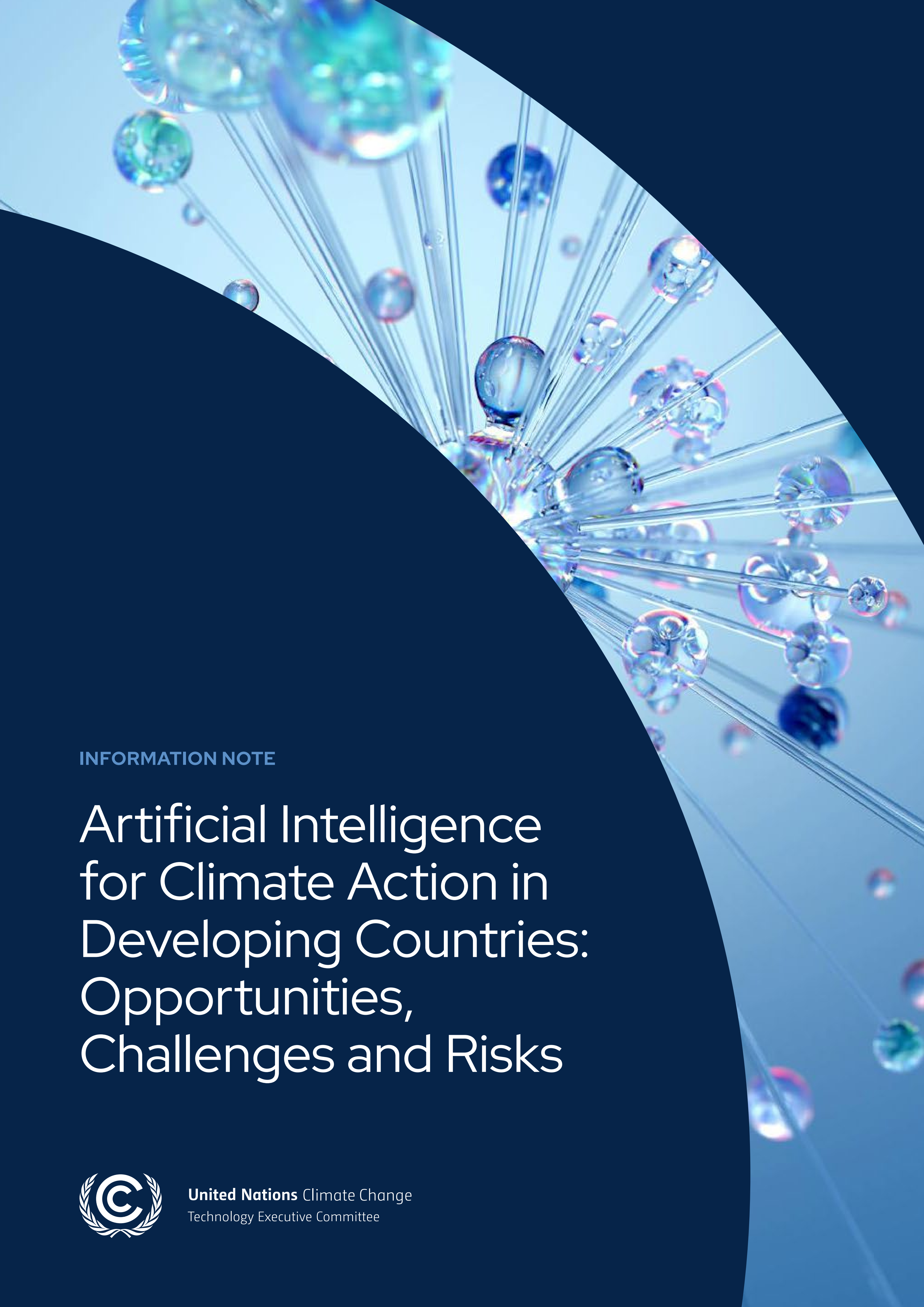

INFORMATION NOTE

Artificial Intelligence for Climate Action in Developing Countries: Opportunities, Challenges and Risks

United Nations Climate Change
Technology Executive Committee

Acknowledgements

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UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

UNFCCC TEC INFORMATION NOTE:

ARTIFICIAL INTELLIGENCE FOR CLIMATE ACTION IN DEVELOPING COUNTRIES: OPPORTUNITIES, CHALLENGES AND RISKS

Contents

IMAGE © PEXELS-DEEPMIND

1. Introduction

This information note is intended to serve as an accessible introduction to the relationship between artificial intelligence (AI) and climate action. The Technology Executive Committee (TEC) has prepared this publication as part of the Technology Mechanism Initiative on AI for Climate Action (#AI4ClimateAction) to provide an overview of the opportunities, risks and challenges of using AI for climate action in developing countries, with a focus on least developed countries (LDCs) and small island developing States (SIDS). The Technology Mechanism consists of a policy arm, the TEC, and an implementation arm, the Climate Technology Centre and Network (CTCN) to advance the development and transfer of climate technologies under the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement.

AI-enabled systems can support both climate change adaptation and mitigation action, ranging from early warning systems for natural disasters to optimizing agri-food production and improving the efficiency of energy systems. However, the deployment of AI can also pose challenges and risks such as widening of the digital divide, data security and transparency issues, reinforcing bias including gender bias, facilitating the spread of disinformation and misinformation, and increasing energy and water consumption. This publication aims to raise awareness among policymakers and stakeholders regarding these opportunities, challenges and risks, providing insights into how AI can be responsibly leveraged for effective climate action in developing countries.

