ITUPublications

International Telecommunication Union
Telecommunication Standardization Sector

Unlocking AI's Potential to Serve Humanity

Robotics, Geospatial AI and Communications Networks

2025 Report

UNU CPR

About the authors

This report was written by Eleonore Fournier-Tombs, Head of the Anticipatory Action and Innovation research programme at United Nations University-Centre for Policy Research (UNU-CPR); Muznah Siddiqui, AI Research Associate at UNU-CPR; and Andrew Ham, Associate Research Fellow at UNU-CPR. The authors worked closely with many colleagues at the International Telecommunications Union (ITU), receiving significant support throughout the project from Guillem Martinez Roura and Thomas Basikolo, under the leadership of Frederic Werner. The authors also acknowledge the valuable contributions of Kseniia Fontaine, Alexandra Bustos Iliescu and Vijay Mauree.

Acknowledgements

The authors would like to thank the experts who agreed to be interviewed and contributed their insights to the report. These include Davide Scaramuzza, Olivier Lambercy, Selma Šabanović, Shelly Levy-Tzedek, Maria Antonia Brovelli, Pengyu Hao, Monique Kuglitsch, Rohini Sampoornam Swaminathan, Andrew Zolli, Paul Harvey, Francesc Wilhelmi, Abhishek Dandehar, James Agajo, Nicolas Simon, Vincent Vanhoucke and Rui Kotani. Communications and production was led by Jack Durrell, Tess Pilkington and Vina Qinge Li.

Disclaimer

ISBN: 978-92-808-6656-8 © United Nations University 2026

Citation: Eleonore Fournier-Tombs, Muznah Siddiqui and Andrew Ham, *Unlocking AI's Potential to Serve Humanity: Robotics, Geospatial AI and Communications Neworks* (New York, United Nations University, 2025).

Forewords

The world has made vast progress in the development of Artificial Intelligence (AI). These promising achievements, however, are of no use if they do not benefit human beings and our planet.

The key question of our time is how to use AI and other emerging technologies to solve our biggest global challenges: achieving the Sustainable Development Goals, responding to crises and promoting peace.

In this groundbreaking report, United Nations University-Centre for Policy Research outlines several pathways for using AI for good. We focus on three uses of AI: robotics, geospatial technologies and 5G networks. The report documents many promising uses that were showcased at the AI for Good Conference 2025, from biodiversity conservation to healthcare.

This report speaks to the core mandate of United Nations University (UNU) – providing independent and academic research that informs the work of the multilateral system and its Member States. We have sought to document and synthesize some of the impressive work done by International Telecommunication Union in its AI for Good Conference since its launch in 2017.

Created 50 years ago by Secretary-General U Thant, the work of UNU has focused on peace and security; social change and economic development; and the environment, climate change and energy. In this report, these themes continue to resonate, as researchers document the efforts of AI experts to apply new technologies to advance these topics.

I was particularly impressed by some of the robotics use cases. One of the interviewees is a French company that makes exoskeletons. These exoskeletons can have many uses in the future, from supporting victims of neurological accidents to helping the elderly stay mobile in their own homes. The examples of drones delivering life-saving aid during humanitarian crises are also striking, especially at a time of increased humanitarian need.

Any country or organization seeking to implement an AI for good strategy will find great value in considering the five pathways outlined in this report – data quality, access and governance; infrastructure and access; AI literacy and talent; responsible AI policy; and digital ecosystem development. For the sake of our world, I certainly hope that they will do so.

As former Secretary-General Kofi Annan once said: "Knowledge is power. Information is liberating." The pages ahead demonstrate the power that knowledge of AI can have in shaping our society.

January 2026
Tshilizi Marwala, Rector of United Nations University
Under-Secretary-General of the United Nations

While it is easy to agree that Artificial Intelligence (AI) should serve humanity, turning that shared ambition into a global reality is far more complex – and increasingly urgent.

Across the world, AI is rapidly reshaping how we learn, manage resources and do business. But it is also revolutionizing how we respond to disasters, deliver healthcare and connect people with opportunity.

This report looks closely at practical, real-world applications of AI across three areas where such progress is already visible: robotics, geospatial AI and communications networks. Together, they show how AI can support both human well-being and healthier ecosystems – when it is designed, deployed and governed with care.

The International Telecommunication Union (ITU) brings the benefit of hindsight – and responsibility – to this AI moment. Founded 160 years ago to help the world connect across borders, ITU has always worked at the intersection of transformative technology and international cooperation. Each wave of innovation – from telegraphy to radio, from satellites to mobile broadband – has raised the same core challenge of ensuring new technologies are reliable, trustworthy and developed in ways that benefit all.

That long view and deep experience shapes ITU's engagement with AI today. Together with 194 Member States and more than 1,000 members from the private sector, academia and beyond, our work involves developing international standards, strengthening skills and capacity and convening spaces for meaningful dialogue and collaboration on AI.

The AI for Good platform is the clearest expression of our collaborative approach, further strengthened by ITU's close partnership with the United Nations University that connects independent research with real-world practice, and merges innovation with implementation.

The five pathways outlined in the chapters that follow point to the conditions that must be in place for AI to deliver lasting benefits to all people and our planet – from data governance and infrastructure, to skills, policy and healthy digital and physical environments.

Whether it's supporting rehabilitation, disaster response or strengthening early warning systems, the use cases in this report show what's possible when innovation is guided by public purpose, shared values and multi-stakeholder cooperation.

Whether you are a policymaker, practitioner or partner working within or beyond the United Nations, I hope these pages inspire you to take one or more of these pathways towards applying AI for Good in your own organization and context.

January 2026
Doreen Bogdan-Martin, Secretary-General
International Telecommunication Union

Table of contents

Figures

Tables

List of abbreviations

AI	Artificial Intelligence
ESCAP	United Nations Economic and Social Commission for Asia and the Pacific
ETSI	European Telecommunications Standards Institute
FAO	United Nations Food and Agriculture Organization
GIS	Geographic Information Systems
GeoAI	Geospatial Artificial Intelligence
GPU	Graphics Processing Unit
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
ICT	Information and Communication Technology
IoT	Internet of Things
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
ITU	International Telecommunication Union
LLM	Large Language Model
LVM	Large Visual Model
ML	Machine Learning
NASA	National Aeronautics and Space Administration
NIST	National Institute of Standards and Technologies
OECD	Organisation for Economic Co-operation
RAN	Radio Access Networks
SAR	Socially Assistive Robot
SDG	Sustainable Development Goal
STEM	Science, Technology, Engineering and Mathematics
UAV	Unmanned Aerial Vehicle
UN Women	United Nations Entity for Gender Equality and the Empowerment of Women
UN-GGIM	United Nations Committee of Experts on Global Geospatial Information Management
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNDRR	United Nations Office for Disaster Risk Reduction
UNICEF	United Nations International Children's Emergency Fund
UNOSAT	United Nations Satellite Centre
UNU	United Nations University
UNU-CPR	United Nations University Centre for Policy Research
WFP	World Food Programme
WHO	World Health Organization
WMO	World Meteorological Organization

Glossary

The following technical terms are used in the report and are defined here for the reader's convenience.

AI native: The seamless integration of trustworthy AI capabilities, where AI is inherently embedded across design, deployment, operation and maintenance.

Artificial neural networks: Inspired by the operation of neurons in the human brain, an artificial neural network is a computational model that processes data through interconnected nodes to learn, recognize patterns and make decisions. Artificial neural networks are key components of ML and deep learning due to their ability to classify data and make predictions.

Cobots: Collaborative robots, commonly known as cobots, physically interact with human workers in a shared workspace and increase flexibility and productivity.

Deep learning: A subset of ML that uses multilayered artificial neural networks to process and learn from data independent of human intervention.

Digital twin: A virtual replica of a physical object, system or process that can utilize real-time data to simulate its behaviour and predict real-world performance.

Edge computing: The process of moving data storage and processing closer to the source of data generation and the end users who utilize it, reducing latency and enhancing efficiency.

Generative AI: ML models designed to create various types of new content – such as text, images, audio and video – by learning patterns from vast amounts of training data.

Geospatial AI: Commonly known as GeoAI, geospatial AI is the integration of GIS and AI to analyse and interpret location-based data to extract insights and enhance decision-making.

Internet of Things: A system of interconnected physical objects – such as devices, vehicles and appliances – that are embedded with sensors, software and network connectivity, enabling them to collect and exchange data.

Large vision models: AI models trained on massive data sets to process and interpret visual information, such as images and videos, to perform tasks including pattern recognition, image classification and object detection.

Large language models: Deep learning algorithms trained on vast data sets to process and generate human-like language to perform tasks such as summarization, translation and text creation.

Light detection and ranging: An active remote sensing technology that uses laser pulses to measure distance and create high-resolution, three-dimensional maps of the surveyed environment.

Natural language processing: A branch of AI and computer science that leverages ML to help computers interpret, process and generate human language.

Network slicing: The division of a single physical network into multiple virtual networks, each functioning independently with its own resources, security and configurations. These tailored network segments are designed to meet specific performance requirements, such as speed, latency and reliability, for different services or user groups.

Overfitting: Occurs when a ML model becomes so specialized in recognizing patterns from its training data that it struggles to adapt to new inputs, leading to poor predictive performance.

Remote sensing: The monitoring of the Earth's surface at a distance, such as through satellites, aircraft or ground-based instruments, by measuring reflected and emitted radiation.

Reward hacking: Occurs when an AI system manipulates a reward structure to maximize outcomes without properly learning or fulfilling the intended objective.

Smart grids: Advanced energy systems that leverage digital technology, sensors and software to optimize electricity distribution, ensuring a real-time balance between supply and demand while enhancing efficiency, reducing costs and maintaining grid stability.

Unmanned aerial vehicles: Commonly known as drones, these aircraft operate without a human pilot on board but are instead controlled remotely by an operator or flown autonomously using pre-programmed flight plans or real-time data from sensors and GPS.

1

Executive summary

For nearly a decade, Artificial Intelligence (AI) leaders and experts have gathered in Geneva for the AI for Good Global Summit organized by International Telecommunication Union (ITU) in collaboration with 53 United Nations partners to explore opportunities for unlocking AI's potential to serve humanity. Such initiatives are especially important considering rising geopolitical tension and conflict, deteriorating climate conditions and the long-term repercussions of the COVID-19 pandemic.

AI has emerged as a game-changer. It offers the opportunity to tackle global challenges, while providing constructive pathways to improve quality of life and address the key priorities of the United Nations in domains such as health, disaster response, food security, education and climate change. AI-driven simulations can be used to predict and mitigate global warming, while image processing technologies can help promote crop yield.[1] Elsewhere, robots with generative AI interfaces can provide critical rehabilitation support for patients suffering from neurological damage, while virtual tutors can personalize education for students and improve literacy rates, especially in the Global South.[2]

The opportunities provided by AI are endless, and its widespread application holds considerable promise for the future of society. Seventy-eight per cent of companies worldwide have begun to incorporate AI into their daily operations, and the World Economic Forum estimates that 170 million new jobs can be created in this field in the next few years.[3] Indeed, a survey within the United States suggests that over 70 per cent of leaders are currently upskilling and reskilling, to meet the demands of a changing economy.[4] Through initiatives such as the AI for Good Summit, and other educational repositories (as explored later in this report), ITU leverages its unique technical expertise and industry knowledge to support this necessary transition.

Several countries throughout the world have started looking into ethical frameworks and regulations to mitigate AI's potential adverse effects. Indeed, within the United Nations, the General Assembly adopted a resolution highlighting the respect, protection and promotion of human rights in the design, development, deployment and the use of AI in 2024. As recently as August 2025, the General Assembly also adopted a resolution towards the establishment of two new AI governance mechanisms: an International Scientific Panel on AI and a Global Dialogue on AI Governance.

The Global Summit highlights applications for AI human and planetary well-being, with a focus on three distinct AI fields – robotics, geospatial analysis and communications networks. These fields represent significant avenues for analysis with regard to AI's ability to promote the public good. The proposed applications have specific policy implications, from data governance to environmental concerns, which are distilled into five pathways of AI for human and planetary well-being – critical areas of action for those interested in harnessing AI for good.

---

1 Yi Zeng, "Artificial intelligence: An accelerator for United Nations Sustainable Development Goals", AI for Sustainable Development Goals Think Tank, 18 June 2020 (originally published in Chinese in *Guangming Daily*).

2 Cindy Zheng, "Robotic innovations take centre stage at AI for Good Impact India as part of WTSA 2024", AI for Good; Paul Jasper, "Can AI help us achieve the SDGs?", SDG Action, 9 July 2024.

3 Anthony Cardillo, "How Many Companies Use AI? (New 2025 Data)", *Exploding Topics*, last updated 26 August 2025. Available at https://explodingtopics.com/blog/companies-using-ai; World Economic Forum, "How education can transform disruptive AI advances into workforce opportunities", World Economic Forum, 20 October 2025. Available at https://www.weforum.org/stories/2025/10/education-disruptive-ai-workforce-opportunities/.

4 Lyss Welding, "Managers race to upskill: Why over 70% of leaders are retooling for an AI-driven future | Survey", edX, 18 August 2025. Available at https://www.edx.org/resources/leaders-embrace-upskilling-in-ai.

1.1 AI for human well-being

The six applications of AI for human well-being explore the potential of AI to significantly improve quality of life, including through access to food, health and education.

Table 1: Applications of AI for human well-being

Application	Description
Healthcare and telemedicine	• The global market for medical robots is projected to reach $52.41 billion by 2032, with an estimated annual growth rate of 15.69 per cent;[5] as of 2020, 7.7 per cent of nursing homes used monitoring robots.[6] • Collaborative robots (cobots) currently make up 5 per cent of all robot sales, but the International Federation of Robots forecasts this will rise to 34 per cent by 2025, driven by their use in sectors such as healthcare, education and automotive manufacturing.[7]
Agriculture and food security	• Agricultural and export prices rose by 3 per cent and 6 per cent, respectively, as of February 2025; however, the Food and Agriculture Organization (FAO) estimates that food production needs to increase by 60 per cent by 2050 to meet global demand.[8] • In Uganda, AI and satellite data are used to trigger early action for drought-induced crop failures;[9] in India, startups have used AI and on-farm sensors to deliver tailored crop insights, while FAO's Hand in Hand platform uses satellite analytics to drive rural development.

5 Standard Bots, "The future of robotics in healthcare: automating the industry", 28 April 2025. Available at https://standardbots.com/blog/the-future-of-robotics-in-healthcare-automating-the-industry.

6 Yong Suk Lee, Toshiaki Iizuka and Karen Eggleston, "Robots and Labor in Nursing Homes", *Labor Economics*, vol. 92 (2025).

7 Josip Tomo Licardo, Mihael Domjan and Tihomir Orehovački, "Intelligent robots – a systematic review of emerging technologies and trends", *Electronics*, vol. 13, No. 3 (January 2024).

8 FAO, "Climate Change and Food Security: Risk and Responses", 2015. Available at https://openknowledge.fao.org/server/api/core/bitstreams/a4fd8ac5-4582-4a66-91b0-55abf642a400/content.

9 United Nations Framework Convention on Climate Change and Group on Earth Observations, *Realising Early Warnings for All: Innovation and Technology in Support of Risk-Informed Climate Resilience Policy and Action* (United Nations publication, 2024), p. 35.

Disaster risk response	• Economic losses from disasters increased sevenfold globally – from $49 million per day in the 1970s to $383 million per day in the 2010s;[10] in 2023 alone, disasters caused $250 billion in losses.[11] • The United Nations' FloodAI system uses deep learning to generate real-time flood maps;[12] GeoAI has been used to support earthquake damage assessments for the 2023 earthquake in Türkiye and Syria, alongside providing an aftermath analysis of typhoons in the Philippines using drones and simulations.[13]
Disease mapping and monitoring	• The COVID-19 pandemic infected over 700 million people and caused 7 million deaths by 2023, while non-communicable diseases are projected to cause 77 million deaths annually by 2048 if unaddressed.[14] • During the COVID-19 pandemic, the United Nations used GeoAI to model transmission and optimize vaccine delivery in low-resource settings;[15] scientists also tracked the pandemic using social media data and machine learning in humanitarian settings.[16]
Education	• Currently, 250 million children and youth are out of school, with sub-Saharan Africa most affected as 9 out of 10 children lack basic reading comprehension.[17] Over 400 million students globally faced global school closures between January and June 2024 due to extreme weather events.[18] • The United Nations Children's Fund (UNICEF) and Serbia's Ministry of Education are piloting humanoid robots in classrooms;[19] the United Nations Educational, Scientific and Cultural Organization (UNESCO) is promoting robotics and STEM (Science, Technology, Engineering and Mathematics) access in Africa, and ITU held the Robotics for Good Youth Challenge in 2024 to support inclusive digital education.

10 United Nations, "Climate and weather related disasters surge five-fold over 50 years, but early warnings save lives – WMO report", UN News, 1 September 2021.

11 United Nations Office for Disaster Risk Reduction, "Uncounted costs: Data gaps hide the true human impacts of disasters in 2023".

12 United Nations Economic and Social Commission for Asia and the Pacific, "Strategic foresight to applications of Geospatial Artificial Intelligence (GeoAI) to achieve disaster-related sustainable development goals", Staff Technical Papers Series (December 2022) (UNESCAP, 2022), pp. 11-13.

13 United Nations Institute for Training and Research, "UNOSAT Emergency Mapping service activated over Syria and Türkiye following major earthquakes", press release, 6 February 2023; UNESCAP, "Strategic foresight", p. 13.

14 Karen Feldscher, "The next pandemic: not if, but when", Harvard T.H. Chan School of Public Health, 12 September 2024; United Nations, "Health". Available at https://www.un.org/en/global-issues/health (accessed on 5 May 2025).

15 Joseph Bullock and others, "Mapping the landscape of artificial intelligence applications against COVID-19", *Journal of Artificial Intelligence Research*, vol. 69 (2020).

16 Su Golder and others, "A chronological and geographical analysis of personal reports of COVID-19 on Twitter from the UK", *Digital Health*, vol. 8 (2022).

17 The World Bank, "Education Overview: Development news, research, data", *World Bank* (Education topic overview), last updated 22 April 2025. Available at https://www.worldbank.org/en/topic/education/overview.

18 Ibid.

19 UNICEF, "Humanoid robots to support children in learning", press release, 24 October 2024.

Social assistance	• Socially Assistive Robots (SARs) are increasingly used in homes, schools and hospitals, supporting seniors and children with autism through AI-driven features like voice recognition and adaptive learning. • The 2024 AI for Good Global Summit hosted a "Robots for Good" workshop focused on ethical guidelines, transparency and the responsible deployment of SARs.

1.2 AI for planetary well-being

The applications of AI for planetary well-being address the three elements of the planetary crisis – climate change, biodiversity loss, and waste and pollution – along with disaster risk.

Table 2: Applications of AI for planetary well-being

Application	Description
Biodiversity conservation	• The United Nations' Global Ocean Observing System uses robotic technologies to monitor ocean conditions and manage sustainable fisheries.[20] • Amazon Conservation uses drones and satellite-based robots in Brazil to detect illegal logging,[21] while TrailGuardAI in Africa uses ground robots and camera traps to monitor wildlife in protected areas.[22]
Disaster risk reduction and response	• GeoAI enables real-time crisis mapping, disaster impact assessment (e.g., collapsed buildings) and predictive early warning systems for floods and wildfires, enhancing disaster preparedness and response. • The United Nations launched a 2024 global initiative to lay the groundwork for international standards and support AI-driven disaster resilience.[23]

[20] Jim Leape and others, *Technology, Data and New Models for Sustainably Managing Ocean Resources* (Washington DC, World Resources Institute, 2020).

[21] Amazon Conservation, "MAAP #90: using drones to monitor deforestation and illegal logging", 13 August 2018.

[22] One Earth, "RESOLVE-TrailGuard ground sensors for advanced conservation monitoring". Available at https://www.oneearth.org/who-we-fund/science-policy-grants/resolve-trailguard-ground-sensors-for-advanced-conservation-monitoring (accessed on 14 February 2025).

[23] UNESCAP, "Strategic foresight", p. 13; ITU, "Global Initiative on Resilience to Natural Hazards through AI Solutions". Available at https://www.itu.int/en/ITU-T/extcoop/ai4resilience/Pages/default.aspx (accessed on 2 June 2025).

Climate change and energy use optimization	• As of 2024, global emissions reached 37.4 billion tons and need to be reduced by 7.6 per cent annually to meet the 1.5°C target;[24] fossil fuels account for 81.5 per cent of energy consumption, while 685.2 million people remain without electricity.[25] • Huawei and partners implemented a 5G smart grid network, and the United Arab Emirates launched a $1.9 billion smart grid initiative with Microsoft Co-Pilot to enhance energy efficiency.[26]
Waste and pollution reduction	• AI models using satellite and drone imagery, such as those featured in the 2024 ITU GeoAI Challenge, have achieved over 80 per cent accuracy in detecting agriplastic use and apply environmental monitoring indices like plastic, normalized difference vegetation and bare soil.[27] • GeoAI tools are also being used to map air pollution hotspots, including the estimation of ground-level nitrogen dioxide concentrations, as part of AI for Good innovation efforts.

1.3 Creating an enabling environment for AI for good

To most effectively harness AI for human and planetary well-being, several policy challenges must be addressed.

Table 3: Policy implications of AI for human and planetary well-being

Policy area	Description
Data access, quality and governance	• Geospatial data, which makes up approximately 80 per cent of all data,[28] are essential for AI development, yet many low- and middle-income countries lack the infrastructure, skills and access to collect, label and manage high-quality data, resulting in exclusion, bias and skewed decision-making. • Global gaps remain in enforcement, data quality, ethical oversight and equitable access, especially in the Global South.

24 International Energy Agency, *CO_2 Emissions in 2023* (Paris, 2024), p. 3; United Nations Environment Programme, *Emissions Gap Report 2024: No More Hot Air … Please!* (Nairobi: UNEP, 2024).
25 DieselNet, "Energy Institute releases 2024 statistical review of world energy", 21 June 2024.
26 Kavitha, "DEWA Launches $1.9 Billion Smart Grid Initiative to Boost Sustainably and Efficiency", SolarQuarter, 6 January 2025.
27 AI for Good, "2024 ITU GeoAI Challenge Finale", video, 18 December 2024.
28 Trang VoPham and others, "Emerging trends in geospatial artificial intelligence (geoAI): Potential applications for environmental epidemiology", *Environmental Health*, Vol. 17, No. 40 (2018).

Gaps in AI infrastructure	• Despite national strategies like India's AI for All and the African Union's Digital Transformation Strategy, global AI infrastructure development remains fragmented, with a need to address increasing accessibility to broadband services, compute power or interoperability to lessen digital inequities.
Digital literacy and digital access	• Currently, 77 per cent of the world's data centres are located in Organisation for Economic Co-operation and Development (OECD) countries, while 32 per cent of the global population remains offline;[29] achieving universal broadband connectivity would require an estimated $418 billion.[30] • Only 40 per cent of the global population is digitally literate, with a projected 65 per cent shift in job skill requirements by 2030, highlighting urgent gaps in digital upskilling, particularly in low- and middle-income countries.[31]
Talent gap in developing countries	• An estimated 33 per cent of top network engineering and operations roles currently lack the necessary skills for AI, with only 29 per cent of women holding AI-related competencies compared to 71 per cent of men.[32] • Talent across the various subfields of AI remains scarce, while retention is a critical challenge, especially in developing countries.
Privacy protection and cybersecurity	• Although there have been regulatory advances like the European Union's General Data Protection Regulation and Cyber Resilience Act, many countries lack comprehensive data protection frameworks, while cybersecurity vulnerabilities in 5G and AI systems remain underregulated, exposing users to threats such as data breaches, identity theft and algorithmic bias.
Physical safety	• While some regions have introduced new safety regulations (e.g., European Union Machinery Regulation 2023/1230), most countries are still developing their regulatory frameworks for robotics, leaving populations exposed to unregulated AI systems and unclear liability across supply chains.

