AI for Climate Action

Applications and Principles in Development Cooperation

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- Ruth Schmidt – Fair Forward – Artificial Intelligence for All, GIZ: "FAIR Forward – Artificial Intelligence for All" strives for a more open, inclusive, and sustainable approach to AI at an international level. Collaborating with seven partner countries—Ghana, Rwanda, Kenya, South Africa, Indonesia, Uganda, and India—the initiative pursues three main goals: access to training data and AI technologies for local innovation, strengthening local technical know-how on AI, and developing policy frameworks for ethical AI, data protection, and privacy.

This collaborative effort was developed to address the growing demand for innovative solutions to climate change through the use of AI.

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Executive summary

The climate crisis stands as a paramount challenge confronting humanity today, demanding international cooperation and innovation. Achieving net zero greenhouse gas emissions by 2050 will require rapid and far-reaching transitions in energy, land, urban infrastructure, and industrial systems (IPCC, 2018). The potential of Artificial Intelligence (AI) to offer innovative solutions to this global challenge is increasingly recognized. This position paper outlines important considerations and approaches to proactively promote sustainable climate solutions through AI-driven initiatives, fostering collaboration, and ensuring inclusivity to effectively address climate-related challenges at both local and global levels. The paper explores the intersection of AI and climate change from an international development perspective, focusing on the overarching principles of sustainability and climate justice.

AI Applications for Climate Action: The paper details the diverse applications of AI across various sectors relevant to development cooperation and climate action. In **agriculture and forestry,** AI-based early warning systems enable farmers to better prepare for, adapt to, and recover from climate shocks. These systems analyse satellite imagery and biomass data to monitor vegetation cover and identify areas with high carbon sequestration potential, facilitating targeted climate protection and conservation efforts. In the **energy sector,** AI is employed to optimize renewable energy integration, enhance efficiency through predictive maintenance, and support tailored energy access solutions. **Urban sustainability** is advanced through AI technologies that optimize transportation planning, waste management practices, and infrastructure planning, thereby reducing emissions and improving climate resilience. Additionally, AI's role in **policy and governance** is expanding, with the technology increasingly being recognized as a critical tool for analysing vast amounts of data to inform evidence-based climate policymaking and facilitate access to national policy documents, climate reports, and research.

Implementation Challenges and Ethical Guidelines: Despite AI's immense potential, several challenges must be addressed to facilitate a "Just Transition" on a global and local scale. The digital divide remains a significant barrier, particularly in the Global South, where limited access to electricity, internet, and data infrastructure hinders AI adoption. However, AI's ability to support local planning and create decentralized solutions offers a pathway to bridging this **digital divide.** Additionally, the centralization of research and capital globally has resulted in an **AI- and climate expertise divide.** This divide can be addressed through investments in local training programs, centres of excellence, and peer-to-peer knowledge exchange. Economic viability is another challenge, as smaller, local actors face **financial hurdles** in implementing and maintaining AI systems. Development actors can enhance economic viability by fostering public-private partnerships, establishing dedicated funding programs, and promoting open-source AI applications. To combat **climate data bias,** AI models must be customized and based on local data collection. Furthermore, the carbon **footprint of AI,** including energy and water consumption, must be carefully managed. Addressing AI-spread disinformation is also crucial, as it poses a global threat to climate action and requires targeted educational initiatives.

The **"AI Guiding Principles"** developed in the GIZ project "FAIR Forward" provide essential ethical guidelines for AI development in climate action. These principles emphasize the need for AI solutions to address the needs and priorities of local actors, particularly marginalized communities, ensuring **inclusion.** They advocate for promoting knowledge exchange and capacity building to enable local ownership of AI solutions, thereby advancing equity. **Transparency** is highlighted through the adoption of participatory, open-source approaches that foster collaboration and openness. **Sustainability** is a key focus, with a call for AI solutions that are environmentally, socially, and economically sustainable and feasible to maintain over time.

To effectively harness AI for climate action, it is crucial to tailor AI solutions to the **specific needs** and conditions of **local communities and regions.** Strengthening **partnerships** with public and private sectors, local governments, and NGOs will foster collaborative efforts. Advocating for **open-source AI tools** will enhance transparency and global cooperation. Investing in **local expertise** through training programs will help bridge the AI and climate expertise divide. Furthermore, developing **energy-efficient AI systems** and considering their carbon footprint throughout the AI lifecycle is essential. Addressing **AI-driven disinformation** through educational initiatives will support accurate climate information dissemination. By addressing these recommendations, development corporations can leverage AI's potential to drive effective and inclusive climate action while ensuring sustainability and equity in the transition to a climate-resilient future.

Recommendations

Artificial intelligence (AI) holds tremendous potential, particularly in addressing climate change. GIZ should focus on strategic areas where AI can make a significant difference, with a particular emphasis on international collaboration and climate justice. By leveraging AI in a targeted and equitable manner, GIZ can help accelerate climate action and support sustainable development for all. Of the various use cases highlighted, two stand out as particularly important:

1. **Forest monitoring:** AI can enhance the monitoring and management of forests, helping to prevent illegal logging, track deforestation, and support reforestation efforts. This is vital for maintaining biodiversity, supporting carbon sequestration, and informing policy. Additionally, it aids in complying with sustainable supply chain regulations such as the EU deforestation regulation, and involves collaboration with leading organizations in the field, such as the World Resources Institute (WRI).

2. **Policy stocktake:** AI can help to create a comprehensive and structured repository of climate-related policies, frameworks, and initiatives. By analysing and categorizing vast amounts of policy data, AI can facilitate transparency, benchmarking, and learning across countries and regions. This can provide policymakers with a solid information base for informed decision-making.