The information note is structured as follows. Section 2 provides an overview of AI and machine learning as general purpose technologies, explaining their applications in addressing climate change challenges. Sections 3 and 4 explore AI applications for climate change adaptation and mitigation, highlighting specific AI-driven solutions for reducing greenhouse gas (GHG) emissions and enhancing climate resilience. Section 5 identifies challenges and risks associated with AI. Section 6 examines the current state of AI under the UNFCCC, the Paris Agreement and national technology needs assessments. Section 7 describes several other initiatives that are exploring the use of AI for addressing climate change challenges.

2. AI and machine learning

AI is a multifaceted field with many plausible definitions, but definitions typically focus on an engineered system's ability to perform some form of intelligent-seeming behaviour, such as generating content, forecasts, recommendations or decisions.[1] Machine learning (ML), a subfield of AI, is concerned with computational techniques for enabling a model's behaviour to reflect training data or experience.[2]

Climate-relevant subfields of AI include computer vision and image recognition, natural language processing, data mining and planning, where each suite of techniques can have many climate-related applications. For example, computer vision and image recognition can be used in satellite imagery to monitor deforestation, track changes in land use, improve the accuracy of environmental monitoring and assess damage from natural disasters. Natural language processing aids in facilitating interfacing with computer systems and in querying climate reports, scientific papers and policy documents, allowing researchers to extract relevant information from large datasets of unstructured text. Data mining is important for identifying climate patterns and trends from vast amounts of environmental data, such as temperature records, precipitation levels and CO_2 emissions. Lastly, planning supports decision-making in areas such as resource management, disaster response planning and energy system optimization. AI-driven planning models can help design more efficient energy grids, improve disaster preparedness and prioritize climate adaptation measures for communities at risk of climate impacts.

AI systems that use machine learning techniques are rapidly emerging as transformative technologies with climate change standing out as an area where these innovations can drive impactful change. Research has shown that AI can act as an enabler and inhibitor[3] in addressing climate change challenges. The Technology Mechanism is exploring how AI can help address climate change in developing countries, in particular in LDCs and SIDS, including through the use of AI for monitoring and data collection; climate modelling and prediction; resource, energy and transport management; disaster risk reduction; and education and community engagement. The aim is to assess how these technologies can contribute to climate action, while addressing the challenges and risks of their use.

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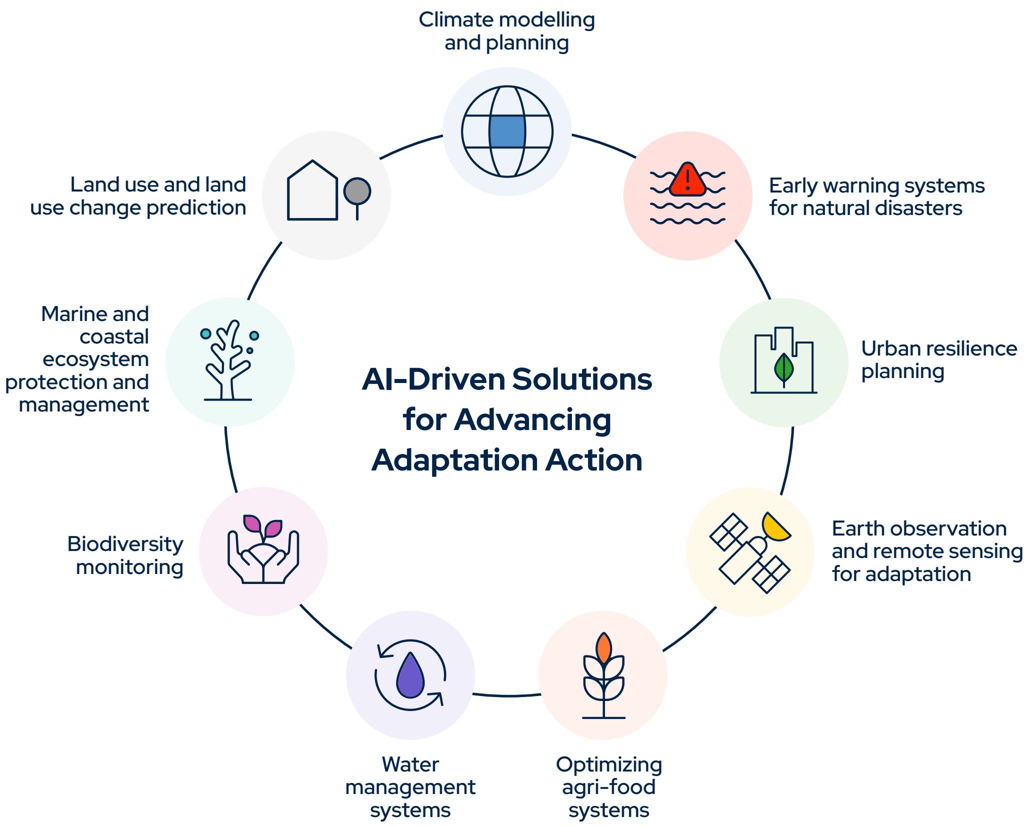
[1] *See, e.g., ISO/IEC 22989; OECD.*

[2] *For example, the International Organization for Standardization defines ML as "a type of AI that allows machines to learn from data without being explicitly programmed by optimizing model parameters through calculations, such that the model's behaviour reflects the data or experience".*

[3] *Vinuesa, R., Azizpour, H., Leite, I. et al. The role of artificial intelligence in achieving the Sustainable Development Goals. Nature Communications 11, 233 (2020). https://doi.org/10.1038/s41467-019-14108-y*

3. AI-Driven Solutions for Advancing Adaptation Action



AI applications for climate change adaptation

Climate modelling and planning

AI systems are playing a role in climate modelling and planning, data analysis, and prediction of sea-level rise, deforestation and other climate impacts. These models can help governments and organizations develop more tailored and efficient adaptation responses, improve disaster preparedness and include resilience in infrastructure planning. AI can also be used to enhance the ability to forecast long-term climate trends and identify the areas that are most vulnerable to climate risks, enabling data-driven decisions that strengthen resilience.