29 Brian Daigle, "Data Centers Around the World: A Quick Look", Executive Briefings on Trade (United States International Trade Commission, May 2021).

30 Edward Oughton and others, "Estimating Digital Infrastructure Investment Needs to Achieve Universal Broadband", IMF Working Papers, WP/23/27 (IMF, 2023); United Nations Department of Economic and Social Affairs "Global Internet Use Continues to Rise, But Disparities Remain"(last accessed on 14 February 2025).

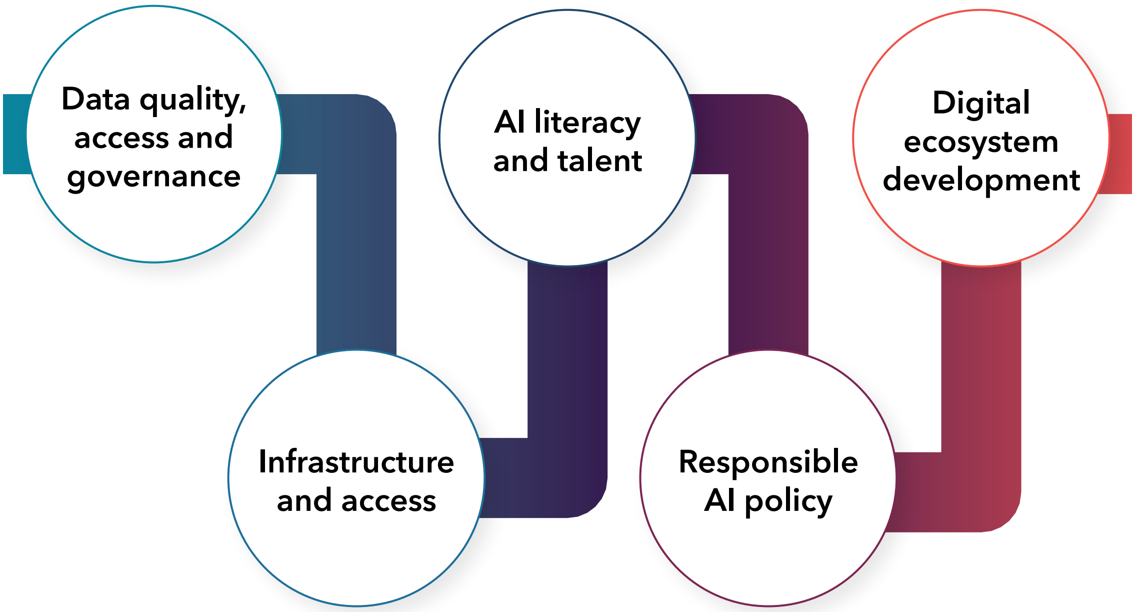
31 "Global Literacy Trends: Statistics on Progress and Challenges in Underrepresented Regions", MATSH, 26 December 2024; Benjamin Laker, "LinkedIn data predicts 65% shift in job skills by 2030 due to AI", Forbes, 3 October 2023.

32 Kelsey Ziser, "Skills gap threatens future of 5G and open RAN", LightReading, 8 April 2022; Sander van't Noordende, "Equitable AI skilling can help solve talent scarcity – this is what leaders can do", World Economic Forum, 5 December 2024.

Interpretation errors and bias	• While the use of embodied AI is growing, enforcement mechanisms to prevent algorithmic bias and interpretation errors remain limited, with many frameworks lacking clear criteria for fairness, third-party auditing or adequate oversight in low-resource settings.
Human labour effects	• Despite global recognition of the need for workforce reskilling, there are no international frameworks to protect workers affected by AI, and many national policies lack labour safeguards or support for those displaced.
Environmental considerations	• As the digital divide shrinks for the 2.6 billion people who remain offline, reducing the energy consumption of AI systems is critical to avoiding climate risks.

This research highlights five key elements for building an enabling environment for AI for human and planetary health:

Figure 1: Five pathways for AI for good



All three sectors that are the focus of this report – robotics, GeoAI and AI for communication networks – would be enhanced by national and global action along these five pathways.

As AI continues to evolve, its trajectory must be shaped through deliberate, ethical and inclusive policymaking. The future of AI for good depends on the collective ability of the global community to balance innovation with human rights and shared values, ensuring that technological progress translates into meaningful and lasting development outcomes. A forward-looking and human-centred AI approach, underpinned by strategic investment and cross-sector collaboration, will be essential in shaping a future where AI serves as a force for equitable and sustainable progress.

2

Introduction

In 2017, International Telecommunication Union (ITU) inaugurated the AI for Good Global Summit, a United Nations leading initiative aimed at bringing companies, governments, civil society and academics together to explore the immense possibilities of Artificial Intelligence (AI) in the service of humanity. The Summit was created at a time when there was still little understanding of AI's risks and potential outside of select technical groups. Since then, however, applications of AI have proliferated. AI has become central to the public imagination and the focus of investments in research and development, largely due to dramatic advances in natural language processing, a subset of the AI field.

Natural language processing has introduced large language models (LLMs), which paved the path for the development of numerous generative AI tools for public consumption, allowing AI to create visuals and text faster and more convincingly than before. While these tools bring both opportunities and risks to human and planetary well-being, they are not the only type of AI available today. Many other subfields of AI, such as robotics and geospatial AI (GeoAI), have evolved rapidly in recent years, warranting further explanation and research. As AI advances, concerns about human and planetary health are growing. Environmental degradation and climate change, a global pandemic, and rising inequality and migration have resulted in what some call a polycrisis, a scenario in which multiple crises exacerbate and accelerate one another. AI for Good offers an opportunity to cut through some of the confusion surrounding these crises and provide effective solutions. However, this can only be accomplished with a deliberate, concerted approach.

This report presents five pathways for AI for good that are required to enable AI for human and planetary well-being. In these pathways, we explore three subfields of AI that have gained prominence in the AI for Good Global Summit and community: robotics, GeoAI and AI for communications networks. These technologies involve many different types of algorithms, including image recognition, LLMs, classification, prediction and optimization. All, however, have distinguished themselves in providing use cases addressing some of the most important global challenges of our time, from climate change to humanitarian disasters, to public health and aging. Together, the five pathways aim to provide guidance on the most impactful avenues for AI, as companies continue to accelerate innovation and governments seek to enhance infrastructure, data and talent, with a focus on safety and responsibility.

2.1 Why a flagship report?

Since the inception of the AI for Good Global Summit, policymakers around the world have recognized the need for a concerted approach to harness the opportunities of AI while mitigating its risks. Since 2020, ITU has published more than 400 international specifications and standards related to AI, developed by open and inclusive working groups such as the Focus Group on AI for Natural Disaster Management,[33] the Focus Group on AI for Health,[34] the Focus Group on AI for Digital Agriculture,[35] and the Focus Group on Autonomous Networks.[36] Many of these groups have concluded their work and transformed into initiatives such as the Global Initiative on Resilience to Natural Hazards through AI Solutions and the Global Initiative on AI for Health.

United Nations Educational, Scientific and Cultural Organization (UNESCO) has concurrently published its Recommendation on the Ethics of Artificial Intelligence, unanimously adopted by its Member States in 2021. In 2023, the Group of 7 countries published the Hiroshima AI Process, outlining a set of international guiding principles for all AI actors in the AI ecosystem, alongside an International Code of Conduct for Organizations Developing AI Systems. In October 2023, the

33 International Telecommunication Union, "Focus Group on AI for Natural Disaster Management (FG-AI4NDM)". Available at https://www.itu.int/en/ITU-T/focusgroups/ai4ndm/Pages/default.aspx.

34 International Telecommunication Union, "Focus Group on Artificial Intelligence for Health (FG-AI4H)", ITU-T Focus Groups. Available at https://www.itu.int/en/ITU-T/focusgroups/ai4h/Pages/default.aspx.

35 International Telecommunication Union, "Focus Group on Artificial Intelligence for Autonomous and Assisted Driving (FG-AI4AD)", ITU-T Focus Groups. Available at https://www.itu.int/en/ITU-T/focusgroups/ai4a/Pages/default.aspx.

36 International Telecommunication Union, "Focus Group on Autonomous Networks (FG-AN)", ITU-T Focus Groups. Available at https://www.itu.int/en/ITU-T/focusgroups/an/Pages/default.aspx.

Secretary-General of the United Nations announced the establishment of a High-Level Advisory Body on AI, which fed into the Global Digital Compact and led to the creation of an International Scientific Panel on AI and the Global Dialogue on AI Governance.[37] The United Nations General Assembly officially adopted its resolution outlining the terms of reference and modalities for the establishment and functioning of an Independent International Scientific Panel on AI and a Global Dialogue on AI Governance in August 2025. Many United Nations agencies, including the United Nations Children's Fund (UNICEF), the United Nations Commission on the Status of Women (UN Women) and the United Nations Development Programme (UNDP), have also explored the potential of AI in their work and examined the impact of ungoverned AI technologies on their activities. Concurrently, other international organizations such as the Organisation for Economic Co-operation and Development (OECD), the African Union, the Association of Southeast Asian Nations and international financial institutions have also contributed strategies, commitments and research to the issue of AI governance.

AI technologies continue to evolve. The development of AI agents – AI-powered tools with a certain level of autonomy in decision-making and planning – has surfaced new possibilities and concerns. For example, AI agents can execute complex tasks independently; however, this independence has led to fears of agents manipulating information or going rogue in other ways. Embedded AI tools, such as socially assistive cobots, exoskeletons and humanitarian drones, have begun to be successfully used to improve human well-being. The use of AI for predicting extreme weather events, in addition to promoting mitigation and adaptation to climate change, has also grown in importance and is now one of the key interventions for this critical global challenge.

It is in this atmosphere of rapid evolution, both of the technologies and the policies that seek to guide and govern them, that this report was written. This report captures the most important trends, use cases and policy implications of the AI for Good Global Summit and community to guide the development of AI in a way that benefits humanity and the planet. Accordingly, it explores the implications of AI for the subfields of robotics, GeoAI and AI for communications networks and synthesizes the policy implications of these applications to support policymakers as they create an enabling environment for AI for human and planetary well-being.

2.2 Methodology

This report is the result of a project undertaken by researchers at United Nations University–Centre for Policy Research from July 2024 to May 2025. The project involved a detailed review of the AI for Good platform and materials, including blogs, videos and interviews with expert participants. Notably, 15 AI experts engaged in the AI for Good community were interviewed in depth, representing each of the fields of interest. A research workshop was also held in December 2024 at ITU in Geneva, gathering staff members engaged in the AI for Good Global Summit. A summary of the qualitative interviews can be found in Annex B.

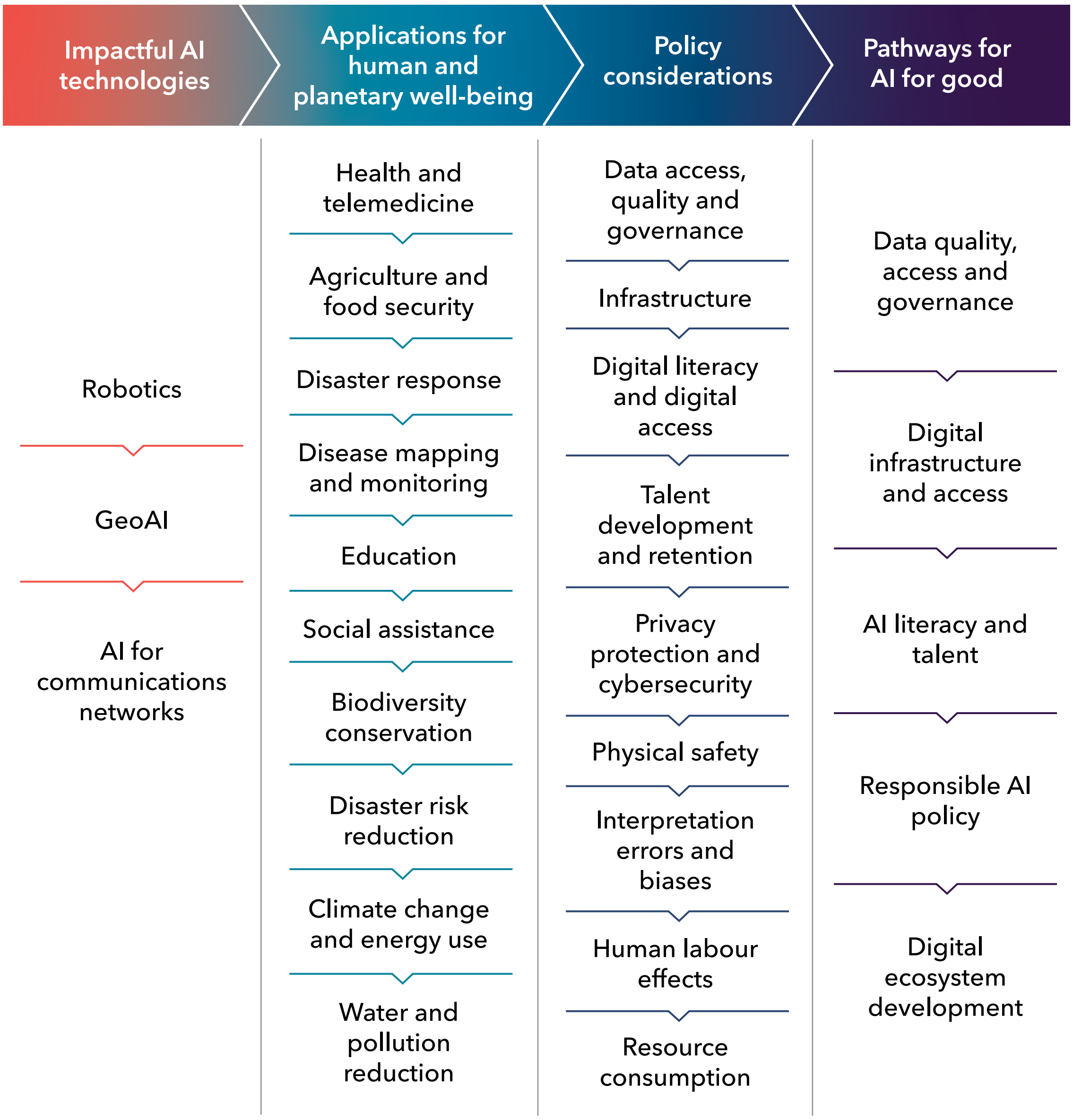
This project also underwent an ethics review process through United Nations University's Ethics Review Board. The objective of this review was to evaluate possible risks to respondents and participants in relation to privacy, emotional or physical impact, and consent. Best practices in data collection, storage and deletion were also followed.

37 United Nations, AI Advisory Body, *Governing AI for Humanity* (United Nations publication, 2024), pp. 10–12.

2.3 Overview

This report begins by describing the three focus technologies of this research: GeoAI, robotics and AI for communications networks. Their applications are then separated into two parts: AI for human well-being, and AI for planetary well-being. While these issues are certainly interconnected and overlapping, it was deemed important to group the applications for the benefit of the reader. Consequently, the first section explores six applications that allow AI to meaningfully contribute to various dimensions of human well-being: access to medicine and telemedicine, agriculture and food security, disaster risk response, disease mapping and monitoring, education and social assistance. The second section turns to four applications of AI in support of planetary well-being: biodiversity conservation, disaster risk reduction, energy use optimization and pollution reduction. Finally, the report examines existing and potential policy frameworks that would best allow countries to achieve the 10 applications, supporting responsible AI innovations that could benefit their populations.

Figure 2: Applications and considerations defining the five pathways



3

The AI for Good platform

AI for Good was launched in 2017. Originally conceived as a physical conference in Geneva, it has expanded into the United Nations' leading platform that seeks to unlock AI's potential to serve humanity through building skills, AI standards and advancing partnerships. The initiative connects AI innovators with public and private sector decision makers to highlight existing AI use cases, facilitate knowledge sharing and support the development of new global AI solutions.

With the historic impact of the COVID-19 pandemic and global shutdowns, AI for Good moved online in March 2020. It launched hundreds of virtual sessions to sustain its mission to continue fostering collaboration on practical AI solutions. Under the motto "All Year, Always Online," the platform leveraged technology to connect innovators with problem owners.

In 2022, the AI for Good Neural Network[38] launched an AI-powered community and content platform designed to connect thought leaders, industry professionals, policymakers, researchers, innovators and civil society from around the globe. This free platform offers inclusive access to all original AI for Good content since 2017. This shift marked a significant milestone that served as a dynamic space for collaboration, innovation and capacity development on AI.

Leading up to the most recent AI for Good Summit in July 2025, the platform has delivered on its action-oriented promise by establishing several initiatives. These include the Global Initiatives on AI and Data Commons, AI for Health (in partnership with the World Health Organization, WHO), AI and multimedia authenticity standards, AI for Road Safety (in partnership with the United Nations Economic Commission for Europe), and AI and Internet of Things (IoT) for Digital Agriculture (in partnership with the Food and Agriculture Organization, FAO). The platform has also concluded several focus groups on AI and Environmental Efficiency and machine learning (ML) and 5G.

With a thriving community of over 55,000 active contributors, and spanning over 180 countries, AI for Good is presently executing its ambitious programme on AI. This is being guided by the ITU Plenipotentiary Conference's Resolution 214 (Bucharest, 2022), and Resolution A/78/L.49 of the United Nations General Assembly (New York, 2024). Concurrently, the recent adoption of Resolution 101 (New Delhi, 2024), Standardization activities of the ITU Telecommunication Standardization Sector on artificial intelligence technologies in support of telecommunications/information and communication technologies, emphasizes ITU's mandate and AI for Good's role establishing trust in AI whilst providing capacity development to Member States. Accordingly, the key tenets of AI for Good complement and address urgent calls from global entities like the United Nations Global Digital Compact, the International Scientific Panel on AI, and the Group of 20 to lead the development of AI standards and capacity-building.

The inaugural Global Dialogue on AI Governance, established under the recent landmark UN General Assembly Resolution A/79/L.118 on AI, and hosted by the UN Secretary-General with ITU's support, will be held back-to-back along the margins of the 2026 AI for Good Global Summit. This milestone resolution provides a strong foundation for enhanced global cooperation on AI and elevates the Dialogue to an unprecedented level of scope and visibility. It positions Geneva as the central forum where governments, industry, academia, civil society and the technical community can shape a shared approach to AI.

Additionally, ITU publishes several reports on AI, including the *AI for Good: Innovate for Impact* report[39] which documents a challenge run by ITU that promotes AI for the betterment of humanity and the preservation of the planet. Submissions are received in several categories, including healthcare, finance, manufacturing, automotive, future networks and other industries, and reflect many of the themes that will be discussed in this report. For example, a use case documented in the 2024 report involves the application of GeoAI to predict wildfires, allowing local communities to prevent fires or act quickly to mitigate and contain them.

---

38 International Telecommunication Union, "Neural Network", AI for Good. Available at https://aiforgood.itu.int/neural-network/.

39 International Telecommunication Union, *AI for Good: Innovate for Impact – Final Report 2024* (Geneva, 2024). Available at https://www.itu.int/net/epub/TSB/2024-AI-for-Good-Innovate-for-Impact-final-report/index.html.

In the 2024 edition of the *United Nations Activities on Artificial Intelligence* report[40], ITU documents 729 AI use cases. In addition, the number of agencies participating in the report and the number of projects reported significantly increased from 2023 – by 13 per cent and 79 per cent, respectively. This shows the commitment of the United Nations system to apply AI tools to address its goals and values.

AI for Good in focus: The future of the Internet of Things and radio frequency intelligence through large language models

LLMs are transforming IoT and radio frequency systems from passive data collectors to intelligent, context-aware networks. On 8 May 2025, the AI for Good platform organized a webinar with Dr. Lina Bariah, Lead AI Scientist at Open Innovation AI, Adjunct Professor at Khalifa University and Adjunct Research Professor at Western University, Canada. The webinar demonstrated how incorporating multimodal LLMs into IoT systems can enable real-time optimization and decision-making. Given that multimodal LLMs can interpret radio frequency signals, environmental data and user intent, they can serve as both interpreters and optimizers and help bridge the gap between low-level signal input and high-level human suggestions.

LLMs can extract insights and communicate them in natural language by analysing complex radio frequency data alongside contextual inputs from sensors such as cameras and microphones, therefore providing users with explanations and practical suggestions. For example, an LLM may identify signal interference produced by a reflective surface and advise moving a sensor. The webinar also featured a revolutionary multi-agent LLM framework that uses specialized agents to oversee problem modelling, parameter estimation and solver execution, allowing for the scalable optimization of IoT networks. It highlighted that including multimodal, edge-deployable LLMs transforms IoT from narrow AI functions to adaptive, personalized and user-focused systems. This enables intent-driven control, allowing users to communicate commands such as "make my space cozy for reading", rather than manually configuring multiple parameters.

The webinar also addressed issues such as edge deployment, real-time latency and multi-user customization, while offering solutions such as lightweight LLM architectures and standardized communication protocols. This marks a significant step forward in the field, allowing for intelligent mechanisms that respond proactively to individual needs and optimize themselves using natural language and situational awareness. It also democratizes IoT control by transitioning from rigid, vendor-locked systems to flexible, user-centred networks. The webinar noted that future possibilities in this field could include large action models for autonomous task execution and federated LLM frameworks to balance competing preferences in shared spaces.

40 International Telecommunication Union, *United Nations Activities on Artificial Intelligence (AI)* (Geneva, 2023). Available at https://www.itu.int/hub/publication/s-gen-unact-2023/.

3.1 The AI for Good Global Summit

The AI for Good Global Summit is organized annually in Geneva in partnership with 53 United Nations agencies and co-convened with the Government of Switzerland. This event brings together leading policymakers and thought leaders across industries to discuss opportunities for AI to advance global development priorities, including health, climate, inclusive prosperity, sustainable infrastructure and addressing the digital divide.

Since its launch, the AI for Good Global Summit has experienced tremendous growth in attendance and reach. The 2025 AI for Good Global Summit, which was held from 8 to 11 July in Geneva, brought together over 11,000 people from 169 countries, a considerable increase from 2024. The 2025 Summit featured various speakers and more than 100 exhibitors showcasing cutting-edge AI innovations which can deliver better healthcare and education, reduce disaster risks, ensure water and food security and bolster economic resilience.

Presentations at the 2025 Summit highlighted the transformative power of AI technologies in robotics, such as prototypes of flying cars, avian-inspired robotic drones, humanoid AI agents, brain-machine interfaces for at-home neurorehabilitation, solar aquatic robots for environmental monitoring and even AI-designed biological organisms.

AI for Good in focus: Biologically inspired AI and a framework for designing adaptive robots

Bio-inspired approaches are helping to create intelligent, robust and adaptive robotic systems. On 8 April 2025, the AI for Good platform hosted a webinar to discuss evolutionary algorithms with Dr. Kyrre Glette, Professor at the Robotics and Intelligent Systems group in the Department of Informatics, and at the RITMO Centre for Interdisciplinary Studies in Rhythm, Time and Motion at the University of Oslo. The webinar discussed the co-design of robot morphology and control utilizing evolutionary and quality-diversity algorithms, which allows systems to automatically adapt to changing environments. A study discussed during the webinar revealed how biologically inspired techniques such as indirect encoding and modular control can produce efficient, resilient robotic structures.

The webinar also explored how simulations and real-world testing are integrated to build robots that are suitable for dynamic, unstructured settings. It addressed the ongoing issue of a "reality gap" in which simulated environments frequently fail to adequately reflect real-world settings, and explored strategies such as domain randomization and lifelong learning to mitigate this issue. The webinar demonstrated practical applications in which adaptive robots outperform traditional systems, particularly in uncertain and unpredictable contexts.

This research offers a significant contribution to the field by proposing a framework for automatic robot design that goes beyond sequential development methods. The research promotes open-source simulation tools, such as evolving modular robot platforms and Unity ML Agents, which fosters greater collaboration. It also highlighted the potential for bio-inspired designs to improve energy efficiency and reduce material use. Overall, the webinar demonstrated how AI-driven, bio-inspired design can improve morphological adaptation and resilient control, laying the groundwork for future innovation in autonomous and adaptive robotics.