To effectively harness AI for climate action and justice, GIZ should adhere to the following principles:

1. **Ensure** that AI systems are designed and deployed in a **transparent** and **accountable** manner, with mechanisms to address **bias** and **discrimination (e.g., responsible AI assessments developed by Fair Forward),** while minimizing carbon footprints and adhering to **environmentally sustainable practices (e.g. see UNESCO Recommendation on the Ethics of AI).** This includes promoting **ethical AI implementation** that involves marginalized and gender-diverse communities, ensuring equitable access, and addressing biases.

2. **Develop context-aware AI solutions** tailored to the **specific needs** and contexts of local communities. This involves users in the design process to ensure relevance and effectiveness and incorporates **indigenous knowledge.** Such solutions are especially crucial in regions most affected by climate change, including AI-driven **early warning systems** and **renewable energy optimization tools.**

3. **Strengthen local capacities** and institutions, support the development of local AI ecosystems, and ensure inclusive governance structures that involve **diverse stakeholders,** including marginalized and vulnerable groups. This includes **enhancing local expertise** through **training programs,** improving digital infrastructure, and upgrading data management systems to build local capacity for implementing and sustaining AI-driven climate solutions.

4. **Foster strategic partnerships** with local governments, NGOs, think tanks, private sector companies, and other stakeholders to leverage expertise, resources, and knowledge. These **public-private partnerships** should combine strengths, such as joint funding and knowledge exchange initiatives, focusing on empowering local stakeholders and balancing power dynamics and ownership between the Global North and Global South.

5. **Support the development of open-source AI tools,** which provide accessible data for initiatives like forest monitoring and conservation, enhancing transparency, interoperability and collaboration.

6. **Adopt flexible and sustainable funding approaches,** combining seed funding with long-term investments and conducting regular impact evaluations to ensure effectiveness and sustainability.

1 Introduction

As the climate crisis demands global cooperation and continuous innovation, AI and Machine Learning (ML) present themselves as powerful tools to accelerate effective solutions on a global scale. The aim of this paper is to explore the intersection of AI and climate change (CC) from an international development perspective, with a focus on sustainability and leaving no one behind (inclusion). Through a feminist climate policy perspective, the German government seeks to accelerate a "Just Transition" in which economies are environmentally and climatologically sound, equitable and climate friendly. Over the last few years, GIZ has increasingly used AI in collaboration with partner countries, with over 20 AI-based pilots developed worldwide. As stated by Ms. Ingrid-Gabriela Hoven, Managing Director of GIZ,

> **"The role of development cooperation is key – as a convener and honest broker for equal rights, as an ambassador for addressing the specific challenges for women and girls, as an advisor for regulatory frameworks and local innovations, as a capacity builder for systems and enablers and awareness raiser for the risks and potentials."**

GIZ has already begun implementing AI to advance climate mitigation and adaptation goals across a variety of sectors including agriculture and forestry, energy, transportation, waste management, manufacturing / industry, infrastructure, and removals. Pilots have included: Forestry conservation monitoring and sustainable land use planning; Crop yield forecasting and crop disease detection for precision agriculture; Early warning systems for natural disasters; Solar PV viability assessments; Forecasts of energy data for wind and PV systems; Predictive maintenance for energy infrastructure; Supply chain transparency for sustainable forestry and mining; Broad-scale analysis of climate policy documentation; Climate risk assessment of infrastructure projects; and Urban transportation planning.

Furthermore, through the FAIR Forward initiative, GIZ is supporting a people-centered, climate-friendly, and inclusive approach to digitalization. In addition to driving innovation, a key component of FAIR Forward's work includes the development of guidelines and policy frameworks for ethical AI, data protection and privacy. This paper will contextualize FAIR Forward's guiding principles on AI adoption through the lens of applications for climate action. The paper will start by reviewing the status quo of climate applications for AI across sectors and in the context of international cooperation, and then discuss guiding principles that will be crucial for GIZ and other organizations to address when implementing such applications.

AI is largely characterized by its ability to analyze data, recognize patterns, and inform decision-making. This has immense potential to fundamentally change the way we understand and deal with climate change issues. AI can help us make more accurate predictions about future climate developments and better understand the impact of certain climate change mitigation and adaptation measures. By using ML algorithms, for example, complex climate models can be created that can simulate different scenarios and predict the potential impact of political decisions or technological innovations on the climate. Furthermore, AI continues to make a crucial contribution to the fight against climate change by optimizing resource utilization and energy efficiency. AI systems are becoming increasingly advanced in pattern recognition, which is being used across key industries to improve the sustainability of business operations. Companies, consumers, entrepreneurs, and entire states can all use AI systems to make more environmentally and climate-friendly decisions and optimize processes for efficient resource and energy use.