CASE STUDY

REDUCING DEFORESTATION IN THE AMAZON RAINFOREST[4]

AI is being used to predict deforestation rates and enable proactive conservation efforts. Researchers applied a neural network with architectural elements designed for both spatial and temporal data to forecast incremental deforestation and future deforestation rates. This method allows for the continuous retraining of models with updated data and comparing prediction outcomes, resulting in accurate deforestation risk maps. The approach was also validated in other countries, including Madagascar and Mexico, proving its reliability in predicting forest loss and informing conservation strategies.

Early warning systems for natural disasters

AI models are increasingly deployed in developing countries, including LDCs and SIDS, to support analysis of weather patterns and provide more accurate forecasts for hurricanes, floods and droughts, allowing for timely alerts and preparedness measures and helping to mitigate these events' impact on vulnerable communities.

CASE STUDY

IMPROVING EARLY WARNING SYSTEMS IN ETHIOPIA[5]

The United Nations Office for Disaster Risk Reduction, Microsoft and other partners involved in the Early Warnings for All (EW4ALL) initiative are working with the Ministry of Irrigation and Lowlands in Ethiopia and the Ethiopian AI Institute to identify communities at high risk of impacts from natural disasters, which are often linked to climate change. They are employing AI, satellite imagery and predictive modelling to accurately estimate the population sizes of such communities, as well as tracking population growth over time. Gaining a clear understanding of where people live is foundational to taking preparatory measures and providing essential resources and to targeting early warning systems more effectively. Recognizing the critical need for such systems, the EW4ALL initiative was launched by the United Nations Secretary-General in 2022 with the aim to ensure that everyone on Earth is protected from hazardous weather, water or climate events through life-saving early warning systems by 2027.

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[4] *Dominguez, D., del Villar, L.D., Pantoja, O., & González-Rodríguez, M. (2022). Forecasting Amazon rainforest deforestation using a hybrid machine learning model. Sustainability, 14(691). https://doi.org/10.3390/su14020691*

[5] *Further information on the EW4ALL initiative is available at: https://www.un.org/en/climatechange/early-warnings-for-all. The TEC has engaged in the EW4ALL initiative in collaboration with the Group on Earth Observation and produced a policy brief on innovation and technology in support of risk-informed climate resilience policy and action (forthcoming).*

Urban resilience planning

AI is increasingly being utilized to map housing stock characteristics in countries vulnerable to natural disasters, such as LDCs and SIDS. It automates the creation of detailed maps that identify building footprints, material types and structural conditions leveraging high-resolution aerial imagery and machine learning techniques, including advanced computer vision models. These AI-driven tools are beneficial for conducting effective vulnerability assessments and enhancing disaster risk management and urban resilience planning. In areas prone to natural hazards, AI systems can enable the rapid assessment of damage following a disaster and can help to identify at-risk structures before such events occur. This supports more resilient urban planning and disaster preparedness efforts.

CASE STUDY

MAPPING IMAGES USING DEEP LEARNING FOR CLIMATE RESILIENCE IN THE CARIBBEAN[6]

The Caribbean region is among the most vulnerable to climate risks due to the increasing frequency and severity of natural hazards such as tropical cyclones, landslides and floods. As SIDS often sustain the highest levels of damage as a result of these natural hazards, particularly in the housing sector, accurate and up-to-date information on the spatial distribution and characteristics of buildings is crucial for effective vulnerability assessment and disaster risk management. However, traditional house-to-house surveys are expensive and time-consuming, creating significant obstacles. To address this, a workflow was developed under the Digital Earth for Resilient Housing and Infrastructure in the Caribbean project that rapidly generates critical baseline housing stock data using high-resolution drone images and deep learning techniques. Leveraging computer vision, particularly the Segment Anything Model and convolutional neural networks, this project automates the generation of exposure data maps. The project has generated detailed building footprint and roof type classification maps for Dominica, Grenada and Saint Lucia, which are needed for conducting comprehensive climate risk and vulnerability assessments and play an important role in identifying areas most at risk from climate impacts, enabling more targeted interventions and resilience planning. The goal is to enable government agencies to swiftly and cost-effectively identify damaged buildings following a disaster and proactively detect at-risk structures before a disaster occurs.

[6] *Tingzon, I., Cowan, N.M., & Chrzanowski, P. (2023). Can AI help build climate resilience in the Caribbean? Let's look at housing. The World Bank. https://blogs.worldbank.org/en/sustainablecities/can-ai-help-build-climate-resilience-caribbean-lets-look-housing*

Earth observation and remote sensing for adaptation

AI-driven Earth observation and remote sensing technologies are supporting adaptation efforts in sectors like agriculture, water management and ecosystem conservation. These systems provide real-time information on soil health, water levels and land degradation, helping countries monitor environmental conditions that are critical to adaptation. By using AI systems that include satellite data, governments and communities can be supported in implementing timely interventions, adjusting farming practices and managing natural resources more effectively, supporting food security and sustainable development.

CASE STUDY

IMPROVING FOREST MANAGEMENT IN VIET NAM[7]

AI-driven remote sensing techniques are being applied in Viet Nam to improve the detection of forest cover changes. Researchers have developed a method using a type of neural network architecture designed specifically for dividing images into distinct segments. This technique is particularly effective in identifying changes in images, such as detecting shifts in forest cover. The model is combined with multi-temporal satellite imagery, which involves using images captured by the satellites over different periods and significantly reduces the need for traditional, domain-specific knowledge, allowing for more automated and precise analysis. The system has demonstrated a high detection accuracy of 95.4%, surpassing the accuracy of conventional methods, which are 90% at maximum. Its high precision makes it a valuable tool for forest resource management and planning, particularly in detecting changes in coastal forests. This supports sustainable land use and conservation efforts, providing an effective way to monitor and manage forest ecosystems.