3.2 AI challenges and competitions

ITU hosts several annual AI challenges and competitions regionally and globally under the AI for Good initiative. The primary aim of these competitions is to foster collaboration in determining solutions for real-world problems through the deployment of AI technology. The challenges provide opportunities to engage students and professionals across industry and academia to consider how AI applications can support progress. They also enable participants to gain hands-on experience, compete for global recognition and gain familiarity with AI standards as they create solutions around ITU's specifications.

ITU supports the development of participants' skills by offering real-world and simulated data, technical webinars, mentoring and hands-on sessions through these challenges. Additionally, ITU provides state-of-the-art, free-of-charge computing platforms to participants[41] who lack adequate access to computing technology (free Graphics Processing Unit (GPUs) and Central Processing Units, a hosted Jupyter server, Python kernel and pre-installed ML packages) to promote global participation and address the digital divide. Winners of the challenges are granted prize money and certificates, invited to compete further at the global level and, in some cases, asked to pitch their solutions at the Summit.

See Table 4 for some of the recent challenges and competitions and the Sustainable Development Goals (SDGs) they addressed. Close to 100 ML challenges have been run so far.

Table 4: AI for the SDG challenges

Challenge	Description
ITU AI/ ML in 5G Challenge	An annual competition that calls on participants to address problems in applying AI and ML in communications networks. The 2024 AI/ML in 5G Challenge was hosted as a side event at COP29 with problem statements on smart energy supply scheduling for green telecom to optimize energy consumption in mobile networks while maintaining network stability. This challenge supports efforts to develop ML models to predict daily solar energy generation and diversify energy sources to reduce energy costs.

[41] International Telecommunication Union, "AI/ML in 5G Challenge", AI for Good. Available at https://aiforgood.itu.int/about-us/aiml-in-5g-challenge/.

GeoAI Challenge	This challenge encourages participants to provide solutions for real-world geospatial problems and address the SDGs through the application of AI and ML. The 2024 GeoAI Challenge included the following activities: (1) agricultural plastic cover mapping with satellite imagery, (2) ground-level nitrogen dioxide estimation and (3) clandestine runways detection in the Peruvian Amazonian basin with open-source satellites. The challenges explore the use of ML to support decision-making to improve resilience, support natural disaster preparedness and response, and expand the capacity of existing geospatial tools.
AI for Good Innovation Factory	This initiative provides opportunities for global pitching, funding connections, mentoring, participation in the Startup Acceleration Program, networking with global leaders and media exposure. With hundreds of startups applying annually, the year-long platform hosts monthly online and in-person pitching sessions. These sessions can focus on startups that have impact on a global scale and feature specialized sessions that focus on regions and countries, or different sectors (agriculture, climate, energy, healthcare, smart cities). Finalists of each session are invited to participate in the Grand Finale at the AI for Good Global Summit and pitch to a panel of investors, venture capitalists and philanthropists for potential funding.
Canvas of the Future	This competition invites artists and AI enthusiasts worldwide to create visual artwork using AI tools that showcase their vision for a sustainable future in alignment with the SDGs. This challenge explores the intersection of technology and art to promote awareness and inspire deeper understanding of the SDGs. It also serves to amplify diverse experiences, cultures and perspectives for a more inclusive and representative global dialogue on a sustainable future.
Robotics for Good Youth Challenge	This platform encourages teams to design, build and code a robot to solve challenges relating to natural disaster response. Additionally, the competition encourages the use of recycled materials and environmentally friendly solutions, emphasizing the development of sustainable robots. The thematic focus for the 2024 Robotics for Good Youth Challenge was post-earthquake rescue and evacuation.

AI for Good in focus: AI standards

International AI standards set technical specifications and requirements for AI technologies and help address real and perceived risks by establishing clear, predictable boundaries for AI systems. Employing consensus-based decision-making systems and reducing fragmentation among United Nations bodies, regional organizations and national governments are necessary requirements to enable the implementation of international standards. As a leading platform for developing safe and practical standards, AI for Good plays a key role in promoting international collaboration and best practices in standard-setting. ITU has published over 100 technical standards for AI thus far and has many more currently in review.

Emphasis on standards dialogue through the AI for Good initiative improves interoperability and regulatory approaches. Such discussion provides an opportunity to direct the international community's attention towards addressing relevant emerging threats, such as deepfakes and deceptive AI-generated content.

International standards, such as ISO/IEC 23053: Framework for Artificial Intelligence Systems Using Machine Learning and ISO/IEC 5338: AI System Life Cycle Processes, define system architectures and data requirements to provide structured foundational approaches for robust AI systems. The IEEE bridges technical and ethical dimensions of AI to develop standards across industries, including electrical engineering, telecommunications and emerging technologies like AI and robotics. Similarly, the European Telecommunications Standards Institute (ETSI) is a sector-specific standards-setting body that works closely with the European Commission, the European Union Agency for Cybersecurity and international bodies to provide key contributions to regional AI governance.

ITU currently has over 220 AI standards either published or under development, including standard frameworks to integrate AI/ML in networks, standard terms and definitions, standards to evaluate AI/ML models and their results, and standards for data handling.

At the national level, countries can support standards implementation by developing testing frameworks to evaluate AI systems' compliance with ethical and regulatory guidelines, such as Singapore's AI Verify initiative.

Building on the standardization discussion that took place during the Global Summit, AI for Good held the 2024 International AI Standards Summit in India in October 2024. Led collaboratively by ITU, the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC), the International AI Standards Summit serves as a meeting point for standards bodies around the world to work on the practical implementation of responsible, safe and inclusive AI guidelines. The recent AI for Good Global Summit also featured an AI International Standards Day on 11 July 2025, highlighting the growing prioritization of AI framework discussions.

4

Beyond generative AI: Harnessing innovative AI

Before turning to an exploration of the various applications of AI for human and planetary well-being, this report provides a deeper dive into its three focus areas: robotics, GeoAI and AI for communications networks. While these technologies may benefit from advances in the field of generative AI, their applications for good have been developed over several decades, and they provide concrete opportunities for good beyond the use of generative AI tools.

> The planetary AI revolution will provide a radical expansion in the number of people who can access and utilize geospatial data to better manage the world."
>
> – Andrew Zolli, Planet Labs

4.1 Geospatial AI

The field of GeoAI refers to the combination of AI and Geographic Information Systems (GIS). It enables analysts to augment maps and satellite images with granular and diverse datasets, identifying previously uninterpreted characteristics and making predictions about climate, food security, human mobility and even conflict. GeoAI is a critical part of early warning systems and anticipatory action toolkits, enabling analysts to better anticipate, prevent and monitor natural disasters and man-made crises.

Geospatial information refers to spatial and descriptive data that can be utilized to aid decision-making and provide useful insights to policymakers. It is used to model and predict spatial conditions or location-based events, improving the efficacy and accuracy of analysis. Recent technological advancements have transformed geospatial data from basic mapping exercises to sophisticated AI applications that Member States can utilize to advance the SDGs.

Since its inception in 1945, the United Nations has relied on geospatial information analysis to advance its objectives of fostering peace and security, protecting human rights and promoting sustainable development. The use of geospatial analysis to inform decision-making dates back to early mapping and cartography efforts. In its early years, the United Nations relied on maps to define borders, settle territorial disputes and support peacekeeping missions. Maps were also used to provide visualizations to Security Council sessions, to provide a cartographic basis for the reports of the Secretary-General and to promote decolonization efforts by recognizing nations' political independence and territorial integrity as outlined in the United Nations Charter.[42]

42 United Nations, "Maps and geospatial services". Available at https://www.un.org/geospatial/maps-geo (accessed on 5 May 2025); "UN uses GIS to promote peace and provide aid", Esri, 2010.

AI for Good in focus: Leveraging large language models for advanced spatial decision support and the case of SATGPT

An innovative AI application using LLMs like ChatGPT is being used to enhance advanced spatial decision-making, particularly in areas such as disaster hindcasting and sustainable development. SATGPT combines ChatGPT and Google Earth Engine to provide rapid, prompt-based flood mapping.

On 26 June 2024, the AI for Good platform invited Hamid Mehmood, an Economic Affairs Officer in the Space Applications Section at the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), to discuss uses of SATGPT. Users can generate historical flood maps (from 1984 to the present) in just 15–30 seconds with a simple natural language command such as "map the 2010 flood in North Bangkok", which would normally require hours of manual coding. The LLM evaluates the prompt, extracts the relevant location and time information, then writes and executes Google Earth Engine code to create the map.

The webinar also illustrated the ability of the LLM to use socioeconomic data and build footprints to improve impact assessments and identify flood hotspots over time. Through optimizing geo-prompt engineering, SATGPT addresses global flood monitoring challenges with 82 per cent accuracy, providing consistent AI-generated outputs by including persona, language, functionality, context, sensor specifications and visualization parameters in prompts. This approach reduces hallucinations and enhances transparency by allowing users to download and verify the underlying Google Earth Engine code. In addition to flood mapping, SATGPT also helps to monitor wildfires, droughts and tsunamis.

This webinar made a significant contribution to the fields of geospatial analysis and disaster management by demonstrating a simple, user-friendly, efficient and transparent method for accessing and evaluating historical satellite data. It democratizes access to advanced geospatial tools in low-resource environments, accelerates disaster response with near real-time historical flood analysis and provides transparency through auditable AI-generated code. The initiative's open-access course on Geo-Prompt Engineering teaches best practices in LLM-assisted earth observation data processing, eliminating barriers to entry for non-experts and promoting the rapid creation of critical spatial insights. The methodology improves the reliability and reproducibility of LLM-generated geospatial outputs by emphasizing prompt engineering, establishing a strong precedent for ethical and scalable AI in geospatial decision-making.

Table 5: The impact of inserting AI into traditional Geographic Information Systems

Domain	Traditional GIS	GeoAI
Epidemic management	• Mapping disease incidence • Identifying outbreak clusters • Spatial analysis of healthcare access	• Predictive modelling of outbreak spread using mobility and environmental data • Real-time hotspot detection from social media and satellite data • Early warning via anomaly detection in geospatial health data
Disaster risk reduction	• Hazard zone mapping (e.g., floods, landslides) • Evacuation route planning • Post-disaster damage mapping	• Automated damage assessment via satellite image recognition • Flood prediction using deep learning and SAR imagery • Multi-hazard impact forecasting incorporating dynamic environmental variables
Food insecurity management	• Crop yield estimation using satellite imagery • Mapping food distribution infrastructure • Identifying drought-prone areas	• AI-driven crop health monitoring via high-resolution imagery • Forecasting food shortages using climate, soil and market data • Optimized distribution route planning with reinforcement learning

In the 2000s, advances in satellite imagery and other technologies led to the development of web-based GIS platforms and open-source GIS software. These platforms helped to democratize GIS technology by allowing for the collection and sharing of real-time data on the Internet. Simultaneously, the introduction of smartphones and cloud computing services transformed the way many stakeholders could access GIS data. Cloud computing also reduced expense and time, as complex models could now be run in the cloud. These innovations enabled the United Nations to provide specialized analyses, such as during the COVID-19 pandemic, when WHO used geospatial technology and data mapping to create a disease dashboard that provided timely and accurate insights and assisted policymakers in decision-making for preparedness and response.

More recently, advances in image granularity, increased data storage and advanced analytical capabilities powered by AI have transformed geospatial analysis. In addition, the increased availability of geospatial Earth observation data offers promising opportunities for the advancement of GIS technology. The combination of large datasets and increased computational power considerably improves the scope and precision of spatial analysis, resulting in more accurate insights and informed strategies for addressing complex challenges. This combination can improve scalability, speed and accuracy, while drastically decreasing human error to deliver granular insights and support more informed decision-making at the global level.

AI for Good in focus: Accelerating GeoAI adoption

"AI solutions, such as ones that allow people to interact with geospatial information through natural language, can help bridge the gap between data and decision-making."

- Rohini Sampoornam Swaminathan, UNICEF.

The rise of AI in remote sensing has reshaped the role of geospatial analysts, shifting their focus from manual data collection to designing and evaluating AI algorithms.[43] Commonly used AI-based mapping methods today include random forests, support vector machines and other basic ML techniques. Current efforts aim to enhance forecasting and detection capabilities, develop models that produce high-resolution outputs, and better understand associated risks.

GeoAI solutions that deliver simple, interpretable outputs can accelerate adoption by lowering the technical barrier for understanding remote sensing data, making it more accessible to governments and local institutions.[44] To further GeoAI knowledge, an international coalition of recognized universities and research centres known as the United Nations Global Geospatial Information Management Academic Network is developing curricula and courses to bridge the gap between academic geospatial research and practical application.

While GeoAI solutions offer significant potential, their successful adoption depends on the robustness and explainability of the models. Maria Antonia Brovelli, Professor of GIS at Politecnico di Milano, emphasized that building trust in a model's reliability should be the top priority. She also noted a growing tendency towards over-reliance on AI methods, and underscored the importance of teaching analysts how to assess model output quality before training them to use these tools.[45] Similarly, Monique Kuglitsch, Innovation Manager at Fraunhofer Heinrich Hertz Institute, highlighted the need for explainable AI approaches, such as Layer-wise Relevance Propagation, to provide insights into model behaviour and to better understand the underlying data.[46]

43 Interview with Pengyu Hao, Information Technology Officer, FAO. Interview conducted via videoconferencing technology, 30 October 2024.
44 Ibid.
45 Interview with Maria Brovelli, Professor of GIS at Politecnico di Milano. Interview conducted via videoconferencing technology, 14 October 2024.
46 Interview with Monique Kuglitsch, Innovation Manager at Fraunhofer Heinrich Hertz Institute. Interview conducted via videoconferencing technology, 7 November 2024.

> *LLMs will enable anyone, even a kid, to programme these robots because that's what ChatGPT already does extremely well. Now think of a vacuum cleaning robot. You don't need to programme it or click on the smartphone buttons. You can just talk to the robot one day and say, 'Please clean my bedroom this afternoon at 2pm, and then go back and recharge.'"*
>
> *– Davide Scaramuzza, University of Zurich*

4.2 Robotics

Significant breakthroughs in robotics have resulted in the development of robots capable of imitating or enhancing human labour. Currently, there are approximately 3.9 million operating robots in service worldwide.[47] Additionally, recent advancements in large vision models, LLMs, ML and natural language processing have resulted in more autonomous and adaptive robots.

These new technologies have enabled robots to learn from human behaviour, tailor their responses to social cues, improve decision-making abilities and personalize interactions with humans.[48] This is evident in the case of Google's DeepMind, which employs LLMs to hone a robot's understanding of human commands and intentions, resulting in improved situational awareness.[49] These developments enable robots to engage in more dynamic interactions with humans and increase their use in healthcare and customer service environments. Advances in cognitive processing and computer vision technologies have also allowed robots to adapt to new conditions, make real-time decisions and interact with their surroundings autonomously.[50] Robots are now utilized in a wide range of applications, including planetary exploration, manufacturing, disaster response and education.

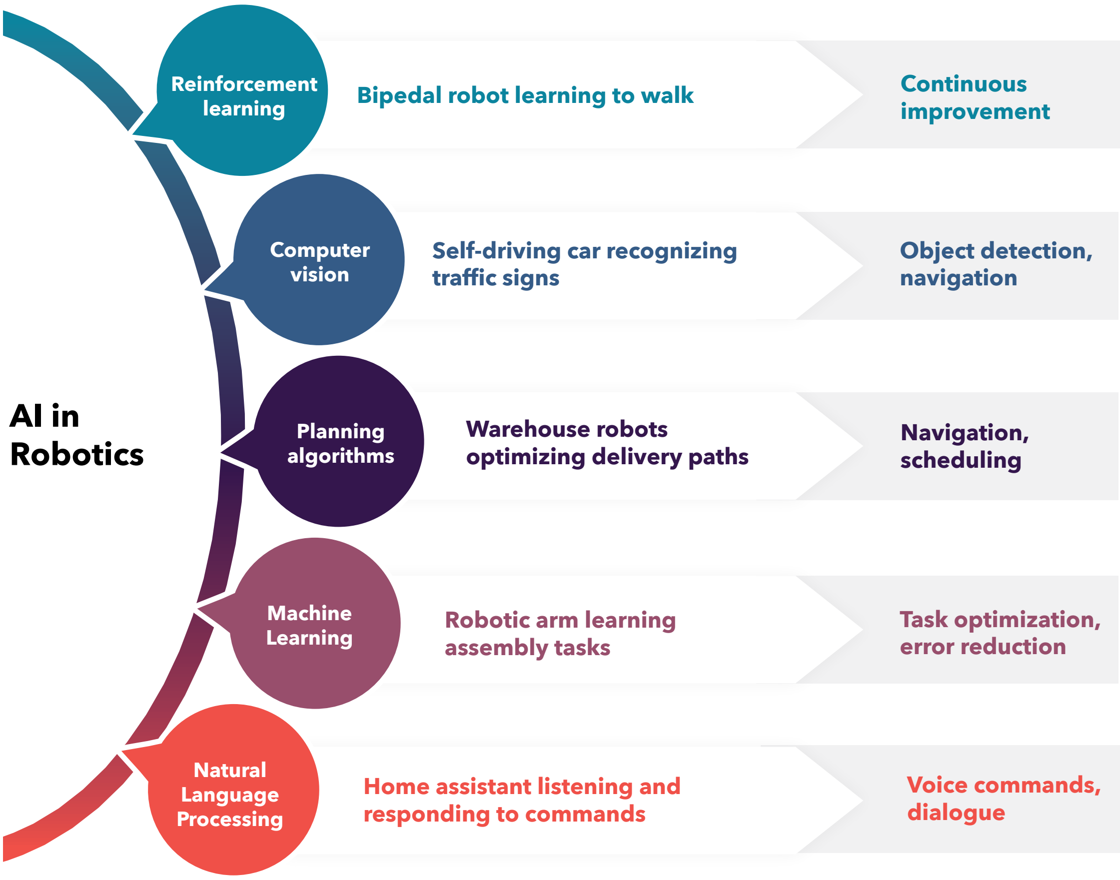
[47] Marin Ivezic, "The dual risks of AI autonomous robots: uncontrollable AI meets cyber-kinetic risks", Securing.AI, 7 April 2024.

[48] Kavyanjali Reddy and others, "Advancements in robotic surgery: a comprehensive overview of current utilizations and upcoming frontiers", *Cureus*, vol. 15, No. 12 (December 2023).

[49] Ivezic, "The dual risks".

[50] Josip Tomo Licardo, Mihael Domjan and Tihomir Orehovački, "Intelligent robots – a systematic review of emerging technologies and trends", *Electronics*, vol. 13, No. 3 (January 2024).

Figure 3: How AI is embedded in robotics



Advances in humanoid robots, or robots designed to resemble the human body, such as Boston Dynamics' Atlas and SoftBank's Pepper, have additionally resulted in increased mobility, dexterity and human-robot interaction capabilities.[51] Humanoid robots are equipped with bipedal locomotion and imitate human dexterity, and sales are expected to reach more than 250,000 by 2030.[52] Amazon is currently supporting Agility Robotics in producing 10,000 units of its robot Digit every year, while Tesla is continuing to research and develop Optimus Gen 2, which can reportedly dance and care for eggs without cracking them.[53] In addition to the private sector, numerous governments are investing heavily in this technology, supporting its mainstream production by 2025.[54] These robots are increasingly being deployed in customer service, education, eldercare and space exploration. For example, the National Aeronautics and Space Administration (NASA) introduced the first bipedal humanoid robot, named Valkyrie, in 2013. Entirely innovative in its design, Valkyrie can run from either battery power for an hour or be configured to run from a wall.[55] It can replace humans in conducting high-risk tasks in space such as equipment maintenance, while on earth it can be used to conduct remote caretaking of unscrewed and offshore energy facilities.[56]

---

51 Kinza Yasar, "Top 6 examples of humanoid robots", TechTarget, 14 June 2024.
52 Jacqueline Du and others, *Humanoid robot: the AI accelerant* (Goldman Sachs, 2024), p. 6.
53 Ivezic, "The dual risks".
54 International Federation of Robotics, "Top 5 robot trends in 2024", press release, 15 February 2024.
55 National Aeronautics and Space Administration, "Valkyrie: NASA's First Bipedal Humanoid Robot" (fact sheet), June 2023. Available at https://www.nasa.gov/wp-content/uploads/2023/06/r5-fact-sheet.pdf.
56 National Aeronautics and Space Administration, "NASA Humanoid Robot to Be Tested in Australia", NASA (Johnson Space Center Office of Communications), 6 July 2023. Available at https://www.nasa.gov/centers-and-facilities/johnson/nasa-humanoid-robot-to-be-tested-in-australia/.

AI for Good in focus: Advancements in vision-based robots

"Perception, also called computer vision, is making mobile robots autonomous."

- Davide Scaramuzza, University of Zurich.

Cutting-edge advancement of vision-based, autonomous drones has widespread real-world applications. The 2024 AI for Good Global Summit featured a presentation from Davide Scaramuzza, professor of Robotics and Perception at the University of Zurich, to showcase how developments in computer vision and agility can allow AI-powered drones to potentially out-perform human pilots. Additionally, AI empowers researchers to simulate a vast amount of flight data, up to hundreds of thousands of drone flights in one night, to train perception and control algorithms at an accelerated rate to rapidly advance drone performance.[57]

Currently, control challenges and short maximum flight durations of 20 to 30 minutes restrict the mobility and range of commercial drones, limiting their application potential. Scaramuzza's team challenged these boundaries by developing Swift – a highly agile drone capable of accelerating from 0 to 100 km an hour in less than one second. By utilizing ML and onboard computers, the drone is able to achieve complex manoeuvres without human operation, and has even beat world champions in several head-to-head races.[58]

The ability of robots to navigate using cameras and onboard computing to map their environments without relying on GPS enables broader worldwide deployment, especially in areas with limited or no satellite coverage. Research from Scaramuzza's team has enabled new applications of vision-based drones for humanitarian well-being. Examples include Suind, a company that utilizes drones with onboard prescription for crop monitoring and wildfire prevention, and Fotokite, a company that develops autonomous tethered drones to provide situational awareness for public safety teams during emergencies.

57 Celia Pizzuto, "From Labs to Skies: The Promise of Vision-Based Drones", AI for Good, n.d. Available at https://aiforgood.itu.int/from-labs-to-skies-the-promise-of-vision-based-drones/.

58 Elia Kaufmann and others, "Champion-level drone racing using deep reinforcement learning", *Nature*, vol. 620 (August 2023), pp. 982–987.

AI could be one of the ingredients to revolutionize the way the spectrum is accessed. And maybe, in the future, that could lead to big paradigm shifts whereby we don't have licensed spectrum anymore, but it's all free to be used by society in an efficient manner."

– Francesc Wilhelmi, Nokia Bell Labs

4.3 AI for communications networks

The development of 5G technology has had a significant impact on the growth of mobile networks, greatly improving connectivity and network performance. This development opens up a wide range of applications, including 3D video streaming, virtual and augmented reality, smart cities and remote medical services. Mobile networks have evolved dramatically over the past five decades, undergoing a profound transformation from analog technology to the anticipated arrival of 6G. This technological advancement has fuelled the rise of new services such as mobile banking, e-commerce and e-government, while creating employment opportunities across various sectors. Moreover, it has strengthened the capacity of governments and helped to bridge the urban-rural digital divide. Looking ahead, the integration of AI into mobile networks presents a unique opportunity to reduce digital disparities, drive economic growth and advance the SDGs.

5G networks represent the latest evolution of wireless technology, capable of processing large volumes of data with reduced latency. Designed to deliver data rates up to 100 times faster than 4G Long Term Evolution, 5G supports connectivity for up to 1 million devices per square kilometre, making it a crucial enabler for the IoT.[59] 5G, by leveraging edge computing, network slicing and cloud-based technologies, can promote the development of smart cities, industrial automation, autonomous vehicles and remote healthcare, among other advancements.