While AI systems are being used to identify solutions for energy savings, one of the important critiques of current AI systems is the significant energy consumed in training these systems. There are also important social and ethical aspects to consider when adopting AI applications. For example, due to existing biases in training data, there have been numerous cases where AI systems have been shown to reproduce and even exacerbate social inequalities and discriminatory patterns in their generated results. This is particularly concerning for women and marginalized communities, as it can widen existing disparities and perpetuate systemic injustices. Because AI solutions are only as good as the data that they have been trained with, there is a risk of biased, unethical, and/or inaccurate results. Further to the risk of biased or incomplete underlying datasets, AI models and algorithms can also have bias introduced through the data labelling, model training, and deployment phases. It is therefore crucial that ethical principles and standards are developed and adhered to when developing and implementing AI solutions, including in the field of climate change. This requires careful monitoring, transparency, and governance to ensure that AI-based approaches to tackling climate change are used both effectively and responsibly. Inequality of access, the so called "AI divide", also poses a significant risk, particularly when we look at the overall context and aims of international development work. The centers of AI development, as well as development and application knowledge, are primarily concentrated in the Global North, which means that Global South countries have considerably fewer opportunities to contribute shaping this technology and making it economically viable and usable for themselves. Global South populations are most impacted by climate challenges, and it is thus crucial that they have access and ownership over their own locally designed and led AI solutions.

This paper will look at AI use cases for climate action and key considerations for implementing AI in the context of international cooperation. The following sections focus on answering three questions:

1. What current and future applications of AI for climate mitigation and adaptation already exist or are currently being developed within the context of international development cooperation?

2. What are the challenges and risks associated with advancing AI for global climate action? What is the role of development corporations in addressing these risks and what ethical frameworks exist?

3. What principles and strategic objectives should development corporations prioritize in their continued work at the intersection of AI and climate change?

2 AI Applications for Climate Action

AI can make substantial contributions to climate action and, if used ethically and inclusively, be part of transformative approaches in development cooperation. Its applications range from adaptation (e.g., monitoring soil conditions and crop diseases including early warning systems) to mitigation (e.g., reducing emissions through predicting renewable energy potential) and can find use across a variety of sectors. In the following section we will highlight the most important AI techniques and methods for climate action before answering the question as to which applications for climate action currently exist or are being development in the context of international development cooperation.

2.1 What is AI and what can it do?

Before looking into the applications of AI in the climate context, it is important to understand what AI entails and, crucially, what it can (and cannot) do. In a broad sense, AI can be defined as a technology that enables computers to simulate human intelligence, allowing systems to perform complex tasks such as analysing data, recognising objects and patterns, translating spoken and written language, and even generating output such as text, images, and speech.

AI systems are commonly trained on vast amounts of data and learn to recognize relationships and patterns that may be difficult for humans to identify. The data used to train AI models can be quite diverse depending on the application, ranging from quantitative data to text data but also images or videos. Current AI systems are considered "narrow" intelligence, meaning that they can perform a narrow set of actions based on the instructions of the underlying AI algorithms and the data used for training. For example, some AI systems use Natural Language Processing (NLP) techniques to process and understand human language, which can be used for tasks such as language translation, sentiment analysis, and question answering. Other AI systems utilize computer vision techniques to interpret and analyse visual information, such as satellite imagery or drone images to recognise objects and facilitate analysis. These applications are important when discussing how AI can be utilized for climate action.

2.2 AI Applications for climate action across different sectors

Given the complex and cross-sectoral nature of the climate crisis, climate action requires intersectional, time-dependent solutions across a variety of different sectors. AI is a powerful tool for climate action because it can help us understand complex natural systems (including the atmosphere, biosphere, and hydrosphere and hence the climate and weather) and optimize resource usage to mitigate and adapt to climate change. In the following, we will explore specific sectors relevant for development cooperation and climate action and examine some development cooperation use cases using AI to advance climate action within them. For a further mapping of AI for climate use cases, please see the Excel sheet here.

AGRICULTURE & FORESTRY

Agriculture and forestry stand as both major contributors to global emissions and a critical component of global food security and the carbon cycle. At the same time, the agricultural and forestry sector face significant challenges exacerbated by climate change. Rising temperatures, heat waves, late frosts, droughts, and heavy rain directly impact agricultural, forestry, and livestock production. As a result, agriculture and forestry must evolve to become more resilient and "climate-smart" in its practices to reduce emissions produced in the sector and ensure global food security and carbon sequestration. There are numerous ways to which AI systems can contribute to that, some of which are highlighted in the use cases below.

The team testing the EWS on a phone

Climate adaptation in the agriculture sector involves implementing strategies to limit the impact of climate change on crop production, livestock farming and overall food productivity. In collaboration with the Local Development Research Institute (LDRI), GIZ has developed an AI-driven early warning system that forecasts crop yields and offers recommendations to combat crop failures and malnutrition, especially among smallholder farmers who do much of the agriculture in Kenya.

Field recordings of trees and carbon stock classes in Indonesia

The AI-based Early Crop Failure Detection System uses data from multiple sources, including weather stations, satellite images and soil sensors to provide farmers with valuable information on when to plant, irrigate, and harvest crops to reduce the risk of crop failure. This not only increased resilience to climate change but also improved food security in an area facing increasing pressure due to climate change.

When looking at climate mitigation, slowing down deforestation caused by increasing demand for agricultural land use is one of the key elements of required climate action. AI can positively contribute to climate mitigation action, for example by supporting data-driven forest mapping and monitoring. In Indonesia, GIZ's FAIR Forward initiative has worked together with the Indonesian community mapping organization, JKPP (Jaringan Kerja Pemetaan Partisipatif), to collect data on trees (e.g., type, sizes and how much carbon they store) in forests to improve forest mapping through the so called High Carbon Stock Approach (HCS). The data collected can be used to improve the accuracy of forest classification using AI which in turn helps to identify forests with a high capacity to store carbon. AI, therefore, provides information on which forests should be protected from deforestation and thus contributes to mitigation action. The data collection is based on the principle of "Free Prior Informed Consent (FPIC)", which focuses on the involvement of local and indigenous communities. The anonymised data and maps will be made available to relevant ministries and political decision-makers to inform local sustainable land use planning.