IMAGE © THUYHABICH,PIXABAY

[7] *Nguyen-Trong, K., & Tran-Xuan, H. (2022). Coastal forest cover change detection using satellite images and convolutional neural networks in Vietnam. IAES International Journal of Artificial Intelligence, 11, 930-938. https://doi.org/10.11591/ijai.v11.i3.pp930-938*

Optimizing agri-food systems

In agriculture, AI can assist in optimizing planting schedules, monitoring crop health and predicting pest outbreaks. This is particularly relevant for LDCs and SIDS, where food security is often threatened by changing climate conditions. AI-driven precision agriculture has shown potential in improving yields and reducing resource use. In sub-Saharan Africa, AI has been used to optimize irrigation and farming practices, improving crop yields in regions affected by unpredictable climate conditions. ML models have been used to support analysis of weather patterns and soil data to provide guidance to farmers, enhancing food security.

CASE STUDY

USING AI FOR CROP YIELD PREDICTION AND MONITORING IN KENYA[8]

Under its FAIR Forward project, the German Development Cooperation is working with the Local Development Research Institute (LDRI) in Kenya to support smallholder farmers to use AI technology for crop yield prediction and monitoring. The AI early warning system developed by LDRI and FAIR Forward significantly enhances harvest management for smallholder farmers by delivering timely and accurate crop yield predictions. By integrating data from weather stations, satellite imagery and soil sensors, the system provides precise, localized information, enabling farmers to anticipate adverse conditions and implement proactive measures. This results in reduced crop losses due to climate variability and optimized resource use. The incorporation of local languages, including Kiembu, Luhya, Kikuyu and Kiswahili, ensures that the advice is accessible to a diverse range of farmers.


IMAGE © THUYHABICH,PIXABAY

[8] *Spratt, A. (2023). How AI helps Kenyan small-holder farmers to adapt to climate change. BMZ Digital. https://www.bmz-digital.global/en/how-ai-helps-kenyan-small-holder-farmers-to-adapt-to-climate-change/*

Water management systems

AI technologies can play a key role in monitoring water resources, predicting water demand and optimizing distribution systems to improve water use efficiency. AI can help forecast water needs and allocate resources more effectively by leveraging correlations on vast datasets on weather patterns, soil moisture and water consumption trends. This is particularly important in LDCs and SIDS, where access to clean water is often limited, and climate change exacerbates water scarcity. AI-driven solutions have been employed to automate irrigation systems, predict droughts and manage reservoirs to maintain optimal water levels, ensuring a reliable supply for agriculture, industry and domestic use. These solutions are relevant in ensuring sustainable water management in countries and states that are vulnerable to both climate variability and increasing water stress.

CASE STUDY

DROUGHT RISK MODELLING FOR CLIMATE CHANGE ADAPTATION IN SAINT KITTS AND NEVIS[9]

Saint Kitts and Nevis is already experiencing the effects of climate variability, including rising temperatures, decreasing annual rainfall and potential increases in tropical storm intensity. The country recently faced its driest rainy season on record, with rainfall dropping from 741.8 mm in August 2022 to 472.1 mm in 2023. As rainfall is the sole source of water in the country, and with demand expected to significantly increase in the future due to tourism and agriculture, securing sustainable water access and developing drought prevention systems are critical for the island's communities. To address these challenges, Saint Kitts and Nevis partnered with the CTCN to incorporate drought risk modelling as part of their climate adaptation measures. The system supports the analysis of the entire water ecosystem, combining multiple datasets and technologies into a drought forecasting tool that supports climate change adaptation and decision-making. Together with a committed stakeholder working group, the technical assistance team generated hazard mapping solutions, which highlight areas vulnerable to drought, providing essential information for planning and resource management.

[9] *CTCN (2023). CTCN progress report 22-23: Catalysing innovation for system transformation, https://www.ctc-n.org/sites/default/files/resources/240308_CTCN_Progress_Report_2022_2023_DPS.pdf*

Biodiversity monitoring

AI is advancing biodiversity monitoring, allowing for the real-time tracking of ecosystems and species affected by climate change. AI systems are used to process data from drones, remote cameras and acoustic sensors to monitor wildlife populations and assess ecosystem health. These systems have helped conservationists and governments to monitor the impacts of climate change on biodiversity, implement protective measures and address the challenges of habitat loss.

CASE STUDY

AI FOR PROTECTING BIODIVERSITY IN COLOMBIA[10]

Under Project Guacamaya, advanced AI models are employed to monitor deforestation and protect biodiversity in the Amazon rainforest. The project combines satellite imagery, camera traps and bioacoustics data to rapidly inform on deforestation patterns. AI models have been used to identify deforestation hotspots more quickly, allowing for faster response and intervention. The initiative supports conservation efforts and aids in creating accurate maps and data for reforestation and carbon capture projects, providing a scalable solution to address the environmental challenges in the Amazon.

Marine and coastal ecosystem protection and management

AI is increasingly being used to monitor and protect coastal and marine ecosystems by tracking changes in coral reefs, fish populations and other vital resources. These ecosystems are essential for biodiversity and provide critical services such as food security, livelihoods and protection from natural disasters. In SIDS, where many communities rely on the health of marine environments for their economic well-being, AI technologies, combined with satellite imagery, are being deployed to track illegal fishing activities, monitor coastal erosion and assess changes in marine habitats. Moreover, AI-powered remote sensing and drones are used to survey hard-to-reach areas, providing real-time data on ecosystem health. However, despite the potential of these technologies, large-scale implementation across all SIDS is not yet uniform, with varying levels of access to AI tools and resources. Efforts are ongoing to scale up the use of AI in marine conservation, contributing to more effective management and protection of these ecosystems.