AI has the potential to become a critical component in modern communications networks, increasing efficiency, security and user experience. AI native networks can help detect and respond to security threats by identifying anomalies and potential attacks in real-time. AI may also be able to identify optimal locations for 5G cell sites based on criteria such as terrain, network coverage and population density.[60] Furthermore, it can provide a better understanding of interactions between neighbouring devices and optimize power consumption by adjusting network resources according to usage patterns, potentially reducing both carbon footprints and operational costs for network providers.[61]

Developments in AI for 5G networks are progressing slowly in comparison to other AI use cases, due to gaps in research and development and a lack of deployment in practice.[62] However, as AI

59 ITU Online, "What is 5G?". Available at https://www.ituonline.com/tech-definitions/what-is-5g (accessed on 14 February 2025).
60 National Instruments, "The future of 5G and AI in telecommunications", 13 May 2024.
61 Flexential, "The impact of AI and machine learning on data centers", 29 August 2024.
62 This is according to several international observers interviewed by UNU researchers between September and December 2024.

evolves, its role in 5G networks will grow, driving innovations in automation, security and energy efficiency.[63] As 6G technologies, which are predicted to be 100 times faster than 5G networks, advance, new applications and capabilities for AI in network optimization may emerge.

Table 6: Inserting AI into different functions of a 5G or 6G network

Function	Traditional network approach	AI-enhanced approach
Traffic management	Static routing policies, manual congestion monitoring	Predictive traffic routing using real-time analytics; dynamic bandwidth allocation
Network fault detection	Rule-based alerts, manual diagnostics	Anomaly detection using ML; automated root cause analysis
Resource allocation	Fixed bandwidth and frequency assignments	AI-driven spectrum allocation and resource scheduling based on demand forecasting
Energy efficiency	Continuous power usage regardless of load	AI-controlled sleep modes and energy-aware routing for base stations and data centers
Security and intrusion detection	Signature-based detection, reactive measures	Behavioural analysis, threat prediction and real-time AI-driven threat response
Self-healing networks	Manual fault resolution and backup configuration	Autonomous network healing and reconfiguration through AI decision systems
Network planning and expansion	Historical usage data and expert input	AI-assisted network planning using demand prediction, demographic and device usage data
Customer support and troubleshooting	Call centre diagnostics and scripts	Virtual agents and predictive troubleshooting based on historical case resolution

Spectrum management refers to the process of efficiently managing and utilizing radio spectrum to its fullest extent, particularly for the public good, such as weather observation, air traffic control and national defence.[64] The emergence of new AI applications, growing reliance on mobile data, and

[63] Interview with Francesc Wilhelmi, Research Engineer in the Radio Systems Research Group at Nokia Bell Labs. Interview conducted via videoconferencing technology, 28 October 2024.

[64] United States Government Accountability Office, *Spectrum Management: Agencies Should Strengthen Collaborative Mechanisms and Processes to Address Potential Interference* (Washington DC, 2021).

Figure 4: AI for communications networks

increased network density have all contributed to the demand for spectrum, which is a scarce and precious resource. Global 5G deployment, which is rapidly expanding, is increasing the demand for spectrum bands across low-, mid- and high-band frequencies – signalling a need for more efficient spectrum management.[65] Currently, wireless spectrum management is governed by a patchwork of complex regulatory frameworks and policies; however, a growing degree of interdependency and bias precludes its efficient allocation and use.[66]

AI and ML tools can play a key role in transitioning to automated dynamic spectrum management in comparison to the existing model of manual frequency assignment.[67] AI tools, for example, can be used to promote optimal spectrum allocation while also predicting future demand for frequencies, and can suggest strategies for allocation, allowing regulators to make more informed decisions.[68] They can also be used to analyse real-time data to identify network usage and performance, in order to detect cases of unauthorized use, and suggest solutions for spectrum sharing arrangements that can maximize efficiency and reduce interference. Both the United Kingdom and the United States have investigated this potential, recognizing its practical and legal implications; elsewhere, other countries have also expressed optimism at the prospect of incorporating AI to address the challenge of spectrum scarcity.[69]

65 Digital Regulation Platform, "Spectrum management: key applications and regulatory considerations driving the future use of spectrum", 25 April 2025.
66 Networking and Information Technology Research and Development Program and the Wireless Spectrum R&D Interagency Working Group, "Artificial intelligence: wireless spectrum opportunities and challenges", 2019 Workshop Report (November 2020), p. 1.
67 Ibid.
68 Ibid.; Paul Waite, "What is the impact of AI on telecom spectrum management?", Wray Castle, 3 January 2025.
69 Ofcom, "Opportunities for dynamic or adaptive approaches to managing spectrum in the UK", Discussion Paper (London, March 2023); Federal Communications Commission (FCC), "Artificial intelligence and other technologies in the management of the radio spectrum: notice of inquiry", FCC 23–60, August 2023. Available at https://docs.fcc.gov/public/attachments/FCC-23-60A1.pdf; India, Telecommunication Engineering Centre, "AI in spectrum management", 2021 March.

AI for Good in focus: AI integration in telecommunication networks

"The networks industry is seeing a transition from a top-level approach where AI is built on top of an existing network to an AI-native system where AI is built right into the network."

- Abhishek Dandekar, Fraunhofer Heinrich Hertz Institute.

The AI for Good webinar, "Convergence of AI and Telecommunications Technologies,"[70] presents global trends in research on AI and ML use cases for telecommunications. Akihiro Nakao, Professor of Applied Computer Science at the University of Tokyo, discussed advancements in research and trending topics around AI integration into telecommunication networks.

Nakao identified energy efficiency, low latency, resilience and open architecture as dominant themes in international discussions around advancing telecommunications ecosystems with AI. Emerging low power consumption opportunities, such as microsleep and deep sleep functions to flexibly turn off base station functions during low traffic periods, are attractive AI-driven features for telecommunications operators to reduce energy expenditure. Nakao also pointed out that telecommunication companies are increasingly investing in edge AI computing due to its ability to improve Radio Access Network (RAN) evolution and support low latency interference from collected data.

Nakao further highlighted that ML models successfully predicted traffic flow with over 90 per cent accuracy, demonstrating how reinforcement learning-based AI features can optimize resource allocation within 5G networks. Additionally, new research conducted by Nokia revealed that AI-native interfaces increased network performance in terms of throughput by 30 per cent and energy efficiency by up to 20 per cent.[71]

70 International Telecommunication Union, "Convergence of AI and telecommunications technologies", AI for Good. Available at https://aiforgood.itu.int/event/convergence-of-ai-and-telecommunications-technologies/.

71 Osman Yilmaz, "Leading AI-native 6G innovation from concept to patent portfolio", Nokia, 26 March 2025.

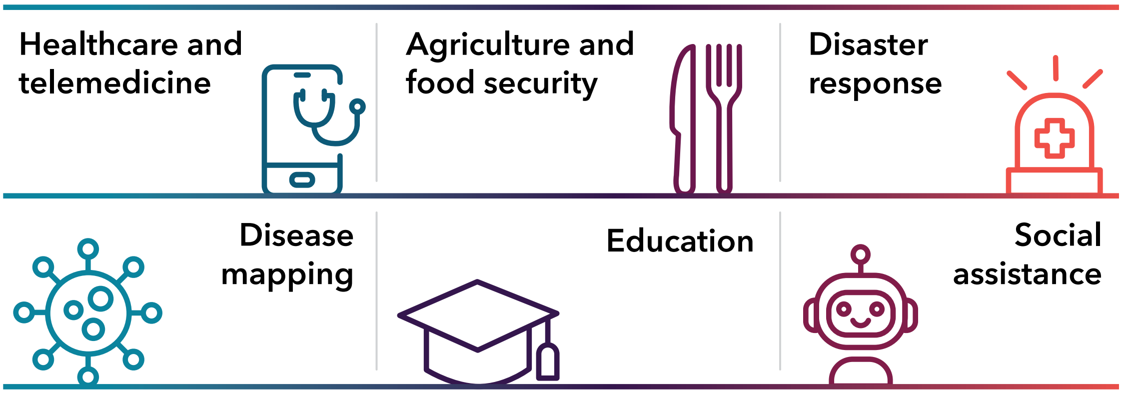
5

Applications for human and planetary well-being

5.1 AI for human well-being

Human well-being is a field that explores the conditions and capabilities necessary for individuals and communities to thrive. Drawing from disciplines such as human development and sociology, it can encompass subjective experiences such as happiness and life satisfaction, as well as objective indicators such as health, education and social inclusion. This section explores the potential of AI for human health, food security, disaster response, disease monitoring, education and social support. While these are not the only uses of AI for human well-being, they represent areas where AI tools have been shown to have significant potential, if deployed responsibly.

Figure 5: Applications of AI for human well-being



5.1.1 Healthcare and telemedicine

Recent years have seen a dramatic rise in the use of SARs in the field of healthcare and well-being services, primarily driven by advancements in AI. SARs are being employed to address global health challenges, which came to the fore during the COVID-19 pandemic and with shifts in the demographic curve of developed countries towards an ageing population. The United Nations estimates that by 2050, one in six persons will be over 65 years of age.[72] Countries globally have experienced care worker shortages and burnout, raising concerns about their capacity to respond to health crises. SARs have been explored as a partial solution, as they hold out the promise of providing scalable and cost-effective support across a wide range of health and care domains. Indeed, the global market for medical robots is expected to reach $52.41 billion by 2032, with an estimated growth rate of 15.69 per cent.[73]

SARs can be used to address global health and well-being challenges aligned with the SDGs, particularly SDG 3 (good health and well-being) and SDG 10 (reduced inequalities). In Japan, for example, robots have increasingly been used in nursing homes to help care for the country's ageing population, albiet with mixed, yet promising results.[74] Robots have also been used in low-income countries to deliver physiotherapy and rehabilitation services.[75]

---

72 *World Social Report 2023: Leaving No One Behind in an Ageing World* (United Nations publication, 2023), p. 17.

73 Standard Bots, "The future of robotics in healthcare: automating the industry", 28 April 2025. Available at https://standardbots.com/blog/the-future-of-robotics-in-healthcare-automating-the-industry.

74 Yong Suk Lee, Toshiaki Iizuka and Karen Eggleston, "Robots and labor in nursing homes", *Labour Economics*, vol. 92 (January 2025).

75 Michelle Johnson and others, "Affordable stroke therapy in high-, low- and middle-income countries: From Theradrive to Rehab CARES, a compact robot gym", *Journal of Rehabilitation and Assistive Technologies Engineering*, vol. 4 (June 2017).

AI for Good in focus: AI-powered wearable robots providing personalized assistance for mobility

Breakthroughs in lower limb exoskeletons that use deep learning have led to exoskeletons being able to provide personalized assistance, particularly for senior individuals. On 5 March 2025, the AI for Good platform convened a webinar showcasing research from Dr. Aaron Young, Associate Professor and Woodruff Faculty Fellow at Georgia Tech's Woodruff School of Mechanical Engineering, and Director of the Exoskeleton and Prosthetic Intelligent Controls Lab. The webinar spotlighted the ability of temporal convolutional neural networks that can process real-time sensor data such as encoders, joint angles, velocities and inertial measurement units at 200 Hz to directly predict internal joint movements. This new breakthrough can support dynamic torque adjustments in exoskeletons, without requiring task-specific calibration. Promisingly, this technique resulted in a 14 per cent reduction in metabolic cost during walking and lifting tasks, exceeding standard State-based controllers by adapting to each user's unique biomechanical characteristics.

The utilization of open-source datasets enables task-agnostic control for 29 different activities, including walking, ramp ascent and descent, and stair climbing. The webinar noted that this eliminates the need for manual controller calibration, while staying in sync with user intent by concentrating on internal physiological cues. While the webinar acknowledged current challenges such as device weight and the complexities of real-world deployment, it also pointed to promising future directions for lighter, clothing-integrated systems with broader clinical applications, including post-stroke rehabilitation. These advancements make a significant contribution to wearable robots by addressing the challenge of generalizing across numerous activities while overcoming the limits of standard control systems. They also open the way for more user-friendly, plug-and-play exoskeletons that can be effortlessly integrated into daily life, allowing individuals to move freely and independently.

In response to the COVID-19 pandemic, UNDP deployed smart anti-epidemic robots in collaboration with the Government of Rwanda, which could screen between 50 and 150 people per minute and were used to distribute food and medication to patients.[76] Elsewhere, SARs have also been used to assist with cognitive support of the elderly, providing them with reminders to take medication and helping to improve their quality of life.[77] Furthermore, exoskeletons and robotic walkers have been shown to help disabled individuals perform daily activities, including walking and climbing stairs, reflecting a growing interest and engagement in the field of robotics for human mobility.[78]

76 UNDP, "UNDP and Government of Rwanda deploy smart anti-epidemic robots to fight against Covid-19!", 21 May 2020.

77 Softbank Robotics, " Meet Pepper: The robot built for people". Available at https://us.softbankrobotics.com/pepper (accessed on 14 February 2025).

78 Sebin Choi, "South Korean team develops 'Iron Man' robot that helps paraplegics walk", Reuters, 23 December 2024.

Indeed, neurological AI has been used to analyse signals received from humans to decode muscle or brain activity, and use such data to detect mobility-challenged patients' intentions to move.[79]

While robotics is not the only use for AI in medicine, it represents a promising advance in the field, amplifying the work of doctors (as in the case of rehabilitation technologies) and enhancing medical capacity where needed. This capability is especially important in the Global South, where the use of robots in medicine can reduce disease burden while potentially improving access to robotic telesurgery and medical care in remote and underserved regions, as in Rwanda, where the French Research Institute against Digestive Cancer opened an institute in Kigali that trains surgeons in robot-assisted surgery.[80]

AI for Good in focus: Exoskeletons for rehabilitation

AI-powered exoskeletons provide mechanical support that enables people with gait and mobility issues to stand and walk again. This robotic technology is transforming the field of rehabilitation by allowing patients and therapists to experiment with a diverse range of treatments and therapies, while improving rehabilitation training sessions. Exoskeletons can also provide customizable assistance and monitoring features, allowing clinicians to easily track functional progress and develop personalized treatment plans that maximize treatment productivity while minimizing training time.

Atalante X is the world's first self-balancing, hands-free autonomous exoskeleton for rehabilitation support following a stroke or spinal cord injury. Produced by the French robotics company Wandercraft, the exoskeleton includes self-balancing features, multi-directional locomotion for task-oriented treatment and custom adjustable assistance that enables patients to gradually increase their motor function through continuous care. Nearly 100 units of Wandercraft exoskeletons are in use at rehabilitation institutions and clinical research centres in the United States, Europe and Brazil today.[81]

79 Interview conducted via videoconferencing technology with Olivier Lambercy, Adjunct Professor and Deputy Director of the Rehabilitation Engineering Laboratory at ETH Zurich, October 2024.

80 Amos Matsiko and Bradley J. Nelson, "Robotics and AI in the Global South", *Science Robotics*, vol. 8, No. 8 (December 2023).

81 Wandercraft, "Medical robotics company Wandercraft receives €25 million in financing from EIB to advance self-balancing exoskeletal technology", press release, 3 April 2024.

Studies have shown that early mobilization and verticalization through frequent rehabilitation sessions can result in improved functional recovery and decrease the risk of complications relating to loss of mobility.[82] From standing up to relearning how to walk, Atalante X claims to empower patients to regain the ability to walk in the early stages of their care. AI-powered multi-directional walking algorithms allow the exoskeletons to mimic human movement and help patients to relearn their natural walking pattern.

Exoskeleton users can reclaim their independence by engaging in daily activities, such as movement and exercise, to enhance their quality of life. The adoption of this assistive technology demonstrates a growing demand for personalized healthcare solutions that optimize treatment plans according to patients' specific needs and conditions. As AI-powered exoskeletons become more prevalent in therapeutic treatment, policies that regulate robotics in healthcare ought to impose standards for rigorous testing to ensure the devices are reliable and safe.

5.1.2 Agriculture and food security

The World Food Programme (WFP) estimates that approximately 343 million individuals in 74 countries are facing acute hunger, with 1.9 million individuals experiencing catastrophic hunger.[83] In 2022, 2.4 billion people globally endured moderate to severe food insecurity, and FAO estimates that 582 million individuals worldwide will be malnourished by the end of this decade, with Africa accounting for roughly half that number.[84] These combination of external factors such as geopolitical conflicts, trade wars, migration, global inequality and the risk of economic recession have prompted the United Nations to proclaim food insecurity a global crisis.[85] As of April 2025, food prices had risen 7.6 per cent from the previous year, with domestic food price inflation remaining considerably high in low-income countries.[86] Restrictions on global food and fertilizer trade, forecasts of economic stagnation and the risk of extreme weather events such as droughts, floods and severe storms (along with a projected global temperature rise of 1 to 2°C) have made the prospect of achieving SDG 2 (zero hunger) increasingly unlikely. Indeed, global food demand is expected to increase by 35 per cent to 65 per cent between 2010 and 2050, putting an additional strain on scarce resources, and threatening the food security of millions.[87]

82 Julie Bernhardt and others, "Prespecified dose-response analysis for A Very Early Rehabilitation Trial (AVERT)", *Neurology*, vol. 86, No. 23 (June 2016); Gereon Nelles, "Cortical reorganization – effects of intensive therapy", *Restorative Neurology and Neuroscience*, vol. 22, No. 3-5 (May 2004).

83 WFP, "A global food crisis". Available at https://www.wfp.org/global-hunger-crisis (accessed on 5 May 2025).

84 United Nations, "Sustainable Development Goals, Goal 2: zero hunger". Available at https://www.un.org/sustainabledevelopment/hunger (accessed on 14 February 2025); FAO, IFAD, UNICEF, WFP and WHO, *The State of Food Security and Nutrition in the World 2024 – Financing to End Hunger, Food Insecurity and Malnutrition in All Its Forms* (Rome, 2024), p. xvi.

85 Food Security Information Network, *2024 Global Report on Food Crises* (Rome, WFP, 2024).

86 FAO, "World food situation". Available at https://www.fao.org/worldfoodsituation/foodpricesindex/en (accessed on 5 May 2025); World Bank, "Food security update", 14 February 2025.

87 C. Béné and others, "Global Drivers of Food System (Un)sustainability: A Multi-Causal Analysis", *Nature Food,* vol. 2, No. 8 (April 2021), pp. 586–596.

The incorporation of AI into geospatial analysis has helped address and mitigate some of these risks. Through the use of satellite imagery, drones, remote sensing and deep learning models, GeoAI can equip farmers and decision makers with the tools needed to build resilient and sustainable agricultural systems.[88] GeoAI tools have provided instantaneous and granular insights into farming processes through the monitoring of crop health, soil quality, weather patterns, water usage and pest outbreaks.[89] Furthermore, satellite imagery, drones and connected devices have made it possible to employ high-resolution imagery to track crop health in all weather conditions, augmented with field imagery to provide real-time assessments and additional layers of data for analysis.[90]

GeoAI has also been utilized to address critical challenges such as inequity, waste and resource management by developing climate-resilient crop varieties that can withstand drought, heat or salinity.[91] This can serve as a safety net for farmers, decreasing the stress and financial burden caused by unpredictable climate disruptions. For example, the Government of Uganda has used statistical models that analyse ground observations and satellite-based data to assess historical drought-induced crop failures and establish predetermined hazard thresholds to scale up disaster risk finance.[92] In India, startups leverage AI and on-farm sensors and devices to deliver targeted insights to farmers based on their specific geography, crops and stages of agricultural development, lowering costs and improving crop yields.[93] Additionally, FAO's geospatial platform, Hand in Hand, leverages satellite-derived analytics and data to contribute to rural development and to drive digital agricultural transformation. These applications are part of FAO's broader initiative to harness geospatial technologies for early warning systems and resilience building in agriculture.

In the field of agriculture, autonomous drones and robotic harvesters can be used to optimize crop yields and reduce resource consumption, thereby contributing to global food security.[94] As improvements in batteries and fuel cells continue, alongside the miniaturization of LLMs and large visual models (LVMs), coming years will see rapid developments in robotics that can reduce the barrier of entry and improve human-machine interaction.[95]

88 Bushra Zaman, "GeoAI: pioneering the future of food security – how AI and GIS are revolutionizing global agricultural resilience", GeoAI Insights, LinkedIn, 28 August 2024. Available at https://www.linkedin.com/pulse/geoai-pioneering-future-food-security-how-ai-gis-revolutionizing-oslkc; GeoAI Group, "Crop monitoring using Earth observation", 30 March 2025.

89 Taylor Geospatial Institute, "TGI Challenge: harnessing geospatial innovation for a more food-secure future", 11 December 2024; Sakshi Singh, "Empowering smart agriculture with GeoAI in India", AGI India, 15 January 2025.

90 Ibid.

91 Taylor Geospatial Institute, "TGI Challenge"; Zaman, "GeoAI".

92 United Nations Framework Convention on Climate Change and Group on Earth Observations, *Realising Early Warnings for All: Innovation and Technology in Support of Risk-Informed Climate Resilience Policy and Action* (Bonn, United Nations Climate Change Secretariat, 2024), p. 35.

93 Ravikant Swami, Poorva Ranjan and Khushbu Khurana, *Agro-Entrepreneurship Startup in India: Case Bank* (Next Gen Publications, 2023); L. Badri Narayanan, Gaurav Dayal and Sarang Dublish, "Agritech: a much-needed digital revolution for the agri sector", in *LKS in Focus: Farm to Food: Key Trends and Regulatory Outlook in Agritech* (Lakshmikumaran & Sridharan, March 2021).

94 G. Nagaraja and others, "The impact of robotics and drones on agricultural efficiency and productivity", *International Journal of Research in Agronomy*, vol. 7, Special Issue 9 (2024).

95 Interview conducted via videoconferencing technology with Davide Scaramuzza, Professor and Director of Robotics and Perception Group at University of Zurich, October 2024.

Figure 6: Agriculture and food security

AI for Good in focus: GeoAI and the digital transformation of agriculture, water and food systems

On 21 September 2022, the AI for Good platform conducted a webinar showcasing GeoAI's critical role in enhancing sustainable agriculture, water management and food security.[96] The webinar was delivered by Yanbo Huang, Research Agricultural Engineer at the United States Department of Agriculture's Agricultural Research Service, Genetics and Sustainable Agriculture Unit in Mississippi, and Zhongxin Chen, Senior IT Officer in the Digitalization and Informatics Division at FAO. The speakers explored the evolution of agricultural information technology and its use in precision to guide smart agriculture, focusing on the increasing use of ML, deep learning with explainable AI, reinforcement learning for crop control, and generative adversarial networks for image augmentation. The presenters noted how AI is used for real-time decision-making, with unmanned aerial vehicles (UAVs), satellite imagery and IoT sensors monitoring crop health, soil conditions and water-use efficiency. The speakers emphasized the need for developing interoperable AI models which can convert data-driven insights into actionable and effective farming techniques, hence increasing trust and usability.

The webinar also highlighted the research and applications of GeoAI across various regions and scales, including FAO's Hand-in-Hand Geospatial Platform, which standardizes data for global agricultural monitoring. It demonstrated how combining multiple data sources can support comprehensive agro-environmental monitoring to boost productivity, profitability and sustainability in both agricultural and water resource management. The speakers also discussed the application of generative adversarial networks and diffusion models for augmenting agricultural imagery to address challenges such as overcoming data scarcity in training AI models for pest and disease detection, yield forecasting and responding to global issues like climate change and labour shortages.

Furthermore, the webinar illustrated how AI enables damage assessments such as post-hurricane crop loss evaluations, and supports water productivity mapping using tools such as FAO's WaPOR platform. It encouraged open innovation through initiatives such as ITU's GeoAI Challenge, and emphasized the significance of ethical AI deployment aligned with the principles of transparency and equity. The webinar emphasized the opportunity provided by cloud-based tools and affordable UAVs to help remove obstacles to data access and foster greater inclusivity. Through integrating domain-specific agricultural expertise with cutting-edge AI technologies, the webinar outlined a roadmap towards a more scalable, climate-resilient agriculture that empowers stakeholders ranging from researchers to policymakers.