FURTHER USE CASES FOR AI IN AGRICULTURE

1) As part of the African Biomass Challenge (ABC) in Côte d'Ivoire and Ghana, a combination of drone imagery, publicly available satellite images and biomass data is used to predict biomass in shaded areas with the goal to measure the impact of reforestation efforts and detect degradation caused by cocoa farming.

2) UNDPs Crop Mate provides farmers with real-time information about the state of the soil provided by AI and automatically recommends nutritional interventions to ensure crop health.

3) A Cashew disease identification system has been developed in Ghana through GIZ's MOVE and FAIR Forward initiative. The crop images trained AI model is open source and assists farmers in Ghana to identify sources of diseased cashew crops to implement effective remedies and increase resilience to climate change.

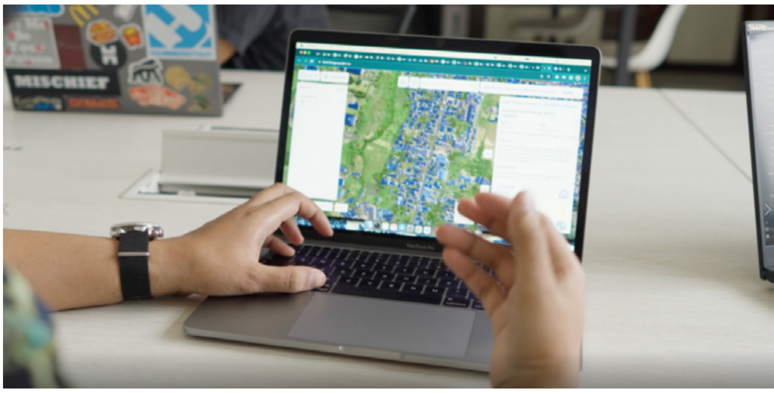
ENERGY

From all global emissions, the energy sector contributes about [40 percent of CO_2 emissions] and is therefore one of the most crucial sectors when looking at effective climate mitigation. However, with [three quarters of those emissions coming from six major economies,] another global issue surrounding energy lies in the challenge of ensuring access to reliable, affordable, and sustainable energy sources for all. Many countries grapple with inadequate infrastructure, limited access to modern energy services, and heavy reliance on fossil fuels, further fuelling climate change and preventing socioeconomic progress. This challenge only increases in the face of more extreme weather events caused by climate change that affect energy infrastructure, calling for stronger climate adaptation actions in the energy sector as well.

When looking at AI Applications for energy in development cooperation, AI applications have thus far predominantly focused on mitigation efforts. There are several use cases who have tested whether machine learning can be used to identify optimal locations for renewable energy installations, facilitate predictive maintenance of energy infrastructure or enable accurate forecasting of energy potential, some of which are highlighted below.

Solar panel installation in village in Uganda

One use case in development cooperation is the Renewable Energies Programme (PEERR II) commissioned by the German Federal Ministry for Economic Cooperation and Development (BMZ). Here GIZ supports the Bolivian Ministry of Energy in the promotion of renewable energies and energy efficiency. It supports energy suppliers in the planning, construction and operation of wind and solar farms to be connected to the public power grid. A central element of the programme is a simulation model based on neural networks which converts weather data and forecasts into forecasts of energy data for wind and PV systems, therefore ensuring maximum efficiency and minimal environmental impact.



Bali leading the way as the first area for SEERI implementation

FURTHER USE CASES FOR AI IN THE ENERGY SECTOR

1) The SEERI (Solar Energy Estimator for Rooftop in Indonesia) project is an AI and machine learning powered web-based platform that allows mapping the potential, economic feasibility, environmental implications and investment requirements for rooftop PV installations with the aim to support adaptation of renewable energy.

2) GIZ's FAIR Forward partnered up with Sunbird Ai and the Ugandan Ministry of Energy and Mineral Development to support the implementation of the National Electrification Strategy (NES), using Sunbird AI's tool which uses machine learning methods to detect and sort types of buildings to predict energy demands to better plan and implement the optimal energy supply in rural areas.

3) The Indo-German Energy Programme (IGEN) is a technical cooperation project funded by the BMZ which uses data science and machine learning for predictive maintenance of energy transformers.

URBAN SUSTAINABILITY

Cities are major contributors to climate change, with emissions coming from various sources (e.g., construction of buildings or transport, among others). According to UN Habitat, cities consume 78 per cent of the world's energy and produce more than 60 per cent of greenhouse gas emissions while only accounting for less than 2 per cent of the Earth's surface. Simultaneously, urban areas – and with that a high number of people worldwide – are also increasingly exposed to climate risks such as flooding, extreme temperatures, water and food shortages and infrastructure damages, requiring both successful mitigation and adaptation actions to achieve urban sustainability and resilience. AI applications can help tackle some of these climate change induced issues, as highlighted in some of the use cases below.

Flooded streets in the aftermath of heavy rains.

For example, SEEDS India, a non-profit organization, has developed an AI-based system for predicting natural disaster risks based on local factors, facilitating enhanced disaster response and swifter delivery of humanitarian aid during critical situations. Their Sunny Lives AI model incorporates various parameters such as waterbodies, rivers, distances from road networks, and landslide risk, enabling more effective risk reduction strategies against climate emergencies and disasters. These and other technologies for disaster risk mitigation, including AI, can be found in the UNDP's report on innovation in disaster management.