[10] *Elliott, S. (2024), AI may hold a key to the preservation of the Amazon rainforest, https://news.microsoft.com/source/latam/features/ai/amazon-ai-rainforest-deforestation/?lang=en*

Land use and land use change prediction

AI models are being used to predict land use and land cover changes using spatial data related to soil type, altitude and proximity to infrastructure, among other features. These predictions help forecast shifts in land use patterns, enabling policymakers to better manage resources and plan for sustainable land use.

CASE STUDY

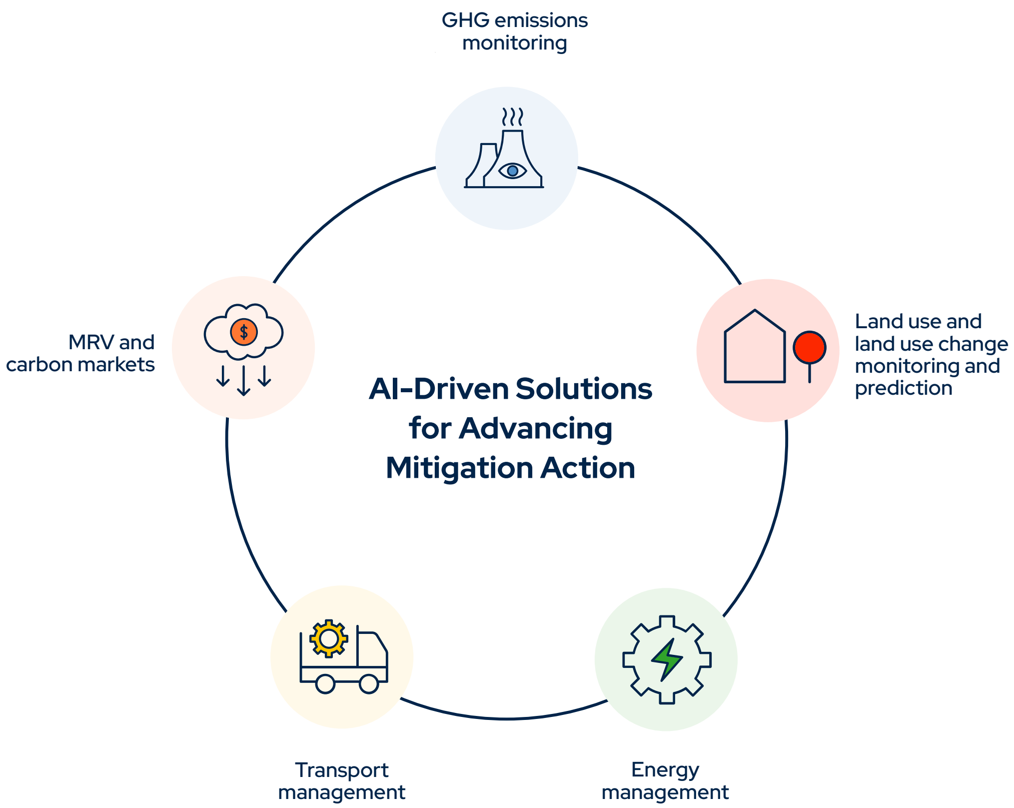
USING AI FOR LAND RESOURCE MANAGEMENT IN INDONESIA[11]

In North Sumatra, Indonesia, AI is being used to predict land use and land cover changes with an artificial neural network-based cellular automaton model. This model uses factors such as altitude, slope, road proximity and soil type to simulate changes in land use patterns over time. The predictions indicate a shift from forested areas and croplands to plantation development, with significant changes projected by 2050 and 2070. By forecasting these shifts, the AI model helps policymakers and environmental managers take proactive steps to manage land resources and mitigate the impacts of deforestation and agricultural expansion.


IMAGE ©SASINT PIXABAY

[11] *Saputra, M.H., & Lee, H.S. (2019). Prediction of land use and land cover changes for North Sumatra, Indonesia, using an artificial-neural-network-based cellular automaton. Sustainability, 11(11), 3024. https://doi.org/10.3390/su11113024*

4. AI-Driven Solutions for Advancing Mitigation Action



AI applications for climate change mitigation

GHG emissions monitoring

AI has become a tool in GHG emissions monitoring, particularly for methane, one of the main GHGs, making its detection and reduction critical for climate mitigation efforts. By leveraging vast datasets from satellite imagery, remote sensors and ground-based monitors, AI systems can help pinpoint methane emissions with greater precision. These systems enable real-time detection, allowing for faster interventions in sectors such as oil and gas, agriculture and waste management, where methane leaks are prevalent. Moreover, prediction of potential leaks based on historical data patterns is transforming methane management strategies better equipping governments and industries to address these emissions before they escalate, in line with global efforts, such as the Global Methane Pledge, where countries have committed to reducing global methane emissions at least 30% by 2030.

Land use and land use change monitoring and prediction

AI-powered Earth observation and remote sensing technologies may be important for tracking land-use changes that impact GHG emissions. By processing satellite data, AI systems can support detection of environmental changes in real time, monitoring of deforestation and land use change, along with urban expansion, and industrial activity, all of which are significant sources of GHG emissions, enabling governments to identify emission hotspots and implement targeted mitigation efforts.

CASE STUDY

TRACKING GHG EMISSIONS USING AI[12]

Climate TRACE leverages AI to enhance the accuracy and transparency of global GHG emissions inventories. Traditional emissions data has often been self-reported and unverified, leading to discrepancies and delays in reporting. Climate TRACE tackles this issue by using data from over 300 satellites and 11,000 sensors, combined with AI algorithms, to independently monitor and quantify emissions from diverse sources, including oil and gas production, shipping, aviation, forest fires and rice production. Many of these emissions have been found to be significantly higher than previously estimated.