96 International Telecommunication Union, "GeoAI and the digital transformation of agriculture, water and food systems", AI for Good. Available at https://aiforgood.itu.int/event/geoai-and-the-digital-transformation-of-agriculture-water-and-food-systems/.

"The most significant shift I see is in our capacity to analyse geospatial data with unprecedented speed and scale during emergencies. Moving from traditional GIS to a semi-automated GeoAI solution isn't merely an upgrade—it's a fundamental transformation of our emergency response ..."

– Rohini Sampoornam Swaminathan, UNICEF

5.1.3 Disaster response

Between 2000 and 2019, the United Nations Office for Disaster Risk Reduction (UNDRR) estimated a record number of global catastrophic disasters, with the majority of the resulting deaths occurring in developing countries.[97] Sudden-onset disasters lead to the displacement of 25 million people globally each year and cause billions of dollars in damages that disproportionately impact low- and middle-income countries.[98] The United Nations estimates that economic losses from global disasters increased sevenfold between the 1970s and 2010s.[99] Climate change has also increased the frequency and severity of global disasters. This has had a variety of consequences, including increasing the vulnerability of low-lying megacities and deltas in countries such as Bangladesh, the Maldives and the Philippines.

Research indicates that the last-mile portion of medical delivery systems in low- and middle-income countries is often costly and inefficient, resulting in delayed access to blood and emergency medical supplies, negative health outcomes and many preventable deaths for women, children and residents of rural communities. To address this issue, AI-powered UAVs, commonly known as drones, are now being used to deliver critical healthcare supplies to hospitals and medical centres. Drones can overcome challenging terrain and limited infrastructure to rapidly deliver lifesaving medications and supplies, including blood samples, gloves, oxytocin, vaccines and other types of medication. For instance, Zipline, a company based in the United States, has been providing a 24-hour medical commodity service in hard-to-reach parts of Africa since 2016. Zipline's drones can make up to 600 on-demand delivery flights daily and serve about 22 million people across over 2,000 healthcare facilities in sub-Saharan Africa.[100]

97 Centre for Research on the Epidemiology of Disasters and UNDRR, "Human cost of disasters: an overview of the last 20 years, 2000–2019", 2020, pp. 7, 23.

98 UNDRR, "Words into action: disaster displacement: how to reduce risk, address impacts, and strengthen resilience". Available at https://www.undrr.org/words-into-action/disaster-displacement-how-reduce-risk-address-impacts-and-strengthen-resilience (accessed on 15 May 2025); UNDRR, "Disaster risk reduction in least developed countries". Available at https://www.undrr.org/implementing-sendai-framework/sendai-framework-action/disaster-risk-reduction-least-developed-countries (accessed on 14 February 2025).

99 United Nations, "Climate and weather related disasters surge five-fold over 50 years, but early warnings save lives – WMO report", 1 September 2021.

100 Information in this and the following paragraph is drawn from O. Atiga and others, "Shortening the last-mile: impact of Zipline Medical Drone Delivery on the operations of hard-to-reach healthcare facilities in northern Ghana", *African Journal of Applied Research*, vol. 10, No. 1 (2024).

AI-powered drones are delivering critical healthcare supplies efficiently and cost-effectively - overcoming challenging terrain and limited infrastructure.

Figure 7: Drones for humanitarian aid

AI-powered UAVs can provide last-mile medical deliveries in low- and middle-income countries by providing extended emergency resource delivery and dispatch, regardless of topographic and infrastructural obstacles. UAVs utilize AI to analyse weather conditions, terrain and air traffic restrictions to determine optimal flight paths for deliveries, monitor opportunities to improve flight systems and make real-time decisions to reduce the risk of accidents. They also have widespread potential to lead global immunization campaigns and increase vaccination rates in last-mile health facilities in developing countries due to their high-speed logistical efficiency and reduced lead time.

AI for Good in focus: Integrating AI into Geographic Information Systems workflows

"AI really helps us see things that we can't see [in an image or in text] to help us learn new workflows in each model. […] It helps accelerate our reading capabilities, analysis and creation of different layers."

- Rami Alouta, ESRI.

AI is primarily used in geospatial analysis in two key ways: (1) enhancing GIS workflows by rapidly automating data extraction at scale, and (2) powering AI assistants and agents that understand user intent, generate insights, perform GIS tasks and create geospatial content. The AI for Good webinar, "Unlocking the Power of Geospatial Artificial Intelligence for humanitarian use cases,"[101] explores how GeoAI solutions can accelerate geospatial analysis across a wide range of applications. In this session, Rami Alouta, Geospatial Enterprise Systems Expert at ESRI, explained how AI integrates complex ML and deep learning workflows to enable cohesive analysis of large-scale geospatial data.

Over 150 pre-trained models and foundational models to create, manage and analyse spatial and geographic data are currently available on ArcGIS, a growing open-source deep learning library developed by ESRI.[102] These models provide powerful, ready-to-use tools, such as flood detection, imagery and remote sensing, and time-series forecasting, that allow users to leverage AI to prevent and mitigate humanitarian harms. Object detection and text extraction features accelerate the analysis of multidimensional models to uncover hidden insights that enhance decision-making and support timely intervention.

5.1.4 Disease mapping and monitoring

Despite significant improvements in the health of the global population, disease outbreaks and pandemics have become increasingly frequent and severe, leading to significant global health and economic impacts. For instance, 44 countries have experienced a tenfold increase in infectious diseases since the beginning of 2022 compared to a pre-pandemic baseline.[103] Climate change,

101 International Telecommunication Union, "Unlocking the power of geospatial artificial intelligence (GeoAI) for humanitarian use cases", AI for Good. Available at https://aiforgood.itu.int/event/unlocking-the-power-of-geospatial-artificial-intelligence-geoai-for-humanitarian-use-cases/.

102 "Unlocking the Power of Geospatial Artificial Intelligence (GeoAI) for humanitarian use cases", AI for Good webinar, 16 September 2024.

103 Jane Feinmann, "Analysis reveals global post-covid surge in infectious diseases", *BMJ*, vol. 385, No. q1348 (18 June 2024).

Geospatial AI can track disease spread, identify hotspots and inform public health interventions by combining geospatial data with traditional ML and deep learning techniques.

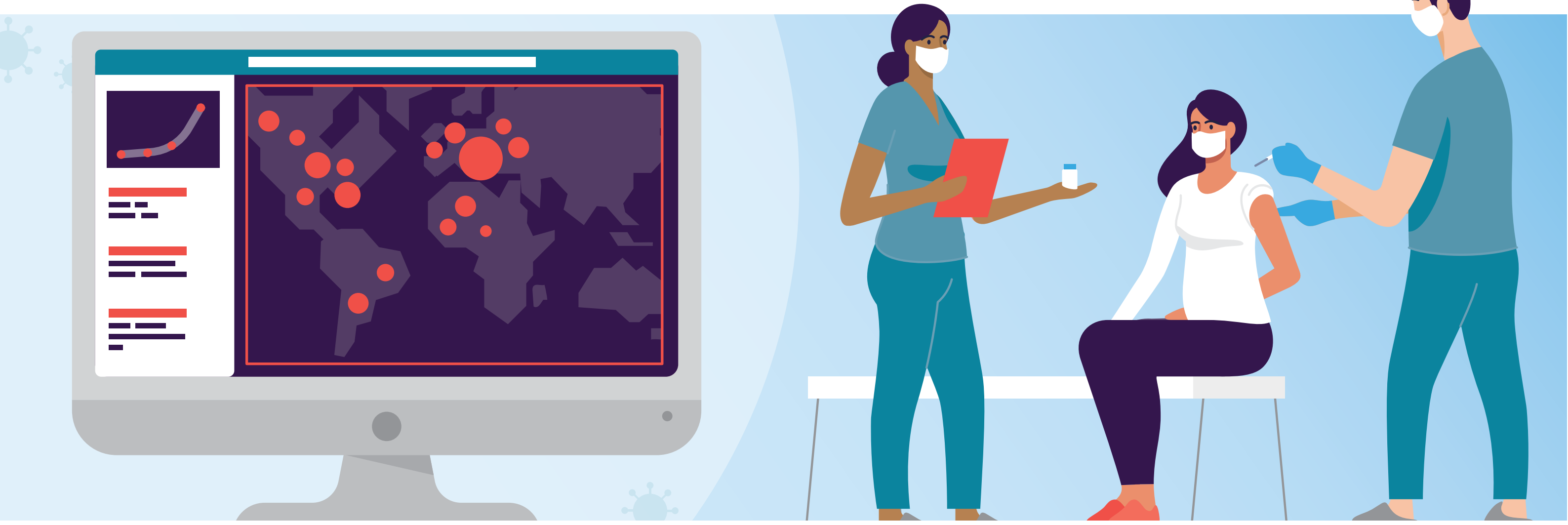


Figure 8: Disease mapping tools

urbanization and global travel are factors contributing to the spread of infectious diseases, with vector-borne diseases like malaria and dengue fever surging in the past decade.[104] The COVID-19 pandemic alone had infected more than 700 million people and caused 7 million deaths as of August 2024, reversing over a decade of gains in life expectancy.[105] Vulnerable populations such as migrants and refugees are most at risk as they receive only limited access to healthcare and experience high rates of exposure to communicable diseases.[106]

GeoAI can track disease spread, identify hotspots and inform public health interventions by combining geospatial data with traditional ML and deep learning techniques. By combining spatial data and maps with demographic, environmental and healthcare information, GeoAI can accurately and effectively visualize epidemiological trends and patterns, while identifying areas with high disease prevalence.[107] For instance, GeoAI can analyse environmental data such as population density, air quality and access to health services to inform disease prevention strategies.[108] Through its ability to efficiently model and predict disease outbreaks such as malaria and dengue fever, GeoAI can also be used to improve public health responses and provide evidence-based support for treatment plans.[109] During the COVID-19 pandemic in 2020, the United Nations Global Pulse initiative explored using GeoAI to track infection rates, model transmission patterns and optimize vaccine distribution in low-resource settings.[110] Elsewhere, scientists relied on social media data as a complementary resource to natural language processing and ML to track the transmission and trajectory of the COVID-19 pandemic in the United Kingdom.[111]

104 WHO, "Dengue – global situation", 21 December 2023; WHO, *World Malaria Report 2024: Addressing Inequity in the Global Malaria Response* (Geneva, 2024), p. xvi.

105 Karen Feldscher, "The next pandemic: not if, but when", Harvard T.H. Chan School of Public Health, 12 September 2024; United Nations, "Health". Available at https://www.un.org/en/global-issues/health (accessed on 5 May 2025).

106 UNHCR," Access to Healthcare". Available at https://www.unhcr.org/us/what-we-do/protect-human-rights/public-health/access-healthcare (accessed on 28 May 2025).

107 Ahmed Fadiel and others, "Utilizing geospatial artificial intelligence to map cancer disparities across health regions", *Scientific Reports*, vol. 14, No. 7693 (April 2024).

108 Amponsah, Latue and Rakuasa, "Utilization of GeoAI".

109 Ibid.

110 Joseph Bullock and others, "Mapping the landscape of artificial intelligence applications against COVID-19", *Journal of Artificial Intelligence Research*, vol. 69 (2020).

111 Su Golder and others, "A chronological and geographical analysis of personal reports of COVID-19 on Twitter from the UK", *Digital Health*, vol. 8 (2022).

AI for Good in focus: AI medical diagnostics and treatment

AI-powered medical devices and cloud-based data analysis systems are transforming medical diagnostics and screening processes. These technologies enhance the clinical value of medical data and enable earlier detection and intervention for life-threatening diseases.

Le Lu, a researcher and Senior Director at Alibaba DAMO Academy, presented on the growing capabilities of AI-powered cancer screening at the 2024 AI for Good Global Summit. He highlighted that today's AI models can detect the seven deadliest cancers – breast, lung, esophageal, stomach, colon, pancreatic and liver – which together account for 70 per cent of cancer deaths and 50 per cent of new cases globally each year.[112] These AI systems are accessible via AI cloud platforms through public Application Programming Interfaces, broadening global access to advanced diagnostics. Lu also shared case studies where AI detected pancreatic tumours that routine CT scans missed, underscoring their superior diagnostic accuracy.

Tuberculosis, the world's deadliest infectious disease, disproportionately affects low-income populations, with treatment costs often reinforcing cycles of poverty.[113] AI Diagnostics, winner of the 2024 AI Innovation Factory Africa, developed an AI model that detects tuberculosis by analysing lung sounds. The company created a commercial AI-powered stethoscope and a tuberculosis lung sound training database to provide accurate, low-cost detection of lung abnormalities. This innovative technology lowers detection barriers, reduces patient suffering, speeds up treatment and helps limit disease transmission.

112 Celia Pizzuto, "AI-Powered Cancer Detection Revolutionizing Oncology", AI for Good, 10 December 2024.

113 Cindy X. S. Zheng, "Meet AI Diagnostics, the pioneer behind AI-enabled stethoscopes to simplify clinal diagnosis and speed up treatment of Tuberculosis", AI for Good, 27 November 2024.

AI for Good in focus: Soft robots for humanity

Soft robotics refers to the coupling of soft material with the force-generating capabilities of rigid structures. These robots have a wide range of uses, including being used in archaeological exploration (e.g., exploring Peruvian ruins) and environmental monitoring (e.g., inspecting salamander habitats). Cameras and sensors placed at the robot's tip can further enable real-time environmental feedback, enabling autonomous navigation and manipulation using techniques such as reinforcement learning.

On 18 March 2025, the AI for Good platform conducted a webinar with Dr. Allison Okamura, the Richard W. Weiland Professor of Engineering at Stanford University and a founding member of the Stanford Robotics Center. A major breakthrough presented in the webinar was the development of a patient-specific concentric tube robot - a semi-soft, pre-shaped nitinol system designed for minimally invasive surgery. This device outperforms traditional rigid surgical robots by successfully navigating complex anatomies with sub-millimeter precision.

The webinar also introduced novel fabrication techniques, such as ultrasonic welding of thermoplastic polyurethane fabric to create strong yet flexible pneumatic actuators capable of significant elongation via tip eversion. One of the main innovations was the "vine robot" - a pneumatically actuated, everting structure with 2D and 3D steering capabilities and the ability to grow autonomously. The webinar also featured soft haptic technologies, such as 3D-printed pneumatic wearables, which give realistic tactile feedback for teleoperation and social interaction while addressing power efficiency and sensor integration challenges. These improvements showcase the unique ability of soft robots to bridge the gap between rigid and fully soft systems. They also address critical concerns such as material durability, autonomy in unstructured environments and the scalability of pneumatic systems. Looking ahead, researchers are investigating 3D-printed multifunctional materials and AI-driven control systems. The webinar concluded by underlining how soft robotics may help democratize access to key technologies by using low-cost, bioinspired designs.

5.1.5 Education

A cornerstone of sustainable development relates to access to quality education, with SDG 4 aiming to ensure inclusive and equitable quality education for all. However, many individuals globally lack access to education due to poverty, conflict and geographic isolation. Rates of education still have not recovered completely since the COVID-19 pandemic in 2020 which resulted in widespread school closures. Approximately 250 million children and youth were deemed to be out of school in 2021, with the population in sub-Saharan Africa the most impacted.[114] While many turned to the use of digital services to receive their education, ITU estimates that 32 per cent of the global

[114] UNESCO, "250 million children out of school: what you need to know about UNESCO's latest education data", press release, 19 September 2023.

population is still offline, with this percentage higher in Africa (62 per cent).[115] These figures are impacted by the gender digital divide, with only 65 per cent of women having access to the Internet globally compared to 70 per cent of men.[116]

Robots have been explored as a pathway to promote education and digital inclusion, particularly in underserved communities. Educational robots, such as programmable kits and AI-powered tutoring systems, are being used to enhance learning experiences and make education more accessible.[117] For example, UNICEF has collaborated with the Ministry of Education in Serbia to explore the use of humanoid robots to provide educational support to students.[118] In Africa, UNESCO has collaborated with technology companies to provide students with hands-on experiences in robotics and ML and promote accessibility of STEM subjects.[119] In early 2024, ITU also launched its Robotics for Good Youth Challenge, which invites youth to learn robotics and coding, while promoting inclusivity and sustainability. The challenge held its second iteration at the AI for Good Summit 2025, where it invited students aged 10-18 to develop AI and robotics-based solutions to address global challenges. This challenge offers a unique opportunity for STEM students to develop critical problem solving and teamwork skills. Furthermore, telepresence robots – which are remote controlled – are being used to connect students in remote areas with teachers and experts from around the world.[120]

Recent developments in generative AI have led to significant advances in the use of AI for education. Many countries are exploring personalized platforms and tutors to accelerate learning in primary and secondary school. While these efforts face several challenges, as detailed in UNICEF's *Policy Guidance on AI for Children*, they may facilitate learning strategies that are more flexible and adapted to each child's learning preferences.

5.1.6 Social assistance

SARs are robots that interact with users through social engagement and support. Equipped with AI-enabled features, SARs are increasingly being adopted in homes, schools and hospitals to improve accessibility, monitoring and assistance. Their diverse functionality allows them to serve as companions or health monitoring tools for seniors, as well as to assist children with special needs in developing their social skills.[121]

Deep learning, facial and voice recognition, and adaptive learning features allow SARs to foster long-term engagement with their users by making interactions feel more human-like, even if the robot itself is not humanoid. While SARs' ability to remember user preferences, routines and personal history allows them to create more personalized user experiences, this functionality has also spurred discussion around ethical risks and the potential for malicious actors to abuse human-robot relationships for emotional manipulation or deception.

115 ITU, "Measuring digital development: facts and figures 2024", 2024, pp. 1-2.
116 Ibid., p. 3.
117 Alexandra Bustos Iliescu, "The future of educational robotics: enhancing education, bridging the digital divide, and supporting diverse learners", AI for Good, 31 March 2023.
118 UNICEF, "Humanoid robots to support children in learning", press release, 24 October 2024.
119 Alex Okosi and Miguel de Andrés-Clavera, "A robotics program transforming AI education across Africa", Google Africa Blog, 13 December 2024.
120 Naomi Lee and Simon So, "Pedagogical exploration and technological development of a humanoid robotic system for teaching to and learning in young children", *Cogent Education*, vol. 10, No. 1 (2023).
121 ITU, "Exploring the role of socially-assistive robots in education, companionship, and care", AI for Good. Available at https://aiforgood.itu.int/exploring-the-role-of-socially-assistive-robots-in-education-companionship-and-care (accessed on 5 May 2025).

Equipped with AI-enabled features, SARs are increasingly being adopted in homes, schools and hospitals to improve accessibility, monitoring and assistance.

Figure 9: Socially Assistive Robots

The 2024 AI for Good Global Summit featured a Robots for Good workshop to foster discussion around ethical guidelines and standardization in the design and development of SARs.[122] Robotic researchers emphasized the need for transparent decision-making and communication to convey what values are being embedded into robotic technology and the expected positive or negative outcomes from their deployment. Consideration of why a robotic solution is required in the first place, identification of whom the robot affects, and a cost-benefit analysis of the immediate and long-term impacts of its implementation are core determinants in guiding thoughtful deployment. Further, the capabilities and limitations of a robot should be communicated clearly to ensure that its potential risks are not obscured by the allure of its benefits.

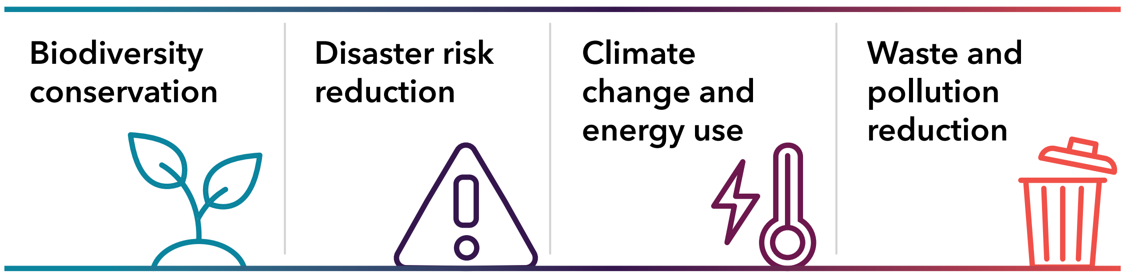
The findings from this workshop highlight the need for a systematic approach to designing and developing SARs that considers their potential impact on individuals and society as a whole. This effort includes the development of standardized metrics for assessing "good" outcomes across different countries and further contextual, local or temporal contexts. Additionally, the design and assessment process requires active community involvement that captures multidisciplinary and diverse perspectives to consider best practices.

122 Information in this paragraph and the next is drawn from an unpublished manuscript by Leigh Levinson and others titled "Robots for Good: Ethical guidelines and standardization for the design and deployment of societally beneficial assistive robots", prepared for ITU following a workshop conducted at the AI for Good Global Summit, 30 May 2024.

5.2 AI for planetary well-being

Although human and planetary well-being are deeply interconnected, the following four applications can be considered closely connected to the triple planetary crisis, as well as to disaster risk reduction. The triple planetary crisis refers to what the Intergovernmental Panel on Climate Change (IPCC) considers the most urgent global challenges – climate change, biodiversity loss, and waste and pollution. The applications below show significant potential for AI to benefit efforts in each of these domains, which would have a further positive effect on human well-being.

Figure 10: Applications of AI for planetary well-being



5.2.1 Biodiversity conservation

AI tools can be used in various ways to monitor plant and animal biodiversity, track effects of policies such as those that create wildlife corridors, and assess adverse events, such as pollution and deforestation. The United Nations' Global Ocean Observing System has used robotic technologies to monitor ocean conditions and support the management of sustainable fisheries. Organizations monitor marine biodiversity and assess the impacts of climate change on ocean health by collecting relevant data such as temperature, salinity and pollution levels.[123] On land, remote sensing robots are put to diverse uses, such as monitoring deforestation, tracking wildlife populations and assessing the health of ecosystems.[124] For instance, the organization Amazon Conservation has employed drones and satellite-based robots to track illegal logging activities and monitor deforestation in the southern Peruvian Amazon.[125] In Africa, TrailGuardAI is using ground robots and camera traps to monitor wildlife poaching in protected areas.[126]

123 Jennifer A. Cardenas and others, "A systematic review of robotic efficacy in coral reef monitoring techniques", Marine Pollution Bulletin, vol. 202 (May 2024); MassChallenge, "Ocean Technology's Moment: A More Sustainable Future with Ocean A.I. and Bluetech Innovation", 8 December 2023.

124 API4AI, "Environmental monitoring with AI: the role of image processing APIs in conservation", API-4AI Blog, 2 October 2024.

125 Amazon Conservation, "MAAP #90: using drones to monitor deforestation and illegal logging", 13 August 2018.

126 One Earth, "RESOLVE-TrailGuard ground sensors for advanced conservation monitoring". Available at https://www.oneearth.org/who-we-fund/science-policy-grants/resolve-trailguard-ground-sensors-for-advanced-conservation-monitoring (accessed on 14 February 2025).

AI for Good in focus: Machine learning supporting ecology

ML and conservation ecology is revolutionizing wildlife monitoring and ecological research. On 21 November 2022, the AI for Good platform hosted Dr. Devis Tuia, Head of the Environmental Computational Science and Earth Observation Lab in Sion. The webinar addressed the challenge of harnessing vast amounts of unstructured digital data in wildlife monitoring, demonstrating how AI-powered drone imaging systems and camera traps can automate animal detection and population estimation across expansive savannah landscapes with up to 90 per cent recall, a significant improvement over manual methods.

In order to address the challenge of detecting small animals in aerial imagery (averaging just 30.18 pixels) and navigating complex backgrounds, the webinar demonstrated the use of crowdsourced annotation platforms, which processed 26,000 images in a matter of days, as well as curriculum-based deep learning models pretrained on ImageNet. These models reduced false positives by 95 per cent, allowing rangers to analyse 300 photos rather than 1,500 during population surveys. The webinar also illustrated how open-source tools such as AIDE (AI Interface for Ecological Data) can combine citizen science with ML, therefore allowing ecologists to create custom detection models without requiring programming skills.