When looking at mitigation efforts, AI especially offers huge benefits in terms of optimization in different sectors ranging from transportation to waste management. One major source of urban emissions is traffic. The GIZ SUTi project in Albania developed an open-source AI application for traffic counting and modal share analysis. The model can be used not only for counting vehicles but also to distinguish different modes of transport, representing a significant advance in traffic analysis, especially in countries with limited data capabilities. The application is part of the #UP2Speed project and provides real-time dashboards and AI-powered video analytics. The information derived from the system can be used for better traffic planning or for supporting alternative mobility solutions, not only reducing emissions but also pollution.

These applications show, AI can have a significant impact on promoting urban sustainability and climate action in cities. However, the applications are not limited to the examples mentioned above. Solutions can enable more efficient transportation systems, better waste management practices, and smarter urban planning (incl. for example green spaces and wind corridors), all of which contribute to reducing cities' carbon footprints and enhancing their resilience to climate-related risks. With its ability to analyse vast amounts of data and generate actionable insights, AI plays a crucial role in empowering cities to achieve their sustainability goals and build resilience against the impacts of climate change.

FURTHER USE CASE FOR AI IN URBAN SUSTAINABILITY:

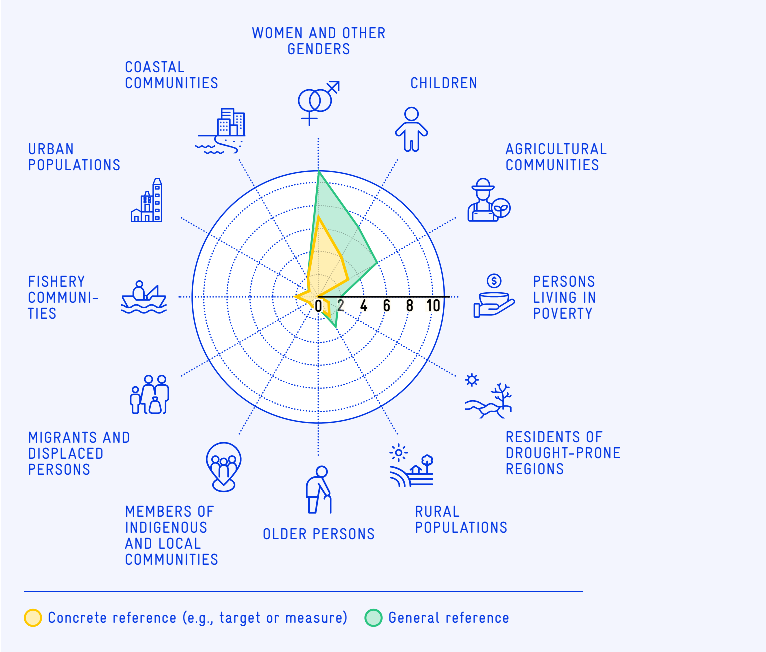
1) The World Bank is using AI to make housing more resilient in the Caribbean. Using Earth Observation data, machine learning algorithms, and local expertise, rooftops can be assessed for their anticipated resilience to extreme weather events.

POLICY & GOVERNANCE

Climate policy plays a critical role in implementing successful climate mitigation and adaptation action. However, designing effective policies to combat climate change poses a significant challenge to policymakers who are often faced with overwhelming amounts of information from various stakeholders. Filtering through policy, research and other related documents is a time- and labour-intensive task with high responsibility to not miss key information. Simultaneously, once policies are implemented, monitoring their effectiveness and impact can be difficult and time-intensive for citizens and other stakeholders. This lack of transparency and accountability can undermine public trust in the policymaking process and hinder the achievement of policy objectives.

Making information easily accessible and sharing it transparently is one major cornerstone of successful climate policy and governance. Tools such as the Climate Watch platform, hosted by the World Resources Institute (WRI), support this objective by assembling information and various datasets related to climate action in one place and providing free access and opportunities to analyse and visualize the information to researchers, policymakers or other stakeholders. Here one can also find an analysis of countries' NDC documents. Since the analysis is done manually, GIZ's Data Service Center and Data Lab worked on several applications to expand the NDC analysis and automatically extract information from climate policy documents using Natural Language Processing (NLP), an elaboration of which can be found in the following paper. The Climate Policy Analysis Assistant is an open-source digital tool which aims to assist policy analysts and other users in extracting and filtering information related to targets and policies from public documents in context of Climate Change Commitments and Strategies. Similarly, the Climate Vulnerability Assistant extracts references to vulnerable groups from documents and provides AI-generated summaries of the relevant actions and targets mentioned to support these groups in policy documents, such as the Nationally Determined Contributions (NDCs).

On the other hand, to facilitate the work of policy makers who work on forest restoration and support them finding documents that are most useful to their work, the WRI has worked together with Omdena and Solve for Good to filter and categorize information from different policy documents, using NLP. Their "automatic assistant" synthesizes policy incentive information from several countries and places it into six subcategories (fines, technical support, supplies, direct payments, credits, and tax reductions), reducing the time spent by policy makers to identify the right information they are searching for.



Identifying references to vulnerable groups in climate policy documents

The use cases above show that AI can not only support policy makers to design effective policy and speed up that process but also democratize access to information by condensing complex policy documents and making them readily available to everyone. Here, NLP techniques are currently in the centre of the applications in development cooperation and the AI technique can be employed to analyse policy documents, such as those related to climate, extracting key information and insights, engaging citizens more effectively in the policymaking process and holding decision-makers accountable.

FURTHER AI USE CASES FOR POLICY & GOVERNANCE

1) NDC Transport tracker summarizes relevant and up-to-date information on countries' climate targets and actions in the transportation sector based on their NDCs and LTS.