Energy management

AI is increasingly being used to optimize the development and operation of renewable energy systems, such as batteries, solar and wind power, by predicting energy demand and supply based on weather patterns, grid data and consumption habits, and adjusting supply to ensure reliable energy access despite fluctuations in renewable energy sources. AI can also be utilized in demand-side management, where it optimizes energy consumption through smart grids and connected devices, allowing for more dynamic pricing models and real-time demand response. Furthermore, AI can play a role in grid optimization, improving energy dispatching processes and ensuring efficient use of resources during high-demand periods. AI also has the potential to reduce energy use in residential and commercial buildings, such as through the optimization of building orientation for solar heat gains, accurate prediction of power and heat needs, and maximizing renewable energy integration. AI can also contribute to energy savings in the industrial sector by supporting analyses of operational data, optimizing production processes and improving overall energy efficiency. Lastly, AI can improve power grid reliability by rapidly identifying maintenance needs. In Barbados, Mauritius and Seychelles, AI already plays a role in managing microgrids that distribute energy efficiently across local networks. Embedding AI in these systems enabled these countries to optimize energy flows, reducing the need for fossil fuel-based energy and supporting the transition to clean energy sources.

[12] *Global Partnership on AI (2021), Climate Change and AI: Recommendations for Government Action, https://www.gpai.ai/projects/climate-change-and-ai.pdf*

Transport management

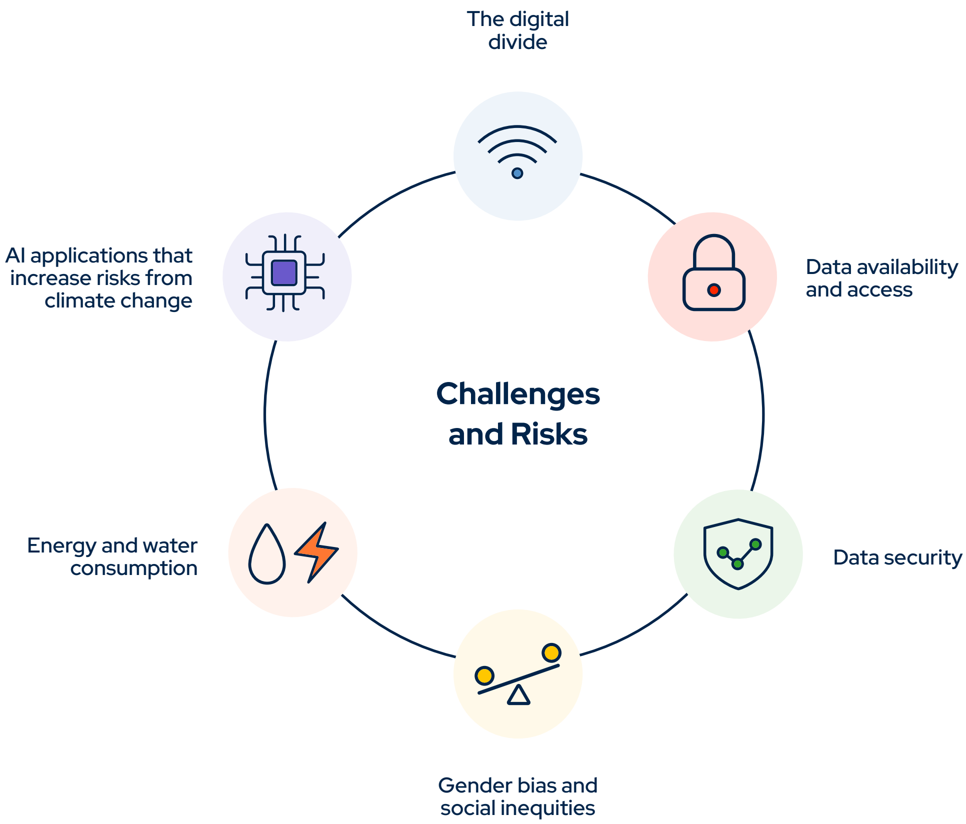
AI offers a range of solutions to optimize transportation systems and diminish their carbon footprints. AI-powered traffic management systems and personal route planners use real-time data from sensors, cameras and GPS devices to monitor traffic flow and adjust traffic signals dynamically. For example, AI can enhance traffic flow, predict congestion and optimize routes, thereby reducing emissions from idling and unnecessary detours. AI algorithms, leveraging extensive data on traffic patterns, passenger demand and weather conditions, can significantly reduce emissions and enhance efficiency in transportation systems, resulting in substantial cost savings, decreased GHG emissions and a more sustainable transportation sector.

MRV and carbon markets

AI can play a role in enhancing the implementation of robust carbon credit certification standards by automating the monitoring, reporting and verification (MRV) of carbon sequestration projects, such as reforestation and land-use change initiatives. AI-powered systems analyse satellite data and assess land-use practices to support accurate quantification of carbon storage. This can reinforce transparency and efficiency in carbon markets by providing information about results in real time. AI's ability to streamline MRV processes can help countries participate in global carbon trading and potentially increase their access to climate finance. While some uses have been tested in relation to carbon markets, the extent that AI-powered systems can be used for carbon markets is dependent on the requirements of the laws, regulations and standards of each market.

While these examples showcase the potential of AI in supporting climate action, some of them also offer insights regarding the importance of ensuring that AI technologies are accessible, contextually relevant and implemented in a way that considers local conditions and capacities.

5. Challenges and Risks



Challenges and risks associated with AI

The digital divide

The persistent digital divide remains a substantial gap between the developing and developed countries, but also within countries between vulnerable and rural communities and well-connected hubs. In particular, the lack of access to energy and digital infrastructure, such as reliable electric grids, internet, data storage and computing power, severely limits the use of AI for climate action in remote and underserved areas. Also, a shortage of technical expertise, and the absence of robust data management systems and national policies that promote endogenous innovation could be factors that can further hinder the development, deployment and effectiveness of AI solutions in these countries.