The webinar additionally highlighted how platforms such as Wildbook and iNaturalist can harness citizen science and social media data for ecological monitoring. This democratization of AI tools enables conservation practitioners to independently apply advanced ML methods, encouraging a critical synergy between ecological expertise and technical innovation. The webinar featured case studies on species identification in Namibia and migratory bird monitoring in West Africa, where AI cut analysis times from weeks to hours. It also introduced new and emerging methodologies such as taxonomy-aware models and spatio-temporal species distribution modelling to improve the precision of ecological decision-making. The webinar presented a scalable, replicable framework for global conservation efforts, tackling critical issues in real-time biodiversity monitoring and threat detection, such as poaching.

5.2.2 Disaster risk reduction

GeoAI can have transformative effects on disaster risk reduction programmes. For instance, these tools have been used to develop real-time crisis maps and filter geotagged data to pinpoint areas requiring urgent rescue operations.[127] Additionally, image recognition techniques can assist in

127 Santosh Kuman Bhoda, "How AI is transforming disaster response", LinkedIn, 3 November 2024.

identifying disaster impacts such as collapsed buildings, while filling historical disaster data gaps.[128] GeoAI tools have enabled governments and international organizations to develop early warning systems that can predict the spread of wildfires or floods and identify areas of vulnerability.[129]

The United Nations has frequently employed GeoAI to assist in its disaster risk reduction efforts. For instance, the United Nations Satellite Centre (UNOSAT) launched FloodAI, an end-to-end pipeline that automatically downloads synthetic aperture radar imagery and uses a deep learning model to develop flood-extent maps and produce real-time flood updates.[130] Additionally, UNOSAT used GeoAI to analyse satellite imagery and create damage assessment maps for the Türkiye-Syria earthquake in 2023, helping to identify collapsed buildings, plan rescue operations and allocate resources efficiently.[131] The Philippines, commonly known as the typhoon alley of the world, has also utilized GeoAI in conjunction with drones and digital twins software to quickly identify the aftermath effects of typhoons and determine flood-prone areas.[132] In November 2024, the United Nations established a Global Initiative on Resilience to Natural Hazards through AI Solutions,[133] the successor to the recently completed Focus Group on AI for Natural Disaster Management.

5.2.3 Climate change and energy use optimization

The triple planetary crisis represents one of the most urgent global challenges, with the IPCC warning of more frequent and severe weather events, rising sea levels and biodiversity loss arising from a 1.5°C rise in global temperatures.[134] Climate change is predicted to cost the global economy $23 trillion annually by 2050. A rise of sea levels by 0.5 to 1 metre by 2100 could cause the displacement of up to 200 million individuals, while climate change could trigger desertification of 25 per cent of the Earth's land surface by 2050.[135] Global emissions, which currently stand at a record 37.4 billion tons, need to be cut by 45 per cent by 2030 and 57 per cent by 2035 to meet the 1.5°C target.[136]

However, energy demand continues to grow, as do the effects of the energy divide. Although global energy consumption increased in 2023, 685.2 million people worldwide remain without access to electricity.[137] This persistent energy poverty is driven by a combination of factors, including geopolitical instability stemming from global conflicts and the escalating impacts of climate change.

128 Ibid.

129 Ibid.; UNESCAP, "Strategic foresight", pp. 10-13, 17, 21-22, 24; Innovation News Network, "How geospatial technologies aid in effective disaster management", 27 October 2023.

130 UNESCAP, "Strategic foresight", pp. 11-12.

131 United Nations Institute for Training and Research, "UNOSAT Emergency Mapping service activated over Syria and Türkiye following major earthquakes", press release, 6 February 2023.

132 UNESCAP, "Strategic foresight", pp. 13.

133 International Telecommunication Union, "Global Initiative on Resilience to Natural Hazards through AI Solutions", n. d. (last accessed 15 September 2025).

134 IPCC, *Global Warming of 1.5°C* (IPCC, 2019).

135 Scott Kulp and Benjamin Strauss, "New elevation data triple estimates of global vulnerability to sea-level rise and coastal flooding", *Nature Communications*, vol. 10, No. 4844 (2019); Climate Central, "Flooded Future: Global Vulnerability to Sea Level Rise Worse Than Previously Understood", 29 October 2019; Leah Thomas, "Earth Will Start Becoming a Desert by 2050 if Global Warming isn't Stopped, Study Says," Newsweek, 3 January 2018.

136 International Energy Agency, *CO_2 Emissions in 2023* (Paris, 2024), p. 3; UNEP, *Emissions Gap Report 2024.*

137 Enerdata, "Total energy consumption". Available at https://yearbook.enerdata.net/total-energy/world-consumption-statistics.html (accessed on 14 February 2025); World Bank, *Tracking SDG 7: The Energy Progress Report 2024* (Washington DC, International Energy Agency, International Renewable Energy Agency, United Nations Statistics Division, World Bank and WHO, 2024), p. 19.

Concurrently, global CO_2 emissions are projected to have risen by 0.8 per cent in 2024, a stark contrast to the annual reduction target outlined in the Paris Agreement.[138] Although renewable energy consumption has seen gradual growth, it constitutes only 30 per cent of global energy use, and investments in the energy transition have decelerated in recent years.[139] The IPCC warns that without immediate and substantial action, global temperatures are likely to exceed 1.5°C above pre-industrial levels by the early 2030s, with profound implications for ecosystems, economies and human well-being.[140]

The United Nations Framework on Climate Change (UNFCCC) AI for Climate Action initiative addressed both climate mitigation and climate adaptation, aiming to promote activities aimed at harnessing AI for climate, as well as developing knowledge products that would support policies and best practices in that domain.[141]

In addition, the integration of AI into network technologies holds significant potential to advance sustainable energy consumption and enhance energy efficiency globally. Smart grids can enable dynamic changes in energy supply according to local demand, provide greater accuracy to monitor and forecast energy needs, and enhance load balancing to reduce electricity peaks and costs.[142] 5G serves as a key enabler for smart grids by significantly enhancing their reliability, providing high-speed data transmission and enabling connectivity for a massive number of IoT devices. In a smart grid, household appliances, buildings and entire city regions are interconnected, allowing energy consumption to be monitored and managed more effectively.

An extension of 5G known as 5G-Advanced enables AI algorithms to dynamically adjust energy production and distribution according to real-time demand and increasing energy-sharing opportunities.[143] For example, Huawei, in collaboration with China Telecom and the State Grid Corporation of China, has successfully established a 5G smart grid experimental network in Qingdao. This initiative has set a global benchmark for 5G-enabled smart grids and network slicing, particularly through its innovative application of network slicing technology in power grid management.[144] Similarly, the United Arab Emirates recently announced a $1.9 billion smart grid initiative, developed in partnership with Microsoft's Co-Pilot, aimed at improving operational efficiency and fostering sustainable energy practices.[145] These efforts have been actively supported by the United Nations and ITU. Notably, the AI for Good platform played a pivotal role in fostering collaborations between technology companies and energy providers, enabling the deployment of AI-driven solutions to optimize energy efficiency and facilitate the integration of renewable energy sources into existing grids.

138 CICERO, "Still no peak in global fossil CO_2 emissions", 12 November 2024.

139 Enerdata, "Share of renewables in electricity production". Available at https://yearbook.enerdata.net/renewables/renewable-in-electricity-production-share.html (accessed on 14 February 2025); BloombergNEF, "Energy transition investment trends 2025", abridged report, 30 January 2025, p. 1.

140 IPCC, *Climate Change 2023: Synthesis Report* (Geneva, 2023), p. 68.

141 UNFCCC, "Technology Mechanism Initiative on AI for Climate Action", n. d. Available at https://unfccc.int/ttclear/artificial_intelligence#activities (last accessed 15 September 2025).

142 Accenture Strategy, "Smart cities: how 5G can help municipalities become vibrant smart cities", 2017, p. 7.

143 Andres Carvallo, "5G-Advanced is a game changer for smart energy and smart grid networks", RCR Wireless News, 15 October 2024.

144 LightReading, "GSMA selects Huawei-powered Qingdao smart grid as 5G SA benchmark use case", 27 April 2020. Available at https://www.lightreading.com/5g/gsma-selects-huawei-powered-qingdao-smart-grid-as-5g-sa-benchmark-use-case; Huawei, "State Grid Qingdao, China Telecom, and Huawei co-awarded 'Best Innovative Commercial Case in 5G Automation Award'", press release, 27 April 2020.

145 Kavitha, "DEWA launches $1.9 billion smart grid initiative to boost sustainability and efficiency".

AI for Good in focus: Leveraging AI in 5G networks to address efficiency challenges

"The energy consumption of 5G base stations is more than three times that of 4G, in order to support enhanced connectivity."

- Guirong Wang, China Telecom.

AI is playing an increasingly transformative role in 5G and telecommunications networks, enabling advanced capabilities such as predictive optimization and real-time traffic management. Autonomous fault detection and anomaly detection features enhance network maintenance by identifying issues early, leading to more robust performance and reducing the need for human intervention. While these advancements improve performance and reliability, they also introduce significant energy demands, underscoring the importance of AI-driven solutions to enhance the energy efficiency of 5G networks and support broader SDGs.

In his presentation "How can AI enable green operation of cloud network infrastructure"[146] at the 2024 AI for Good Global Summit, Guirong Wang, General Manager of the Science and Technology Innovation Department at China Telecom, shared several AI-enabled tools and initiatives that are setting new industry standards for green infrastructure and network operations. Through the 5G Co-construction and Sharing initiative, China Telecom and China Unicom collaborated to build the world's largest and fastest 5G network, leading to annual electricity savings exceeding 20 billion kilowatt hours.[147] This demonstrates how co-construction and sharing collaborations can enhance network efficiency, reduce costs and accelerate 5G deployment.

As Summer Chen, Vice President of ZTE Corporation, discusses in the AI for Good article "AI's Role in Digital Transformation,"[148] AI and 5G technologies enable city management systems to collect vast amounts of data, such as gas, water and infrastructure usage to enhance urban safety and performance. Network slicing allows smart cities to create dedicated virtual networks on shared physical infrastructure, enabling tailored connectivity based on real-time demand. This capability supports the dynamic allocation of bandwidth among emergency services, public transport and IoT devices, helping to reduce energy waste and optimize operational efficiency.

---

146 Guirong Wang, "How can AI enable green operation of cloud network infrastructure?", AI for Good, video, 11 June 2024. Available at https://www.youtube.com/watch?v=ETcVKogV5Es&list=PLQqkkI-wS_4kV0fRMgyl8F3oAejtgjTV98.

147 Celia Pizzuto, "China Telecom's AI Initiatives Driving Sustainable Connectivity", LinkedIn, 17 January 2025.

148 Celia Pizzuto, "AI's Role in Digital Transformation", 19 July 2024.

ITU's Focus Group on Autonomous Networks has played a critical role in identifying critical gaps in the standardization of autonomous networks, while also exploring evolution in future networks, real-time responsive experimentation, dynamic adaptation to future environments, technologies and use cases. Key outcomes include its work on concepts such as zero management networks, which provides a fully autonomous network management solution with human oversight, and network orchestration, which automates complex, multi-step processes across diverse network domains and IT systems.

5.2.4 Waste and pollution reduction

There are many use cases for AI to monitor waste and pollution, enabling timely intervention. A high-impact example is the use of GeoAI tools to monitor agricultural plastic. Farmers are increasingly relying on plastic in production due to its ability to protect crops, reduce pesticide consumption, extend growing seasons and increase yields by up to 60 per cent.[149] Plastic covers for greenhouses can protect crops from adverse climate factors and animals, and can enhance solar radiation to create more favourable growing environments.

However, the mismanagement of large amounts of agricultural plastic can negatively impact the environment and agricultural yields. Given that most agricultural plastic products are single use, their frequent replacement generates high volumes of waste in landfills. The accumulation of film residue in agricultural soils directly contributes to negative soil properties and plant growth, such as reduced crop yield, plant height and root mass.[150] Improperly disposed plastic in agricultural soil releases microplastics that pose harm to ecosystems, threaten food security and potentially harm human health.[151]

Deep learning models can enable agriplastic modelling by analysing satellite and drone imagery to identify plastic-covered fields. For example, a study utilized multi-spectral remotely sensed imagery and classic ML classifiers to map the plastic cover in rural areas of southern Italy with an average classification accuracy of over 80 per cent. Another method revealed that AI-generated plastic mapping yielded more accurate results than hand-crafted methods that had a low generalization ability and high sensitivity to noise.[152] Agriplastic mapping models developed in the 2024 ITU GeoAI Challenge featured various spectral indices relevant to agricultural productivity, such as a plastic index, vegetation and water indices to assess green cover and moisture, and a bare soil index.

149 UNEP, "How plastic is infiltrating the world's soils", 3 December 2021.
150 Ekta Tiwari and Seeta Sistla, "Agricultural plastic pollution reduces soil function even under best management practices", *PNAS Nexus*, vol. 3, No. 10 (October 2024).
151 FAO and UNEP, *Global Assessment of Soil Pollution: Report* (Rome, 2021), sect. 3.3.
152 Quanlong Feng and others, "Mapping of plastic greenhouses and mulching films from very high resolution remote sensing imagery based on a dilated and non-local convolutional neural network", *International Journal of Applied Earth Observation and Geoinformation*, vol. 102 (October 2021).

AI for Good in focus: Multimodal adaptation of large language models for smart mobility in Africa

LLMs and vision-language models can deliver smart mobility solutions in Africa in order to address the region's unique transportation challenges. On 29 April 2025, Dr. Ahmed Biyabani, Associate Teaching Professor at Carnegie Mellon University Africa, with a specialization in AI and digital transformation, led an AI for Good webinar exploring this topic. The webinar explored how LLMs can process various data sources such as GPS, images and time-series data, in order to predict congestion and optimize traffic flows. It highlighted the value of employing domain-adapted models trained on mobility-specific datasets from African cities, arguing that while general purpose LLMs perform well in broad tasks, they often require domain-specific expertise in order to be applied in transport-related scenarios.

In order to effectively address this issue, the webinar explored how retrieval-augmented generation can be used to improve LLM performance. Dr. Biyabani noted that this could be done by integrating real-time, localized data such as GPS, schedules, weather patterns, infrastructure maps and traffic warnings to assist in contextual decision-making. The webinar incorporated case studies from Kigali, Nairobi and Lagos to demonstrate how local data can improve model accuracy. It also proposed a three-stage system architecture - namely data collection (i.e curating Africa-specific datasets), model adaptation (i.e fine-tuning vision-language models and deploying retrieval-augmented generation for dynamic updates) and deployment (i.e a web-based application for real-time mobility and insights).

This framework provides the ability to improve traffic management, emergency response and public transportation services in low-resource settings. The webinar additionally explored issues such as computational resource requirements, data privacy, bias reduction and human oversight, in addition to emphasizing the need for access to high-quality, relevant data. It noted that this framework can be applied to sectors beyond transportation, such as healthcare and logistics, therefore demonstrating the applicability of multimodal AI in emerging economies. The webinar concluded with a call towards more collaborative data-sharing initiatives and the need to develop supportive policy frameworks which can help grow innovative solutions across the African continent.

The following section explores the policy implications of applications of AI like these for human and planetary well-being.

6

Creating an enabling environment for AI for good

How can policymakers develop AI applications for human and planetary health, along with the multitude of other potential uses of AI for good? High-quality local, national and global policy frameworks allow AI innovations to thrive in the interest of human beings and the planet, while also protecting key societal values and rights. The following 10 applications raise several important policy implications, from data availability to infrastructure gaps and safety considerations. Some of these are addressed at least partially by current strategies, standards and regulations, while others are not supported yet in the evolving policy environment. In addition, this report highlights five areas of direct action – the five pathways of AI for human and planetary well-being, which address many of the policy implications described below. These five pathways aim to provide clear areas of focus for all stakeholders aiming to improve the benefit of AI.

6.1 Implementation challenges

While technological advancements in the field of AI have empowered governments and international organizations to address global challenges and advance the SDGs, significant obstacles persist.

6.1.1 Data access, quality and governance

Filling data gaps, supporting data sharing and governing datasets

Data is the cornerstone of decision-making and a vital element of AI development. Approximately 80 per cent of all data is geographic in nature, encompassing official statistics, satellite imagery, big data, trajectory data, meteorological information, knowledge graphs and geotagged social media posts, as well as remote sensing images.[153] However, there are significant gaps in the quality, collection and interoperability of geospatial data, reflecting broader issues of digital divides and inequalities. This disparity underscores the need for more equitable access to and distribution of data infrastructure to ensure inclusive and effective AI development worldwide.

Access to high-quality, reliable and timely data remains a significant challenge, notably in geospatial analysis. Existing data is often outdated or fragmented, limiting its utility. Additionally, collecting high-quality geospatial data in remote or rural areas is difficult, especially in many low- and middle-income countries that lack the necessary skills, training and infrastructure.[154] Collecting and labelling data is a time-intensive task, and many regions may not be able to invest in such an endeavour, which risks leaving historically excluded groups behind.[155] These realities exacerbate the existing digital and data divides, while leading to an overrepresentation of data-rich countries and contributing to algorithmic bias.[156]

Additionally, many organizations use proprietary datasets where sources of bias are difficult to identify, leading to concerns about the transparency and trustworthiness of data and algorithms.[157] As a result, governments and organizations may be forced to rely on incomplete or low-quality data, undermining their ability to make informed, equitable and effective decisions.

---

153 Gengchen Mai and others, "On the opportunities and challenges of foundation models for GeoAI", *ACM Transactions on Spatial Algorithms and Systems*, vol. 10, issue 2, No. 11 (June 2024), pp. 1-4; Trang VoPham and others, "Emerging trends in geospatial artificial intelligence (geoAI): potential applications for environmental epidemiology", *Environmental Health*, vol. 17, No. 40 (April 2018).

154 World Bank, "Geospatial technology and information for development", Brief (Washington DC, 2019).

155 Interview conducted via videoconferencing technology with Maria Brovelli, Professor of GIS at Politecnico di Milano, October 2024.

156 Ibid.

157 Information in this paragraph is drawn from the interview with Maria Brovelli.

AI for Good in focus: Synthetic data for gaps in datasets

The development of AI tools to organize and assess datasets serves as a significant opportunity to address this dilemma, if deployed responsibly. AI tools can be used to harmonize and consolidate data at the local, national and regional levels, prepare datasets for modelling and evaluate dataset bias.[158] AI tools can also be used to generate synthetic data, filling gaps in datasets and providing a more accurate frame of reference when existing data is deemed inaccurate.[159] In this way, AI can support policymakers by providing insights on resource allocation according to needs.

Data presents a similar challenge in the deployment of AI within 5G networks, with significant implications for global equity and technological advancement. While 5G networks enhance data collection capabilities and enable AI systems to process vast amounts of information, many regions lack the necessary infrastructure to store, manage and process this data effectively.[160]

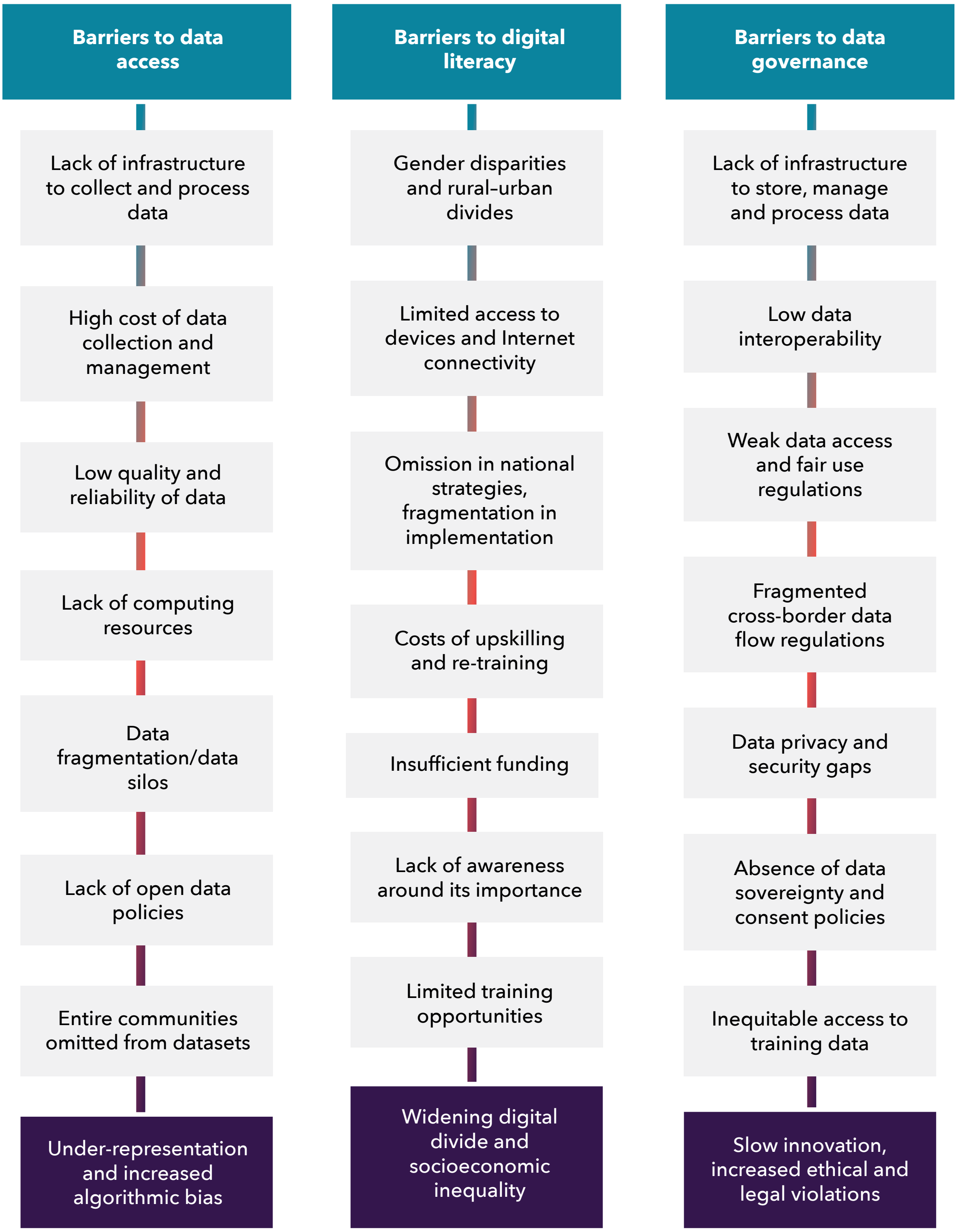
Furthermore, differences and incompatibilities between the mature and heavily standardized mobile network industry and the comparatively open ecosystem of the AI industry may lead to challenges in interoperability, particularly of data interfaces. The reliance on centralized data centres for AI processing can undermine the low-latency promise of 5G networks, which is essential for real-time applications.[161] While edge computing, a decentralized approach to data processing, offers a potential solution, its widespread adoption requires substantial investment, innovation and capacity-building to scale effectively.

AI regulation frameworks increasingly acknowledge that high-quality, well-governed data is essential for developing safe, reliable and fair AI systems. The European Union's Data Governance Act (2022) created structured mechanisms for sharing industrial, public and personal data while promoting fairness and transparency in value creation. Regulations like the General Data Protection Regulation and Open Data Directive govern data protection and access to public datasets. Globally, guides like the Integrated Geospatial Information Framework of the United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM) and ISO Technical Committee 211 standards promote interoperability and metadata quality, supporting data consistency across domains. National efforts, such as the Netherlands' Algorithm Registry and the Fundamental Rights

158 Interview conducted via videoconferencing technology with Andrew Zolli, Chief Impact Officer at Planet Labs, January 2025.
159 Interview conducted via videoconferencing technology with Pengyu Hao, Information Technology Officer at FAO, October 2024.
160 Kirti Devadiga, "5G vastly improves data collection and AI capabilities", ET Edge Insights, 5 February 2024; Rohit Sehgal, "AI needs data more than data needs AI", Forbes.com, 5 October 2023.
161 Mischa Dohler, "The synergy of AI in elevating 5G edge computing", 24 October 2024.

and Algorithms Impact Assessment tool, proactively govern algorithmic data use. Meanwhile, soft law instruments like the OECD AI Principles, the United States' National Institute of Standards and Technology Risk Management Framework, and ISO/IEC 5338 offer structured approaches to managing data throughout the AI lifecycle.