2) The Climate Policy Radar uses data science and AI to map and analyse the world's climate change policies and laws and allows the user to search through documents to advance global research efforts to understand the effectiveness of climate laws, policies and litigation.

3) ChatClimate allows users to interact with information from IPCC reports.

3 Implementation Challenges and Ethical Guidelines

While AI technology holds immense potential for climate action, its development and long-term application include certain challenges, especially a notable environmental footprint with high CO_2 emissions and significant material consumption. Both must always be weighed up against the climate benefits. In addition, the successful implementation of AI systems relies on complex, primarily technical prerequisites. This especially applies in the field of climate action, which is based on specific data that is often very elaborate to collect. The resources to establish these prerequisites, or the financial means to acquire them, are unevenly distributed globally, particularly along the North-South divide. Weather stations, crucial for projects like the Crop Monitoring in Kenya, exemplify this global disparity. AI advancements risk exacerbating existing inequalities, leaving less developed countries, especially in the Global South, further behind. As the AI revolution unfolds, development cooperation organizations face a dual mandate: Firstly, tackling existing inequalities becomes even more pressing due to AI's potential amplifying effect. Secondly, it is crucial to empower the Global South to actively shape this economically as well as technically transformative development.

To fulfil this dual task, one has to understand the associated challenges along the way as well as the solutions that currently exist. The following chapter therefore attempts to provide an initial overview. The first section deals with general hurdles and solution strategies in the implementation and development of AI for climate action, while the second section deals with ethical principles to be considered here.

3.1 Cross-cutting Implementation Challenges: The Enabling Environment for AI

There are several requirements that are crucial for the application and development of AI, but which are not sufficiently available, developed or addressed, especially in countries of the Global South. Development cooperation organizations should see it as a key future task to actively promote these preconditions through their work.

3.1.1 Carbon Footprint of AI

AI plays a dual role in the climate crisis: on the one hand, it can help to reduce emissions, as in Fair Forward's Indonesian forest mapping project, or improve the prediction of extreme weather events, as is possible with the help of Sunny Lives AI. On the other hand, building a machine learning model as the basis for an AI system has a major carbon impact (estimated around 300,000 kg CO_2e for one) – both due to the energy required for the computing power and for the construction of the basic material infrastructure. For projects working on the AI and Climate Action Nexus, it is therefore important to estimate the carbon impact of AI models – for example using the "ML CO_2 Impact" or "Code Carbon" tool – and weigh it up against the short and long-term climate impact. At the same time, all measures should be taken to reduce the carbon impact of machine learning systems by choosing efficient models and reducing wasteful model retraining and execution. This includes measures such as ensuring that the model is trained at a location where the servers are operated with clean energy or only activating the services at certain important times a day (here is a detailed article on measures).

To achieve a sustainable climate impact, it is also important to consider possible rebound and lock-in effects: potential efficiency gains using AI can be negated by the expansion of the more efficient production system. Economic growth should be supported in contexts where it is desirable and otherwise be subordinated to the targeted climate impact with tailored measures.

3.1.2 AI- and Climate-Expertise Divide

In addition to the digital divide, there is also an expertise divide both in climate expertise and in the area of AI. Climate research is concentrated in the Global North: Less than 5 percent of global funding for climate change research goes to the African continent and even here only around 15 percent goes to African research institutes. The same applies for the AI expertise in Global South countries, which are also particularly affected by brain drain. For this reason, AI expertise must be developed specifically for application in the area of climate action.

To overcome these hurdles, investments in local training programs for scientists, engineers, and policymakers are essential. Establishing AI centers of excellence at universities in developing countries can further strengthen this expertise. Fostering collaboration between AI and climate experts across disciplines is also key. Finally, promoting South-South knowledge exchange can accelerate progress. Outstanding examples of such initiatives include Africlimate AI, a grassroots community that strengthens the use of AI for a climate-resilient Africa, and the non-profit organization Climate Change AI, a global community that creates educational opportunities at the interface of AI and climate.

3.1.3 Financial Hurdles Slow Down AI Adoption for Climate Action

The widespread adoption of AI for climate action faces substantial financial barriers. While establishing basic digital infrastructure is already costly, the additional expenses required for AI-specific technology pose an even greater challenge. These costs apply in two ways, both for the development and use of AI and for the development of specific applications in the field of climate action. This includes investments in hardware, software licenses, specialized data sets, and, crucially, the technical expertise to effectively utilize these tools.

Exploring public-private partnerships to share the financial burden and establishing dedicated funding programs specifically tailored to AI for climate action are promising avenues. Additionally, promoting open-source AI tools can further incentivize the use of AI in climate action efforts.

3.1.4 Climate Data Bias

Another challenge is the context-specificity of Climate-AI applications and solutions. Models that have been developed in a specific context or for a specific problem, with the data given there, may not be easily transferable to other contexts – they often have a data bias. Again, most of the climate modelling takes place in the Global North, which also controls most of the important technical infrastructure for collecting climate data. As many AI models have been trained with climate data from the global North, this can lead to certain climate patterns from the Global South being unintentionally masked out – especially if historical data is used.

To successfully address this bias and realize the full potential of AI for climate action, data collection technologies can be actively promoted in Global South countries, for example by supporting local initiatives and investing in the development of sensors and other data collection technologies. The promotion of cooperation between researchers and institutions from countries around the world, the support of South-South exchange, cooperation with the private sector and the promotion of open-source software can also prove to be useful measures.