Data availability and access

AI solutions are heavily dependent on high-quality, comprehensive data. However, many LDCs and SIDS face significant gaps in data infrastructure, leading to a scarcity of reliable climate-relevant data. Limited data collection systems, inability to digitalize hardcopy data, inadequate data-sharing frameworks, and poor integration between local and global datasets, further compound this issue. Also, availability of data can correlate with demographic and socioeconomic status, creating a compounding effect with other sources of bias. In addition, developing countries may lack financial resources for access to satellites or high-resolution hyperspectral imaging, which are essential for building accurate AI models for some purposes.

Data security

This is a growing concern as AI becomes widespread. The vast and complex datasets used in AI-driven climate-relevant models, including sensitive information about environmental conditions, national resources and vulnerable communities, are increasingly at risk of cyberattacks and unauthorized access. Protecting these datasets is essential, as any breach or tampering could lead to the misuse of information, potentially undermining climate action efforts.

Gender bias and social inequities

AI systems, if not designed with inclusivity in mind, can unintentionally perpetuate existing biases and social inequities in climate action. For example, AI models trained on biased datasets may overlook or misrepresent the climate needs of women and marginalized communities, resulting in solutions that fail to address their specific climate-related challenges, such as access to resources or disaster preparedness. This can exacerbate existing vulnerabilities in climate-sensitive regions or communities, where these groups often bear the brunt of climate impacts. As AI becomes more integrated into disaster response, resource management and environmental monitoring, there is a risk that such systems may deepen existing social divides if not carefully monitored and adapted.

Energy and water consumption

AI systems, especially those powered by deep learning and large language models (LLMs), are highly energy intensive. While some studies highlight the increasing resource demands of AI, its current contribution to global GHG emissions is minimal, at around 0.01%, and even with rapid growth, AI's operational footprint is not expected to significantly impact GHG emissions in the near future.[13] Predicting the long-term energy and resource use of AI is challenging due to the sector's fast evolution, and simple projections based on past trends often miss important social, economic and technological factors, leading to inaccurate forecasts.[14] [15] Moreover, focusing solely on AI's indirect emissions may overlook its potential to drive climate solutions. Regardless, it is important to acknowledge the degree of uncertainty when separating AI emissions from those produced by data centres and data transmission.

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[13] *Luers, A., Koomey, J., Masanet, E., Gaffney, O., Creutzig, F., Lavista Ferres, J., & Horvitz, E. (2024). Will AI accelerate or delay the race to net-zero emissions? Nature. https://www.nature.com/articles/d41586-024-01137-x*

[14] *Masanet, E., Shehabi, A., Lei, N., Smith, S., & Koomey, J. (2020). Recalibrating global data center energy-use estimates: Growth in energy use has slowed owing to efficiency gains that smart policies can help maintain in the near term. Science, 367(6481), 984–986. https://doi.org/10.1126/science.aba3758*

[15] *Chen, C., Nguyen, D.T., Lee, S.J., Baker, N.A., Karakoti, A.S., Lauw, L., Owen, C., Mueller, K.T., Bilodeau, B.A., Murugesan, V., & Troyer, M. (2024). Accelerating computational materials discovery with artificial intelligence and cloud high-performance computing: From large-scale screening to experimental validation. arXiv. https://doi.org/10.48550/arXiv.2401.04070*

The emissions from data centres and data transmission are currently estimated to account for approximately 0.6% of global emissions.[16] While AI is unlikely to result in significant near-term increases in GHG emissions, policy development could benefit from scenarios that quantify the potential long-term climate effects of AI expansion under various assumptions. This would help ensure that AI's future growth is managed in a sustainable and climate-conscious manner.

In addition to the energy demand, data centre operations require significant quantities of water for cooling purposes. Some estimates, such as from the Organization for Economic Cooperation and Development (OECD), put water consumption by AI at 6.6 billion m^3 of water by the year 2027.[17] Due to the local nature of the impacts of water consumption and extraction, the location of the infrastructure and the source of the water used can add further pressure on water resources in vulnerable communities where water scarcity is, or will be in the future, a critical issue.

Efforts to address these challenges are underway. Energy-efficient AI algorithms are being developed to reduce the computational load required for AI models. Similarly, hardware has also become more efficient, with data centres increasingly turning to renewable energy sources to power their operations. Innovations in cooling technologies are also aiming to decrease water usage in data centres, such as using air-cooled systems or recycled water in place of freshwater. In addition, improving standardization in the measurement of AI energy consumption and promoting the disclosure of relevant information helps reduce uncertainty and increase accountability across the industry.

AI applications that increase risks from climate change

AI can be used for applications that benefit climate action; it can also be used for applications that increase risks from climate change. For example, AI is being leveraged to enhance fossil fuel exploration and extraction, directly contradicting global efforts to transition to renewable energy. Moreover, AI plays a central role in targeted advertising that perpetuates consumerism and encourages unsustainable behaviours, driving demand for products and services that contribute to climate change. Additionally, AI systems are increasingly used to amplify the spread of climate disinformation and misinformation, further complicating efforts to address climate change challenges.

