approaches.

And promoting the use of open-source AI models and platforms (DPGs) is also instrumental to achieve the same goal. This can be supported by creating regional AI research centres and knowledge-sharing platforms.

Further analysis of the challenges and policy options for addressing AI-related divides in developing countries, particularly in relation to infrastructure, data and skills, is provided in the UNCTAD Technology and Innovation Report 2025: Inclusive Artificial Intelligence for Development.

5. Key Messages and Recommendations

The TEC Technical Paper outlines a comprehensive set of key messages and recommendations essential for harnessing the potential of AI while mitigating its associated risks, particularly in developing countries.

1. Promote the use of open-source AI applications, as appropriate, in climate change mitigation and adaptation strategies in developing countries, ensuring they are deployed and are the most suitable tool for the task.
2. Encourage the use of AI for climate action by promoting supportive policies, local training, and resources to empower stakeholders to use AI to reduce GHG emissions and build climate-resilience.
3. Integrate AI technologies into national and regional climate strategies where they can enhance areas such as early warning systems, optimization of resource allocation, and data-driven decision-making, as appropriate, in climate adaptation and mitigation efforts.
4. Build and strengthen technical capacity for development, deployment and maintenance of AI within the local communities.
5. Strengthen global partnerships and knowledge sharing by fostering international cooperation and developing capacity-building programmes to enhance the skills and capabilities of local stakeholders, promoting knowledge-sharing and collaboration to maximize AI’s potential in climate strategies.
6. Develop inclusive and sustainable policies and establish governance approaches, enabling data-driven decision-making, as appropriate, and access to climate regulatory frameworks and state-of-the-art research.
7. Reduce the energy consumption and carbon footprint of AI by implementing energy-efficient algorithms and promoting the use of Small Language Models while encouraging the use of low-emission energy sources aligned with national circumstances for AI infrastructure.
8. Strengthen data security and ethical governance by developing robust data governance frameworks to ensure privacy, security, and ethical use of data, protecting against unauthorized access and breaches.
9. Address gender bias by applying inclusive design practices, generating and using diverse datasets, and establishing gender-responsive policies, particularly in climate-related applications.
10. Bridge the digital divide through equitable access by investing in infrastructure development and capacity-building initiatives in developing countries to promote equitable access to AI technology and resources.
11. Invest in AI research, development, and innovation tailored to local contexts and priorities by:

(a) Collaborating with local communities, governments, and organizations to identify specific climate challenges and priorities;
(b) Supporting research initiatives that create AI solutions aligned with the unique environmental, social, and economic conditions of different regions;
(c) Allocating funding for local AI innovation hubs to foster relevant and sustainable home-grown solutions;
(d) Expanding access to AI resources for climate solutions by facilitating the availability of AI tools, data, and technical expertise to support effective, locally relevant AI-driven climate responses at local and national levels in regions facing significant climate challenges.

12. Enable AI deployment for climate action in developing countries with a focus on SIDS and LDCs by facilitating relevant infrastructure and skills development, financial support and the establishment of governance and policy frameworks.
13. Integrate local knowledge into AI-powered solutions:
    (a) Engaging local and indigenous communities to incorporate traditional knowledge into datasets and the development of AI models for local context-specific climate action. This is particularly relevant in sectors such as land management, disaster preparedness, and biodiversity conservation, where local insights complement AI-generated predictions.
14. Ensure gender-responsive approaches in AI development by:
    (a) Investing in gender disaggregated data generation, collection and use to feed AI-powered climate solutions;
    (b) Involving women and gender experts throughout all phases of the design, development, and implementation of such solutions;
    (c) Promoting inclusivity by addressing the specific needs, contributions, and lived experiences of women and girls, particularly in contexts where socio-economic disparities limit access to climate technologies;
    (d) This is especially pertinent in climate adaptation policies, disaster resilience planning, and AI applications in sectors such as sustainable agriculture and water resource management, where gender-differentiated vulnerabilities and contributions must be considered.
15. Promote information integrity in AI-enabled climate action by encouraging the development and deployment of AI systems that are transparent, science-based and safeguarded against climate-related disinformation and misinformation.
16. Create special funds for supporting development, deployment and management of AI in LDCs and SIDS.

6. Conclusion

AI is a powerful tool for accelerating climate action in developing countries, including LDCs and SIDS, by enhancing both adaptation (e.g., early warning systems, resource management) and mitigation (e.g., energy optimization, decarbonisation). However, the sustainable adoption of these technologies is contingent upon navigating a complex landscape of structural hurdles. The **digital divide** remains a primary barrier, as many regions still lack the reliable electricity and internet connectivity required to support high-performance computing. This is compounded by **data scarcity**, where the absence of high-quality, localized climate data limits the accuracy of predictive models. Furthermore, **ethical risks** such as algorithmic biases can inadvertently perpetuate social inequalities, and compromise sustainability goals, while the **environmental footprint** of advanced AI, specifically the high energy and water consumption of Deep Learning and Generative AI, presents a paradox that must be managed.

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