3.1.5 Digital Divide Hinders AI Use for Climate Action

The world faces a digital divide that limits AI's potential for climate action. Limited access to electricity, limited internet access and data infrastructure, particularly in the Global South, restrict data collection and processing crucial for effective AI models. Addressing the digital divide requires a multifaceted approach that includes expanding internet access, improving data infrastructure, and promoting digital literacy. While private companies are likely to drive future infrastructure expansion, governments need support to develop frameworks and potentially invest alongside them. On the one hand, the digital divide inhibits the development of AI, but on the other hand, AI can also be used to address this problem efficiently –for example by supporting planning processes for the development of renewable energy systems. In addition, decentralized solutions like local data storage and low-bandwidth AI models can help bridge the gap. Collaboration across sectors is key to overcome data scarcity.

3.1.6 Threat to Climate Action through AI-spread Disinformation

The legitimacy of climate action is increasingly threatened by disinformation campaigns. These are jeopardizing the promotion and political prioritization of the fight against climate change in many countries. AI is increasingly being used to spread misinformation and counter-campaigns, which can be used to disseminate messages in a more targeted and authentic way – for example through deep fakes – as well as in larger quantities. For the work in the nexus of climate action and AI, it is therefore important to be aware of this threat and to actively address it through targeted education and countermeasures, for example by supporting the objectives of the seven goals of the Climate Action Against Disinformation – Coalition (CAAD).

3.2 Principles for the use and promotion of AI as a technology for climate action

All the challenges mentioned so far make it clear that the numerous developments that will come as a result of the development of AI in the coming years and decades are based on complex prerequisites and have potentially serious effects on the economy and society. Countries in the Global South must be supported in creating the conditions to benefit from this change and be protected from the potentially negative effects of change through AI. For this reason, AI must not only be a technical challenge but must always be considered in the context of its potentially negative environmental, climatological, social, and economic effects. AI is therefore always an environmental and ethical issue. The following section brings together environmental and ethical principles that must be observed when working with AI. The principles are a tailored and slightly extended version of the "AI Guiding Principles" developed in the GIZ project "FAIR Forward".

ENVIRONMENTAL AND ETHICAL PRINCIPLES FOR WORKING WITH AI:

1. **Balancing AI's Climate Potential with AI's Carbon Footprint:**
   The energy required for the computing power and for the construction of the basic material infrastructure make AI a carbon intense technology. For every project, this means weighing up the climate benefits against the carbon intensity and trying to keep the latter as low as possible. For this, it is necessary to quantify and evaluate both the climate impact and the carbon footprint of every planned and implemented AI application

2. **Be Active in the Fight Against Climate Disinformation:**
   Effective climate policy is increasingly threatened by disinformation campaigns and polarization, which have taken on a new quality using AI. Every project working in the nexus of AI and climate action should take its responsibility seriously and counter misinformation in the climate discourse with education, transparency, and public visibility.

3. **Aligning AI with Sustainable Development Goals (SDGs):**
   While the climate impact of a project is crucial, AI-powered mitigation or adaptation strategies should also align with all 17 SDGs and actively contribute to at least one or more of them.

4. **Ensuring Long-Term Climate Impact and Sustainability:**
   Sustainability of the project-activities must be ensured in two ways: Firstly, after the end of a support project, the results (e.g., developed digital public goods, AI solutions or policy frameworks) must be able to continue to be used, maintained, and improved. Secondly, the climate impact achieved during the project phase must be permanent and the conditions must be in place to continue building on it after the end of the project.

5. **Ensuring Additionality:**
   The development or use of AI is not an end but must realize a clear additional climate benefit compared to other technical or non-technical approaches for the sector to be addressed, either directly or indirectly.

6. **Promoting Equity in AI-Climate Action:**
   To address the general North-South imbalance in the design of climate action measures, it is also important to try to incorporate the needs and priorities of local groups and institutions into the design of project activities in the best possible way, while also realizing meaningful stakeholder engagement. This approach ensures that the voices of those most affected by climate change are actively integrated into the decision-making process AI-solutions are built on.

7. **Open-Source:**
   Sharing Solutions for Global Climate Action: Activities that promote the use of AI for climate action measures should always develop their products as open-source models, firstly to enable global application of solutions and secondly to drive global climate action innovation through AI.

4 Conclusion

AI holds immense potential in combating climate change. As this paper demonstrates, AI can open up new project areas in both mitigation and adaptation, while also technically optimizing established approaches and enhancing their efficiency. AI is suitable for application in many sectors, particularly where large amounts of data need to be collected or evaluated. It was shown how AI can help farmers to optimize their harvest with the help of remote sensing, weather stations and soil sensors. In Indonesia, AI is helping to identify forests that have a particularly high storage capacity for CO_2. The example of Sunny Lives AI shows how AI can be used to improve the prediction of extreme weather events. And the expansion of renewable energies can also be optimized using AI, as the example of PEERR II in Bolivia shows.

However, as highlighted in the third section, several hurdles still hinder the optimal utilization of AI. One major consideration is the carbon and environmental footprint of AI systems, that further contribute to climate change, raising demand for efficient models and shared open-source solutions. In countries of the Global South in particular, there is still a lack of many technical prerequisites for equal participation in the AI revolution. In some cases, this starts with the power supply and the internet connection, but above all relates to climate and/or AI-specific requirements, where there is a clear global imbalance between countries and regions: These include technical expertise, financial budgets and (preconditions to collect) local-specific data, which are crucial for the development of high-quality AI systems in these countries. Development cooperation organizations such as the GIZ should see it as their task to address these challenges in their work.