[16] See *https://www.iea.org/energy-system/buildings/data-centres-and-data-transmission-networks*

[17] See *https://oecd.ai/en/wonk/how-much-water-does-ai-consume*

6. AI under the UNFCCC, the Paris Agreement and national technology needs assessments

Countries increasingly recognize the potential of AI to help achieve their climate change targets, as reflected in their national reports, such as nationally determined contributions (NDCs), technology needs assessments (TNAs) and technology action plans (TAPs). An analysis of 169 NDCs conducted by the CTCN indicated that, as of February 2024, 57 developing countries mentioned the application of digital technologies to support their NDCs, and five of them (Cambodia, Côte d'Ivoire, Papua New Guinea, United Arab Emirates and Viet Nam) explicitly referred to AI as a tool to achieve their climate change targets. AI applications for climate action identified by these countries covered a broad spectrum from promoting the use of AI tools to mitigate flooding in Papua New Guinea to applying AI tools in estimating and forecasting climate change impacts on nature and society in Viet Nam. The Chilean TNA process, supported by the CTCN, generated TAPs for water resources and agriculture that featured machine learning for detecting leaks in water distribution networks, and its use for intelligent irrigation systems.

The Technology Mechanism Joint Work Programme for 2023–2027 includes a focus on digital technologies that can provide climate solutions across multiple sectors and industries. In 2023, the Technology Mechanism launched its #AI4ClimateAction Initiative. This initiative seeks to leverage AI technologies to drive transformative climate solutions, with a particular focus on mitigation and adaptation efforts in developing countries, especially LDCs and SIDS. It focuses on fostering positive uses of AI and enhancing global awareness of its potential and challenges. Activities planned include promoting AI innovations for climate action and addressing risks.

At COP28, Parties noted the #AI4ClimateAction Initiative and provided guidance to the TEC and CTCN, which included that the TEC and the CTCN implement the initiative in a manner that gives special attention to the capacity needs for its use, and to enhance awareness of artificial intelligence and its potential role in, as well as its impacts on, the implementation of the outcomes of TNAs and the Technology Mechanism Joint Work Programme for 2023–2027.[18] The TEC and the CTCN report on the initiative through their joint annual report to the COP and CMA.

The workplan for the #AI4ClimateAction Initiative, as approved in 2023, includes several activities across the following three work streams that span the period from 2024 to 2027:

1. Support the implementation of the Technology Mechanism Joint Work Programme and the implementation of TNA outcomes;
2. Enhance the capacity of stakeholders from LDCs and SIDS regarding the use of AI for climate action in a way that is responsive to gender and vulnerable communities;
3. Raise awareness of AI for climate action, including on challenges and risks posed by AI such as energy and water consumption, data security and the digital divide in this context.

[18] *Decisions 9/CP.28 and 14/CMA.5, paras. 6–8 and decision 1/CMA.5, para. 109.*

Under the initiative, alongside a range of other activities, the TEC, in collaboration with Enterprise Neurosystem, undertook the AI Innovation Grand Challenge. This global competition identified AI-powered solutions for climate adaptation and mitigation action, with a focus on LDCs and SIDS. Under the initiative, the CTCN is carrying out its Global Capacity-building Programme on AI for Climate Action, including capacity-building workshops for national focal points for climate technologies, in Africa, Asia and the Pacific, and Latin America and the Caribbean. The CTCN also supports the implementation of technical assistance with components of AI, in response to requests from developing countries.

The #AI4ClimateAction Initiative can help accelerate climate innovation and action through global cooperation and partnership. Parties and organizations interested in supporting or being part of these efforts are invited to respond to the call for partnerships by the Technology Mechanism.

7. Other organizations and initiatives

In addition to the #AI4ClimateAction Initiative, several other initiatives are exploring the use of AI for combating climate change. For example, the International Telecommunication Union has been convening key stakeholders to identify practical solutions to progress the Sustainable Development Goals through its AI for Good and Green Digital Action initiatives, which aims to leverage AI for global challenges, including climate change. The International Energy Agency's Energy for AI, and AI for Energy initiative focuses on the role of AI in improving energy systems and the challenges it poses in terms of growing power demand. The Global Partnership on AI, now in an integrated partnership with the OECD, is a multi-stakeholder initiative that promotes the responsible use of AI, while recognizing its risks to environmental sustainability. Finally, Climate Change AI is a non-profit organization dedicated to work at the intersection of climate change and machine learning, including using machine learning to tackle climate change challenges. It engages researchers, policymakers and practitioners to advance the application of AI in climate change mitigation, adaptation and resilience efforts and mitigate negative climate impacts from AI.

Abbreviations and acronyms

AI	Artificial Intelligence
CMA	Conference of the Parties serving as the meeting of the Parties to the Paris Agreement
CO_2	Carbon Dioxide
COP	Conference of the Parties
CTCN	Climate Technology Centre and Network
EW4ALL	Early Warnings for All
GHG	Greenhouse Gas
GPS	Global Positioning System
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
LDCs	Least Developed Countries
LDRI	Local Development Research Institute
LLMs	Large Language Models
ML	Machine Learning
MRV	Monitoring, Reporting and Verification
NDCs	Nationally Determined Contributions
OECD	Organization for Economic Cooperation and Development
SIDS	Small Island Developing States
TAPs	Technology Action Plans
TEC	Technology Executive Committee
TNAs	Technology Needs Assessments
UNFCCC	United Nations Framework Convention on Climate Change

About the Technology Executive Committee

The Technology Executive Committee is the policy component of the Technology Mechanism, which was established by the Conference of the Parties in 2010 to facilitate the implementation of enhanced action on climate technology development and transfer. The Paris Agreement established a technology framework to provide overarching guidance to the Technology Mechanism and mandated the TEC and CTCN to serve the Paris Agreement. The TEC analyses climate technology issues and develops policies that can accelerate the development and transfer of low-emission and climate resilient technologies.

About the United Nations Industrial Development Organization

The United Nations Industrial Development Organization (UNIDO) is the specialized agency of the United Nations that promotes industrial development for poverty reduction, inclusive globalization and environmental sustainability. UNIDO provides support to its 172 Member States through four mandated functions: technical cooperation; action-oriented research and policy-advisory services; normative standards-related activities; and fostering partnerships for knowledge and technology transfer. For further information, visit: https://www.unido.org/

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