Figure 11: Barriers to data access, digital literacy and data governance



While regulatory attention to data governance is increasing, enforcement remains uneven and mostly siloed. There is limited legal emphasis on data quality as a formal regulatory criterion, particularly outside the European Union. Few frameworks address the representativeness, timeliness and accuracy of data – factors that are essential for preventing bias and model degradation. Global South countries face constraints in accessing diverse and high-quality datasets. Moreover, global standards for interoperability may not consider ethical or rights-based perspectives, as there are not yet policies ensuring equitable access to training data. Cross-border data flow regulations are fragmented, and mechanisms for shared data stewardship (e.g., AI training datasets with protected characteristics) are still emergent – as addressed in the United Nations' Global Digital Compact.

6.1.2 Infrastructure needed for AI

Building networks, computational capabilities and sustainable infrastructure for AI

Another significant challenge lies in the resource and infrastructure inequities faced by developing countries – countries which most stand to benefit from AI. For instance, while GeoAI may enhance the internal capacities and workflows of public institutions through automation, many nations lack the essential infrastructure and technological access needed to adopt such innovations. In Africa, only 38 per cent of the population has Internet access, largely due to gaps in broadband coverage.[162] Furthermore, in low-income countries, mobile broadband is more than eight times less affordable compared to what people pay in wealthier nations, effectively excluding a large portion of the population from digital participation.[163] This disparity not only limits the adoption of AI but also perpetuates broader inequalities, leaving many countries unable to fully leverage new technologies for development and decision-making.

Moreover, many countries lack the technical expertise or robust national infrastructure to foster an effective geospatial information ecosystem.[164] Although mechanisms such as the UN-GGIM offer guidance to Member States on managing geospatial data, significant efforts are still needed to modernize and strengthen existing frameworks, particularly to foster collaboration between institutions. Vast financial resources are required to develop deep learning models for remote sensing mapping methodologies, which may prove an obstacle for developing countries that receive less investment in AI.[165]

Globally, there is growing recognition that robust infrastructure spanning data availability, compute power, connectivity and skilled human capital is foundational to AI development. Several policy frameworks touch on aspects of infrastructure indirectly. National platforms such as India's AI for All and Singapore's NAIS 2.0 emphasize infrastructure investments in compute clusters and secure data-sharing platforms. The African Union's Digital Transformation Strategy and UN-GGIM Geospatial Framework also highlight the importance of broadband, cloud and geospatial infrastructures, especially in cross-cutting applications. Countries like Chile and the Netherlands

---

[162] Cosmas Luckyson Zavazava, "Connectivity for everyone is key to Africa's growth and prosperity", United Nations Africa Renewal, 18 December 2024.

[163] International Telecommunication Union, *Measuring digital development – Facts and Figures 2024* (annual ICT indicators overview), 2024. Available at https://www.itu.int/hub/publication/D-IND-ICT_MDD-2024-4/.

[164] United Nations Integrated Geospatial Information Framework, "A strategic guide to develop and strengthen national geospatial information management – part 1: Overarching Strategic Framework", 24 July 2018, p. 17.

[165] Interview with Pengyu Hao.

show that robust digital and data infrastructure correlates strongly with AI ecosystem growth. Still, these frameworks remain fragmented and unevenly implemented across regions.

Despite policy progress, most AI regulations prioritize risk and ethics, leaving physical infrastructure under-addressed. Current geospatial standards lack provisions for infrastructure integrity and data provenance, which is crucial for AI systems using spatial data. Furthermore, there is limited guidance on interoperability between infrastructure layers (e.g., linking compute power with data governance). Without coordinated investment, global AI development risks deepening digital divides.

AI for Good in focus: Integrated AI and wireless for sustainable mobile network evolutions

AI can help effectively address the financial and technical challenges associated with frequent mobile network upgrades. On 11 March 2025, the AI for Good platform hosted a webinar to discuss a cutting-edge solution to sustainable mobile network evolution integrating AI and wireless functionalities into a unified, open-source framework. Dr. Zhiyuan Jiang, Professor at the School of Communication and Engineering at Shanghai University and founder of Deep Transcend, led the session. The webinar showcased the use of unlimited vector processing on a RISC-V-based architecture with customized extensions and tailored enhancements for efficient AI and wireless baseband processing.

In comparison to standard vector architectures, which are limited by fixed register sizes and power-of-two constraints, the unlimited vector processing model offers a flexible approach to programming, allowing for non-power-of-two register groupings and optimized load/store processes. This approach offers flexibility while reducing processing overhead in both AI and wireless baseband circumstances. Another key proposal in the webinar was the development of an open-source library for AI computing and mobile network protocol stacks, with the goal of enabling hardware-software decoupling. This approach reflects a significant step towards "white box" base stations and devices, which can be upgraded solely through software, therefore cutting costs, decreasing reliance on proprietary hardware and fostering innovation.

The webinar demonstrated how this integrated model could lead to AI-native mobile networks through the combination of high processing efficiency and open-source programmability. It provides a link between the open AI development ecosystem and the traditionally closed telecom infrastructure, thereby enabling edge computing, real-time signal processing and energy-efficient AI deployment. Simulations validated the concept's feasibility, revealing improved performance in baseband tasks and AI operations.

6.1.3 Digital literacy and digital access

Access to AI and the ability to use it remain essential

There is a deep digital and data divide between developed and developing countries, particularly as it relates to the creation and adoption of advanced technologies such as AI. Currently, 77 per cent of the world's data centres are concentrated in OECD member countries, with the United States accounting for 33 per cent of the total, compared to only 5.2 per cent in China.[166]

Just 40 per cent of the worldwide population is considered digitally literate. By 2030, the skills required for jobs are expected to shift by 65 per cent, necessitating upskilling and capacity-building efforts to meet future demand.[167] The issue of digital literacy encompasses not just the use of fundamental technologies, but also the education of individuals and policymakers about the importance of critical thinking and human oversight while employing AI tools. For instance, policymakers should carefully analyse both the data and insights generated by AI and verify the quality of the results before utilizing them.[168] To address this challenge, the ITU AI for Good platform has introduced the AI skills coalition – a platform which provides free courses to stakeholders to promote AI education and capacity-building, particularly for those from underserved and marginalized backgrounds. Course themes include, but are not limited to, AI and ML, AI and the future of healthcare systems, AI ethics, AI for oceans and AI for social impact. This platform is also in the process of introducing specialized government training in AI governance, ethics and policymaking to address the specific needs of developing countries and least developed countries.

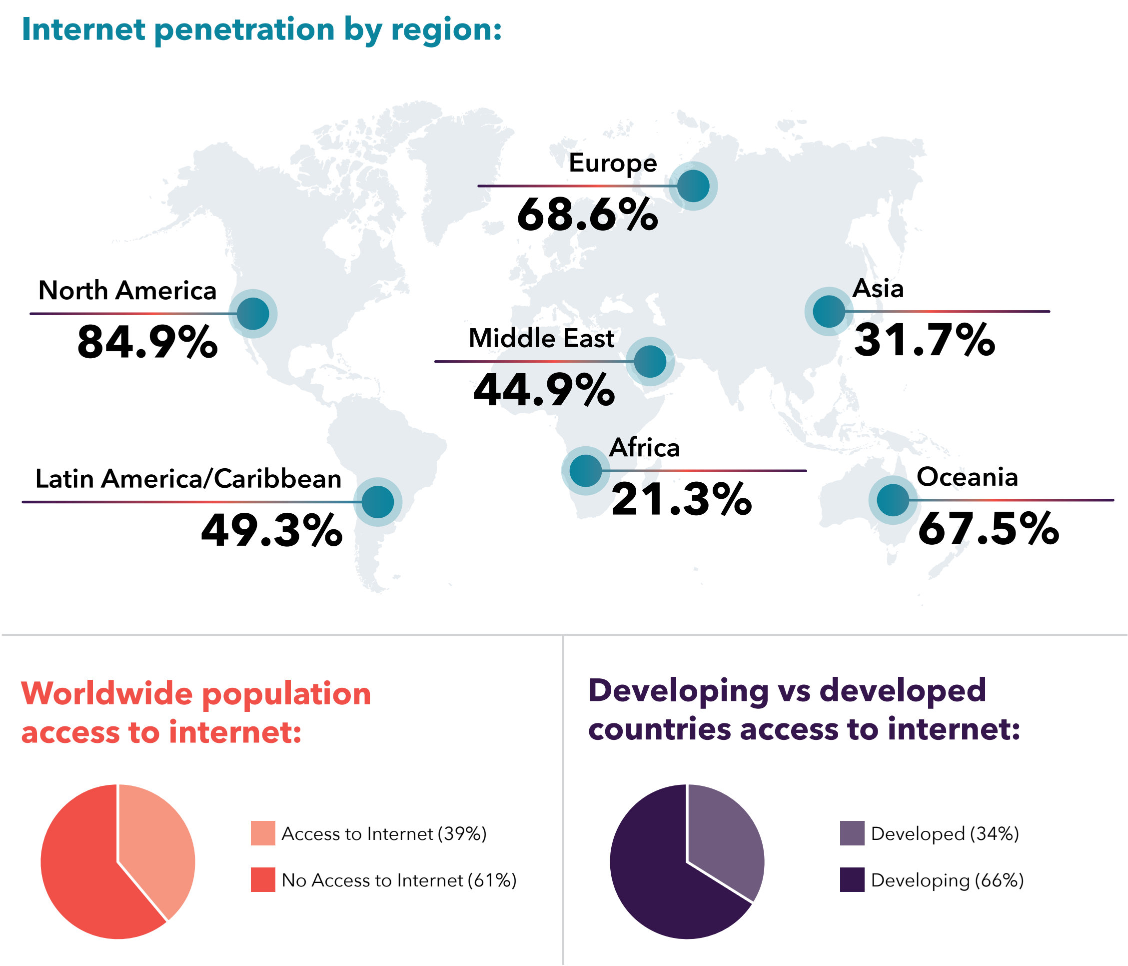
Digital literacy and equitable digital access are increasingly recognized as foundational to inclusive AI adoption. For example, the Framework Convention on AI and Human Rights and the Paris Charter on AI in the Public Interest underscore digital inclusion as a human right, calling for AI to benefit all people regardless of geography or socioeconomic status. National strategies, such as Kenya's Digital Master Plan and the IndiaAI Mission, integrate upskilling and access into broader AI governance goals. Similarly, Chile's AI investments have been accompanied by infrastructure and human capital development. At a technical level, ISO/IEC standards promote FAIR (Findable, Accessible, Interoperable, Reusable) principles, supporting broader access to AI-enabling data systems. Education-focused initiatives, such as Singapore's AI in Schools Framework, aim to embed digital skills early.

Despite many commitments, digital literacy and access remain uneven. Nearly one-third of the world's population is still offline, with pronounced gender and rural-urban divides, especially in sub-Saharan Africa and parts of Asia.[169] Digital literacy is not always included in AI strategies and policies, and digital upskilling programmes can be fragmented across jurisdictions. Frameworks tend to overlook intersectional barriers such as language, gender and disability that inhibit equitable digital participation. While initiatives like Kenya's AI upskilling centre and UNESCO's support for AI education in the Global South mark important steps, provision of digital education or broadband access can still be enhanced in most countries.

---

166 Brian Daigle, "Data centers around the world: a quick look".
167 Ibid.
168 Interview with Pengyu Hao.
169 ITU, "New global connectivity data shows growth, but divides persist", press release, 27 November 2023.

Figure 12: Gaps in digital literacy



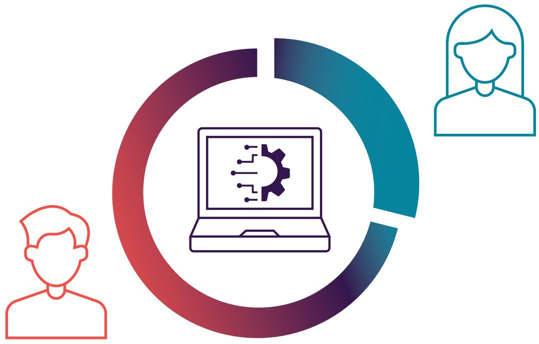
6.1.4 Talent development and retention

Measures to address the new talent requirements in AI combined with talent retention

Developing and retaining talent in AI, especially in highly technical areas such as robotics, GeoAI and communications networks, is a challenge for all countries. AI developers interviewed for this report have all stressed the need for more skilled talent, whether through more specialized undergraduate and graduate programmes, or through the retraining of the existing workforce. At the same time, developing countries have highlighted the impacts of the long-lasting brain drain – an issue that exists beyond AI, but that is even more critical today. A lack of talent retention means that countries investing in AI talent may see their investment evaporate as qualified students leave the country for better work opportunities.

This issue is especially urgent in the field of AI for communications networks. The rapid pace of technological innovation, particularly with the emergence of 6G networks, underscores the critical need for continuous upskilling and reskilling of the workforce. The development and deployment

Only **29 per cent of women** compared to **71 per cent of men** possess AI-related competencies.



of AI systems require specialized expertise in areas such as ML, data science, network engineering and cybersecurity. Additionally, significant demographic disparities exist in access to these skills; for example, of workers who list AI-related competencies on their job profiles, only 29 per cent are women.[170]

To address this pressing issue, ITU has launched the AI Skills Coalition, a global initiative aimed at bridging the AI skills gap and fostering equitable access to training and capacity-building opportunities.[171] ITU is also organizing challenges that provide free computing resources to participants while offering capacity-building opportunities through training and mentoring sessions.[172]

Many AI and digital transformation strategies now highlight the importance of developing local talent and fostering AI skills, particularly in emerging economies. The African Union Development Agency white paper *Regulation and Responsible Adoption of AI in Africa Towards Achievement of AU Agenda 2063* prioritizes capacity-building, with initiatives like Kenya's Africa Centre of Competence for Digital and Artificial Intelligence Skilling aiming to train public servants and address technical gaps. India's National Strategy for AI and the IndiaAI Mission also target skill development and talent retention. UNESCO's Roadmap for Ethical AI in Latin America and the Caribbean and the UN-GGIM Geospatial Framework identify talent as a strategic pillar. International initiatives and partnerships seek to accelerate knowledge transfer, technical training and multi-stakeholder collaboration to close the AI talent divide.

Despite increasing emphasis on talent development, most regulatory and policy frameworks stop short of mandating concrete, funded pathways to close the talent gap in developing countries. Many efforts remain at the pilot or advisory stage, without clear mechanisms for large-scale, sustained investment or monitoring. Fragmented implementation, insufficient funding and limited local training infrastructure persist, especially outside major urban centres. Gender and other social barriers to STEM education remain inadequately addressed. Without strong commitments and resource allocation, the global AI talent gap is likely to persist or even widen, constraining equitable participation in the AI-driven economy.

170 Sander van't Noordende, "Equitable AI skilling can help solve talent scarcity – this is what leaders can do".
171 Matshepo Sehloho, "ITU launches coalition to bridge AI skills gap", Connecting Africa, 21 January 2025.
172 ITU, "Crowdsourcing AI and machine learning solutions for SDGs: ITU AI/ML Challenges 2024 Report", 2024, pp. 10, 38.

6.1.5 Privacy protection and cybersecurity

Increased data collection and interpretation of AI tools requires stronger data protection measures

Privacy is a key consideration in AI ethics and it is one of the human rights most at risk in unsecured digital deployments. Privacy can be further impeded by cybersecurity breaches, where data that was thought to be protected is coopted by malicious actors.

Privacy and cybersecurity are considered key risks of GeoAI, robotics and AI for communications networks. Two phenomena combine here – the increasing granularity of satellite imagery and the growing ease of combining various data sources for analysis. The potential dangers are manifold. For instance, vulnerable migrant groups can sometimes be identified in satellite images, increasing their insecurity, especially if they are fleeing a conflict situation.[173] Due to the increased digitization of humanitarian and development practices in general, groups or individuals might be present in multiple datasets, which, when combined, could lead to their identification. This is known as the "mosaic effect", in which privacy is at risk unless seemingly harmless pieces of data are kept separate.

Data privacy and security are also critical concerns in relation to robotics. The data used both to train AI in robots and collected by robots after deployment require strong governance measures. Breaches of privacy that reveal sensitive personal data can result in identity theft and other forms of cybercrime. For instance, personal-use robots may inadvertently disclose confidential information, such as health records or personal conversations, to family members or third parties without the user's explicit consent.[174] This scenario raises key questions about consent and confidentiality, underscoring the need for oversight to prevent robots from manipulating users, particularly members of vulnerable groups such as children and the elderly.[175] In many instances, users may not even be fully aware of how their data might be collected or used. For these reasons, the United Nations' Special Rapporteur on the Right to Privacy and the Global Digital Compact have called for stronger safeguards to protect data privacy.

The globalized nature of 5G infrastructure, which relies on components and software from various vendors worldwide, increases the likelihood of compromised hardware and software entering the network, amplifying vulnerabilities to cyberattacks.[176] While 5G networks enable transformative applications due to their high bandwidth and low latency, they are also more vulnerable to threats such as distributed denial-of-service attacks.[177]

The integration of 5G with legacy technologies, which often lack robust security measures, creates additional points of vulnerability. The exponential growth of connected devices, such as IoT sensors and smart appliances, broadens the attack surface and creates new entry points for malicious actors.[178] Exploitation of these risks might result in data breaches, privacy violations, service disruptions and even physical harm in critical sectors such as healthcare and transportation.[179]

---

173 UNDRR, *Global Assessment Report on Disaster Risk Reduction – Our World at Risk: Transforming Governance for a Resilient Future 2022* (Geneva, 2022), p. 169.
174 Leigh Levinson and others, "Our business, not the robot's: family conversations about privacy with social robots in the home", *Frontiers in Robotics and AI*, vol. 11 (2024).
175 Interview conducted via videoconferencing technology with Shelly Levy-Tzedek, Director of the Cognition, Aging and Rehabilitation Laboratory at Ben Gurion University, November 2024.
176 Cybersecurity & Infrastructure Security Agency, "5G security and resilience". Available at https://www.cisa.gov/topics/risk-management/5g-security-and-resilience (accessed on 5 May 2025).
177 Samantha Knight, "Safeguarding the future: managing 5G security risks", GSMA, 3 October 2023.
178 Ibid.
179 Darktrace, "What is telecom cybersecurity?". Available at https://www.darktrace.com/cyber-ai-glossary/cybersecurity-in-telecommunications (accessed on 14 February 2025).

Privacy and cybersecurity are among the most developed areas of AI-related regulation, particularly in the European Union. The General Data Protection Regulation sets a global benchmark for personal data protection, including provisions relevant to AI, such as automated decision-making, data minimization and explicit consent. The Cyber Resilience Act and NIS 2 Directive in the European Union strengthen security requirements for AI-enabled digital products and critical infrastructure. Globally, countries like Japan (via the Act on the Protection of Personal Information) and South Korea (through the AI Basic Act) incorporate cybersecurity and privacy into their AI governance regimes. Voluntary frameworks such as the National Institute of Standards and Technologies (NIST) AI Risk Management Framework and the ISO/IEC 27000 series guide risk-based approaches to AI cybersecurity and privacy. On the multilateral level, initiatives such as the OECD AI Principles and the Association of Southeast Asian Nations' Expanded Guide on GenAI Ethics promote baseline standards for responsible data handling and system security.

Despite strong progress in certain regions, there are significant disparities in global privacy and cybersecurity protections. Few regulations specifically address cybersecurity for continuously evolving AI systems, such as those in autonomous robotics or adaptive medical devices. Enforcement capacity is another major gap – many countries lack the technical or institutional resources to ensure compliance, especially when it comes to proprietary AI systems. Additionally, cybersecurity frameworks do not usually account for vulnerabilities unique to AI, such as adversarial attacks on training data or model poisoning. These gaps leave room for exploitation and risk undermining trust in AI systems, particularly in high-stakes domains like healthcare, finance and critical infrastructure.

6.1.6 Physical safety

Robots in our personal spaces – considering physical risks of robot-human interaction

While technological advancements in robotics have created new avenues and opportunities for social good, they have also raised several concerns. Physical safety is a major concern for robotics engineers, especially in domestic and public settings. Cobots, or robots designed to assist people, can relieve humans from performing heavy, repetitive or dangerous tasks. However, if not correctly calibrated, their jarring movements might cause stress in human operators who work alongside them.[180] Furthermore, a robot's communication skills and impact on task organization can place psychological pressure on people. Personal-use robots, such as humanoid assistants, may also inadvertently harm children or pets by failing to detect their presence or by applying excessive force.[181]

Physical safety in AI and robotics is receiving growing attention, especially in regions with advanced manufacturing and automation sectors. The European Union Machinery Regulation (2023/1230) introduces forward-looking requirements for AI-enabled machinery, including autonomous behaviour thresholds, lifetime cybersecurity responsibilities and collaborative risk mapping in shared human-machine environments. It builds on the earlier Machinery Directive (2006) but explicitly expands its scope to account for learning systems. The General Product Safety Regulation (2024) also includes AI-powered consumer products, requiring ongoing safety monitoring and post-market risk mitigation. Beyond the European Union, the American National Standards Institute and

180 Luca Negri and others, "Mental workload and human-robot interaction in collaborative tasks: a scoping review", *International Journal of Human-Computer Interaction*, vol. 40, No. 20 (2024).

181 Harriet Cameron and others, "A taxonomy of domestic robot failure outcomes: understanding the impact of failure on trustworthiness of domestic robots", *TAS '24: Proceedings of the Second International Symposium on Trustworthy Autonomous Systems*, art. No. 7 (2024).

ISO safety standards (e.g., ISO 10218-1 for industrial robots and ISO/TS 15066 for collaborative robots) guide manufacturers, and the United States' Food and Drug Administration evaluates AI-powered medical devices under existing regulations. South Korea and Japan have issued robot-specific safety rules, such as mandatory insurance, damage compensation frameworks and amended industrial safety protocols.

Nevertheless, most safety standards were designed for static systems and are not fully equipped to address the unpredictable behaviour of learning AI models. As AI evolves, calls have been made for an increase of safety-by-design mechanisms for emerging autonomous systems such as drones, surgical robots, or AI-powered vehicles in civilian spaces. Moreover, liability remains a complex issue, with shared accountability across supply chains (e.g., between data trainers, hardware producers and algorithm developers) only beginning to be addressed, notably in the European Union's revised Product Liability Directive.

6.1.7 Interpretation errors and bias

Robot-human misunderstandings – from inappropriate responses to reward hacking

Companies have increasingly explored the integration of LLMs as human interfaces to robots. These models have been shown to misinterpret prompts, produce false content (colloquially termed "hallucinations") and occasionally engage in inappropriate chats with users. Robots with these integrations face risks of misinterpretation and harmful interactions, potentially resulting in dangerous scenarios. Another critical issue is reward hacking, a phenomenon observed in AI systems where an algorithm meets a specific objective but fails to achieve the intended goal.[182] In robotics, this can lead to misinterpreted commands or a failure to recognize emergencies.