The last section presented seven principles that need to be considered here: (1) It is important to weigh the carbon impact of AI against the climate benefits for each project. (2) Projects should also recognize their role as participants in the public discourse on climate change and try to actively combat disinformation. Each project should also aim to contribute to the fulfilment of the SDGs (3) and realize long-term (4) and additional (5) climate benefits. (6) Furthermore, a Climate-AI project should never work against but always alongside the interests of the groups in whose context it is active. (7) Finally, AI solutions should be open source to create transparency and promote global cooperation.

Overall, recent developments in AI show an immense potential for technology to improve and accelerate climate action across different sectors and different local contexts. AI can be one major tool to help us achieve the ambitious goals that are necessary for successful climate mitigation and adaptation and thus prevent even worse consequences of the climate crisis. At the same time, development cooperation faces a responsibility to ensure that AI is used environmentally-consciously, inclusively and is made accessible for all. Therefore, while it is crucial that we explore AI applications in development cooperation and use their potential for good, we are all responsible for ensuring that this is done without any harm.

As recommendations for action, GIZ should focus on developing AI solutions and supporting areas critical to development policy. Critical applications of AI include forest monitoring to help prevent illegal logging, track deforestation, and support reforestation, while AI-driven policy stock take tools can inform and shape effective climate strategies. To harness AI for climate action, development corporations and funders should prioritize context-aware solutions tailored to regions and communities most affected by climate change, promote interdisciplinary collaboration, build strategic partnerships with local governments and NGOs, support open-source AI tools, encourage public-private partnerships, enhance local expertise through training programs, ensure ethical AI implementation, and adopt flexible, sustainable funding approaches.

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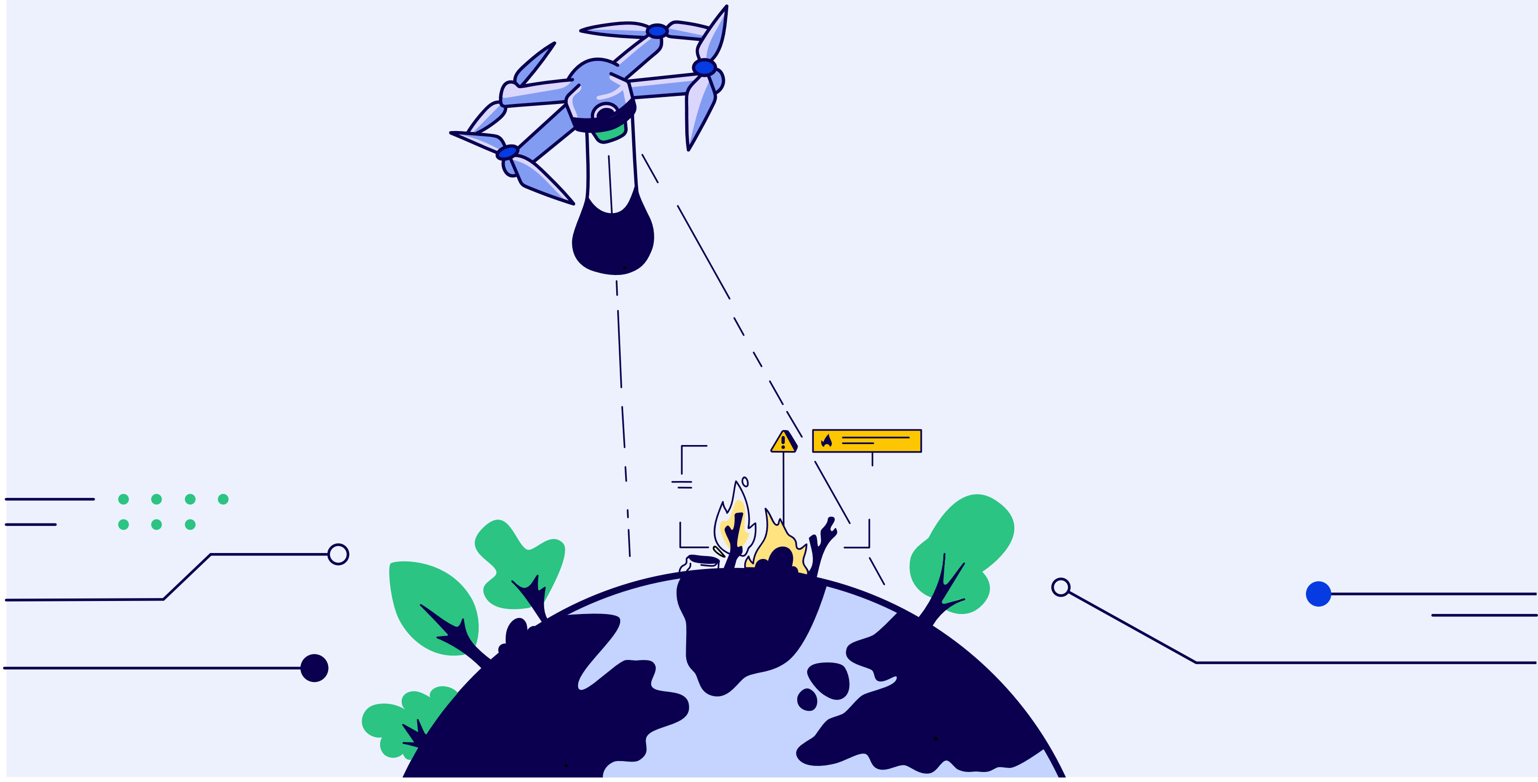

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