Moreover, robotic systems are increasingly connected to the Internet for a variety of reasons including utilizing generative AI models in their interfaces, uploading data for storage and downloading upgrades. As with any connected object, this may increase vulnerability to hacking or other forms of cyber-attacks, which may lead to undesirable behaviour. Given the physical nature of robots, there is an additional concern of physical harm resulting from cyber-attacks. Therefore, there is a need to ensure that robots meet cyber-security standards, are embedded with fail-safe systems, and can operate safely and reliably in human environments – particularly in cases of exposure to children, the elderly or pets.[183]

As robots gain greater autonomy and operate with less human oversight, there is a growing risk that biases embedded in AI systems will influence decision-making processes.[184] Inaccurate or biased datasets can result in algorithms that reinforce gender and racial stereotypes. For example, service robots in customer-facing roles have been known to unintentionally discriminate against, ignore or offend certain demographic groups.[185] Similarly, biased AI algorithms can impact critical decisions regarding eligibility for housing, financial assistance or healthcare access. Over the

---

182 Zachary Arnold and Helen Toner, "AI accidents: an emerging threat", Center for Security and Emerging Technology, July 2021.

183 Interview conducted via videoconferencing technology with Selma Šabanović, Associate Dean for Faculty Affairs and Professor of Informatics and Cognitive Science at Indiana University, December 2024.

184 Christina Pazzanese, "Great promise but potential for peril", Harvard Gazette, 26 October 2020.

185 Jie Zhu and others, "Fairness-sensitive policy-gradient reinforcement learning for reducing bias in robotic assistance", 2024 33rd IEEE International Conference on Robot and Human Interactive Communication, Pasadena, California, 26-30 August 2024.

last few years, as generative AI tools have gained in prominence, they have provided immense opportunity for more responsive and effective human-robot interfaces. However, the risk of physical harm is concurrently present.

Interpretation errors and bias in AI systems are acknowledged in several policy frameworks, particularly in high-risk domains like criminal justice, healthcare and hiring. The European Union AI Act addresses this issue by requiring conformity assessments, transparency documentation and risk mitigation strategies for high-risk systems, which include safeguards against systemic bias and misinterpretation. The Council of Europe Framework Convention on AI and Human Rights emphasizes the need to prevent discriminatory impacts and to uphold fairness and accountability in algorithmic decision-making. Voluntary standards such as the NIST's AI Risk Management Framework, ISO/IEC 22989 (AI concepts and terminology) and ETSI GR SAI 007 (explicability of AI processing) provide methodological guidance for detecting and reducing bias and interpretation errors throughout the AI lifecycle. National frameworks, including the Netherlands' Fundamental Rights and Algorithms Impact Assessment and Chile's GobLab Ethical Algorithms Project, attempt to institutionalize error detection and review mechanisms within public systems.

Nevertheless, this policy domain continues to be an important area of debate among regulators. Regulations and standards tend to focus on inputs (such as data quality and transparency) rather than enforcing thresholds for outcomes (such as error rates, harm severity or human rights). There are no consistent criteria across jurisdictions for what constitutes unacceptable bias, and few regulations require third-party auditing or validation of model outputs. Additionally, few frameworks account for compounded bias in multi-layered systems – where an AI output feeds into another algorithm – or errors that emerge from real-time adaptation and user interaction (e.g., in recommendation systems or dynamic pricing). In many low- and middle-income countries, institutional capacity to audit models is limited, and regulatory bodies lack access to technical documentation or source code. As a result, individuals and groups affected by interpretation errors often have limited pathways for redress or transparency.

6.1.8 Human labour effects

Addressing the evolving effects of AI on the employment market

Robots are expected to replace human labour across various industries. Goldman Sachs estimates that 25 per cent of tasks could be automated by AI in the United States and Europe, while Oxford Economics projects that robots could displace 20 million manufacturing jobs by 2030.[186] This widespread job loss risks exacerbating economic inequality, particularly in sectors such as manufacturing, transportation and retail, where low-skilled workers are most vulnerable.[187] A study from the University of Pittsburgh found that workers who operate alongside industrial robots suffer a higher risk of mental health concerns owing to job insecurity.[188] In contrast, a comparative study in Germany found no significant mental health effects from automation, largely due to stronger employment protection legislation.[189] Additionally, robotic integration may shift the roles of humans in the workplace to commanding and supervising robots, and create new roles around robot maintenance and repair.

[186] Jan Hatzius and others, "The potentially large effects of artificial intelligence on economic growth", Goldman Sachs, 26 March 2023, p. 7; Oxford Economics, "How robots change the world: what automation really means for jobs and productivity", June 2019, p. 4.

[187] Shoplogix, "Robotics in manufacturing: the big impact on job roles", 7 November 2023.

[188] Rania Gihleb and others, "Industrial robots, workers' safety, and health", *Labour Economics,* vol. 78 (October 2022).

[189] Ibid.

A recent report by LinkedIn emphasizes gender disparities in AI skills, separating jobs into three categories – those that will be augmented by AI, those that will be disrupted by AI and those that will remain unaffected by AI.[190] According to the report, women are more likely to occupy jobs that may be disrupted by AI, and when they are displaced, they remain in fields that could shrink due to AI. In the case of robotics, GeoAI and AI for communications networks, the most significant job disruptions have come from the integration of robots in manufacturing and agriculture. As we have seen, there have been numerous experiments with robots in care work, especially in eldercare. Currently, robot care workers are thought to mostly replace human labour in the case of labour shortages.

The transformative effects of AI on human labour are acknowledged in several national and multilateral strategies, though few policies directly govern this domain. The International Labour Organization's Observatory on AI and Work in the Digital Economy has been instrumental in informing policy solutions, with workforce reskilling and protection of vulnerable groups as key priorities. National initiatives such as India's Responsible AI for All, Singapore's National AI Strategy 2.0 and Kenya's Digital Master Plan recognize the need to prepare workers for AI-driven shifts, often through training programmes and upskilling efforts. Soft law instruments, including the OECD AI Principles and the Group of 7 Hiroshima Process, promote inclusive economic growth and encourage countries to manage the social and labour impacts of automation. Some regulatory guidance – such as in the Netherlands and Chile – also explores the ethical use of AI in algorithmic hiring and labour market interventions.

Despite increasing policy awareness, policy instruments addressing AI's impact on labour markets are lacking. There is no global or regional framework that mandates labour impact assessments for AI deployment, nor are there safeguards for workers who are displaced or monitored by AI systems at work. The European Union AI Act covers employment-related systems only when they significantly affect access to jobs, but it does not extend oversight to everyday algorithmic management tools used in gig work, logistics or employee monitoring. Protections against exploitative practices (e.g., opaque performance metrics or biased hiring algorithms) are largely absent in most national policies. Furthermore, there is limited international cooperation on social safety nets or labour rights in the AI economy, and reskilling initiatives often lack sustained funding, coverage and alignment with evolving job markets. Without proactive governance, AI risks exacerbating inequality and job precarity, particularly in economies dependent on routinized or outsourced labour.

6.1.9 Resource and energy consumption

Reducing energy consumption through AI systems and data centres

Despite the numerous benefits they provide, the operation of data centres needed to power modern technology, including AI, causes considerable environmental harm. A single hyperscale data centre consumes as much energy as nearly 80,000 households, and in the United States alone, demand for these facilities is projected to reach 35 gigawatts by 2030.[191] Ironically, processing terabytes of climate data is both costly and environmentally unfriendly, and it must be addressed by improving monitoring and investment in energy efficiency.[192] The average data centre requires

[190] Matthew Baird, Mar Carpanelli and Silvia Lara, "Generative AI and gender: global measures of workers in GAI classifications", LinkedIn Economic Graph, 6 March 2024.

[191] Srini Bangalore and others, "Investing in the rising data center economy", McKinsey & Company, 17 January 2023.

[192] Interview conducted via videoconferencing technology with Rohini Sampoornam Swaminathan, Climate and Environment Data Lead at UNICEF, November 2024.

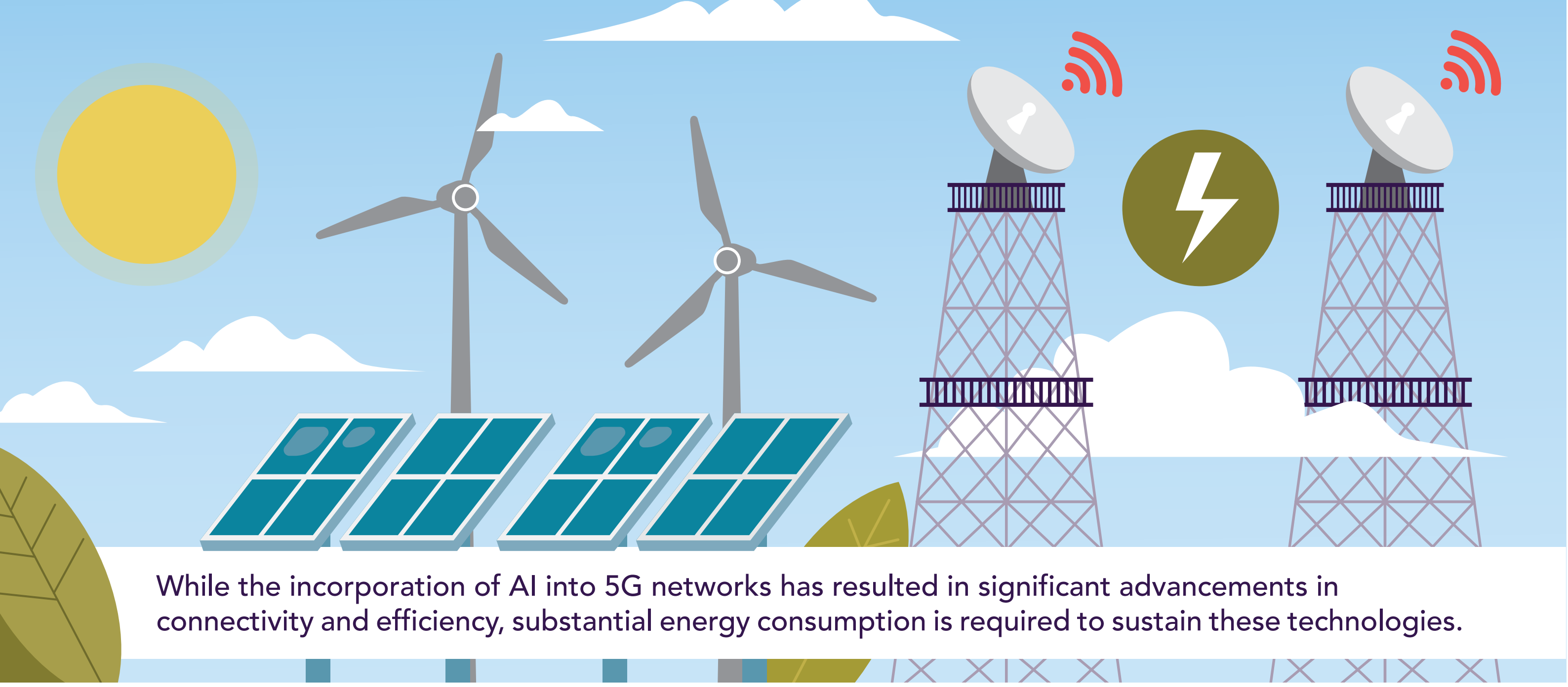


Figure 13: Resource and energy consumption

nearly 300,000 gallons of water every day for cooling, with Google's data centres alone consuming 5.6 billion gallons of water in 2022.[193] In comparison, an estimated 1.8 billion people live in regions facing absolute water scarcity.[194] These figures highlight a striking disparity: on the one hand, there is glaring inequality and resource scarcity, and elsewhere there are unsustainable and damaging levels of consumption.

The United Nations has recognized bridging the digital divide as a critical priority, especially given the substantial implications for the successful implementation of the SDGs. An estimated 5.5 billion people are currently connected to the Internet, but 2.6 billion individuals, predominantly in developing countries, remain offline.[195]

For example, Internet penetration in sub-Saharan Africa is only 36 per cent, compared to rates of more than 90 per cent in developed regions.[196] Furthermore, a significant global urban-rural divide exacerbates the disparity, with Internet connection available to 81 per cent of urban dwellers but only 50 per cent of rural populations.[197] Despite recent advances in closing the gender gap, of the share of those who still lack Internet access, women outstrip men by 17 per cent.[198] The COVID-19 pandemic highlighted the importance of addressing these inequities. One study showed that in the United States, those without connectivity were systematically excluded from essential services such as online education, telemedicine and remote work opportunities, and also were less likely to be vaccinated against the disease and more likely to contract it and die from it.[199]

5G networks hold significant potential to narrow the digital divide by enhancing connectivity and affordability, particularly in developing economies. It is expected that within the next decade, 5G technology could enable an additional 850 million people worldwide to access the Internet,

193 Michael Copley, "Data centers, backbone of the digital economy, face water scarcity and climate risk", NPR, 30 August 2022; Google, *Environmental Report 2023*, July 2023, p. 50.
194 FAO, "Water scarcity". Available at https://www.fao.org/land-water/water/water-scarcity/en/ (accessed on 18 May 2025).
195 ITU, "Facts and figures 2024", p. 1.
196 World Bank, "From connectivity to services: digital transformation in Africa", 27 June 2023; ITU, *Facts and Figures 2023 – Internet Use* (Geneva, ITU, 2023).
197 ITU, "Measuring digital development: facts and figures 2023", 2023, p. 6.
198 Ibid., p. 3.
199 Fei Li, "Disconnected in a pandemic: COVID-19 outcomes and the digital divide in the United States", *Health & Place*, vol. 77 (September 2022).

with a significant impact in regions such as India, Africa and the Middle East.[200] The integration of AI into 5G networks enhances its revolutionary potential, harmonizing with the objectives of the African Union's Agenda 2063 initiative.[201] This synergy may propel growth in vital industries such as agriculture, healthcare and education.

For example, in Kenya, the convergence of 5G and AI is being used to identify agricultural pests and diseases, increase crop yields, and deliver mobile-based financial and educational services to underserved communities through platforms such as Safaricom and Eneza Education.[202] Efforts such as UNICEF and ITU's joint initiative Giga demonstrate the utility of AI in mapping school connectivity and identifying gaps, allowing for targeted investments in digital infrastructure.[203] These efforts align closely with SDG 9, which highlights the importance of building resilient infrastructure, promoting inclusive and sustainable industrialization and fostering innovation, with digital inclusion serving as a cornerstone for achieving these objectives.

The incorporation of AI into 5G networks has resulted in significant advancements in connectivity, efficiency and the potential to bridge the digital divide, therefore contributing to the achievement of global digital inclusion objectives. However, this progress is accompanied by a number of risks that necessitate policy action.

A significant challenge associated with the integration of AI into 5G networks is the substantial energy consumption required to sustain these advanced technologies. The increasing data capacity and network densification which is inherent to 5G infrastructure results in energy demands that are almost twice those of 4G networks.[204] The development and deployment of AI technologies, particularly the training of large-scale AI models, also contributes to rising energy demand. For instance, training the multimodal LLM GPT-4 is estimated to consume 50 times more electricity than its predecessor, GPT-3, and generating a single AI image can use as much energy as is required to charge a smartphone halfway.[205] With the computational power for sustaining AI doubling every 100 days, it is anticipated that by 2028, AI will consume the same amount of power as did Iceland in 2021.[206]

This growing energy demand poses twin challenges. First, regions without reliable electricity, such as sub-Saharan Africa, risk being excluded from the benefits of AI and 5G technologies, inevitably worsening existing digital divides. Second, growing operational costs stemming from increased

---

200 Qualcomm, "5G and the digital divide", 2022, p. 12.

201 Elia Tsouros, "Digital horizons: how AI, IoT, and 5G are shaping Africa's path to Agenda 2063", Cambridge Management Consulting. Available at https://www.cambridgemc.com/digital-horizons-how-ai-iot-and-5g-are-shaping-africa-s-path-to-agenda-2063 (accessed on 14 February 2025).

202 Kenya National Innovation Agency, *Kenya Innovation Outlook (KIO)* (Nairobi, June 2024), p. 13; Carlos Mureithi, "High tech, high yields? The Kenyan farmers deploying AI to increase productivity", The Guardian, 30 September 2024.

203 UNICEF, "Meta and UNICEF working together to close the digital divide", 1 May 2023.

204 Viavi Solutions, "What is 5G energy consumption?" Available at https://www.viavisolutions.com/en-us/resources/learning-center/what-5g-energy-consumption (accessed on 14 February 2025).

205 Eleni Kemene, Bart Valkof and Ginelle Greene-Dewasmes, "AI and energy: will AI help reduce emissions or increase demand? Here's what to know", World Economic Forum, 22 July 2024; Alexandra Sasha Luccioni, Yacine Jernite and Emma Strubell, "Power hungry processing: Watts driving the cost of AI deployment?" in *ACM Conference on Fairness, Accountability and Transparency (ACM FAccT '24),* Rio de Janeiro, Brazil, 3-6 June 2024 (New York, Association for Computing Machinery, 2024).

206 Beena Ammanath, "How to manage AI's energy demand – today, tomorrow and in the future", World Economic Forum, 25 April 2024.

energy demand may hinder progress towards achieving global sustainability goals. Addressing these challenges necessitates a coordinated effort to promote energy-efficient technology, increase access to renewable energy sources and ensure that the deployment of AI and 5G networks is consistent with international climate and sustainability commitments.

The environmental impacts of AI are beginning to receive policy attention, particularly through soft law and integrated digital strategies. The Framework Convention on AI and Human Rights and the Paris Charter on AI in the Public Interest emphasize sustainability and the responsible use of AI to address global challenges, including climate change. UNESCO's Recommendation on the Ethics of AI (2021) explicitly includes environmental sustainability as an ethical imperative. Some national strategies, such as the Netherlands' digital well-being policy and Chile's Franco-Chilean AI Center, incorporate environmental monitoring and sustainability into AI development goals. Additionally, research funding mechanisms like the European Union's Horizon Europe and Destination Earth support the use of AI in environmental modelling, geospatial monitoring and early warning systems.

Despite emerging initiatives, environmental considerations remain underrepresented in AI policy. Most regulations (e.g., the European Union AI Act, the General Data Protection Regulation and the Cyber Resilience Act) do not include sustainability requirements, lifecycle energy efficiency or carbon impact disclosures for AI models or infrastructure. There is no global framework that mandates environmental impact assessments for AI systems, despite the growing energy footprint of large-scale models. Moreover, environmental data used by AI systems is often fragmented and lacks standardization, complicating cross-border applications like climate modelling or biodiversity monitoring. The absence of AI-specific environmental standards within ISO/IEC or national standards bodies also limits the capacity to benchmark and mitigate AI's environmental cost. As the environmental toll of AI grows with compute demand, particularly for generative models and real-time systems, this gap poses long-term risks to sustainability and global climate goals.

6.2 Five pathways towards AI for good

There are numerous policy implications to utilizing AI in a way that will have a positive global impact. These include addressing gaps in infrastructure, talent and data in ways that are sustainable, and mitigating or preventing some of the most important risks of AI tools to protect values and rights globally. To accomplish these goals, stakeholders in the policy, research and private sector spheres need to focus on five pathways towards AI for good: data quality, access and governance; digital infrastructure and access; AI literacy and talent; responsible AI policy; and digital ecosystem development. Together, they provide a holistic way forward for sustainable and beneficial AI development.

Although the three categories of AI discussed in this report – robotics, GeoAI and AI for communications networks – all present distinct opportunities, they can only be harnessed with a concerted multi-stakeholder effort that accounts for challenges such as inequality and cost, and risks to human rights and the environment. AI development for good is not accidental, it is intentional.

6.2.1 Data quality, access and governance

Data is fundamental to AI broadly, and especially AI for good. The Data Governance Objective of the Global Digital Compact outlines several actions that are meaningful to human and planetary well-being, notably in increasing data collection for sustainable development and committing to the development of data governance principles, coordinated by the Commission on Science and Technology for Development. Data governance questions address not only availability and access but also protection and ownership from communities represented in the datasets. The predominance of data-rich countries and the lack of high-quality, timely and interoperable data in developing contexts exacerbates algorithmic bias and policy misalignment. Geospatial data especially, which underpins 80 per cent of AI applications in development, remains fragmented and outdated in many regions. While policies and standards exist to promote data governance and interoperability, there are important gaps in coverage – leaving most human beings underrepresented in datasets and unprotected when it comes to privacy.

6.2.2 Digital infrastructure and access

One of the critical characteristics of AI development over the last few years has been its concentration in a few countries, leading to concerns about an increase in the global digital divide. Foundational to addressing this is enabling access to technologies in the form of building the necessary infrastructure for AI development – data centres, connectivity, computational capacity and energy sources – while also ensuring local access to this infrastructure. Although AI tools have become increasingly accessible – enabling software development on mobile phones, for example – ensuring that countries are able to genuinely focus their AI ecosystem for human and planetary well-being requires stable and accessible infrastructure.

AI systems such as those used for communications networks rely on robust physical infrastructure that is still lacking in many low-income countries. The African Union's Digital Transformation Strategy and initiatives in Kenya and Indonesia highlight the need for targeted infrastructure investments, but implementation remains fragmented. Without globally coordinated action and policy, these gaps risk deepening digital divides. Furthermore, the lack of interoperability across infrastructure layers, especially between geospatial standards and AI platforms, hinders effective deployment. Bridging these divides requires long-term public financing, regional cooperation and policy harmonization that embeds accessibility and equity into AI infrastructure planning.

6.2.3 AI literacy and talent

Data and digital infrastructure provide the necessary components for AI that must then be utilized by competent users and developers. However, there is a key difference between the two, with AI literacy now a necessary part of the education of every child and young adult. Educational systems globally have begun teaching modules allowing for participation in the AI economy, including understanding the tools, choosing appropriate use cases, following digital etiquette and reducing risks. AI literacy goes hand in hand with other forms of digital training, such as Internet and social media literacy and data protection.

Digital literacy is both a prerequisite and an outcome of inclusive AI systems. Yet, as was noted earlier in this report, nearly one-third of the global population remains offline, and only 40 per cent of people worldwide are considered digitally literate. The gender digital divide and rural-urban disparities – particularly in sub-Saharan Africa and parts of Asia – limit not only access to information but also participation in the design and governance of AI systems.

AI talent development may stem from AI literacy, but it has far-reaching implications for the deployment of AI for good tools. This research has identified three areas of action – AI training, capacity-building and talent retention. Several universities worldwide provide high-quality education that combines technical skills in computer science and engineering with social science and environmental training to support responsible development. This type of dual degree can be expanded to universities currently lacking an AI programme to support talent development. It can also be combined with continuing education training for professionals looking to pivot to AI from other fields. In this case, however, a critical consideration is talent retention. Many countries invest in university education for their youth, who then find employment opportunities elsewhere. Talent development must be paired with a retention strategy that provides meaningful opportunities for those who have been trained in AI.

6.2.4 Responsible AI policy

Current AI policies are being developed at local, national and global levels. Since the UNESCO Recommendation on the Ethics of AI was adopted in 2021, a significant portion of countries around the world have adopted AI strategies, with some, such as members of the European Union, adopting comprehensive safety legislation. Global AI standards, such as those developed by ITU, ISO and IEC, cover many dimensions of responsible AI. As societies become increasingly digitized, concerns are growing about the environmental impact of AI, as well as risks to privacy and other human rights. Benefiting from AI along the lines of the applications discussed here will require continued policy support. At the global level, two important policy avenues for ensuring responsible AI development are identified in the Global Digital Compact – the creation of an international scientific panel on AI and the organization of regular global dialogues on AI.

Building responsible AI policy means not only extending existing legal frameworks but also ensuring that these are implementable, context-sensitive and globally harmonized, with mechanisms for redress, transparency and public oversight.

6.2.5 Digital ecosystem development

Finally, AI for human and planetary well-being can best be developed within vibrant digital ecosystems. There are many examples of such ecosystems worldwide, which have enabled researchers and technology developers to create meaningful AI solutions. Some examples include Indonesia, which has produced many AI products that are used widely in the region; Kenya, which aims to be one of Africa's leading AI centres; and Brazil, which has identified the state of Rio Grande do Sul as the site of a Scala AI City, where the sustainable data platform Scala Data Centers is building massive data centres.

One proposed model has been the development of AI Centres of Excellence in different regions of the world, which would support research on specific issues such as climate change and natural disaster management. In addition to Centres of Excellence, digital ecosystems benefit from a holistic approach that involves four main stakeholder groups – governments, which can act as clients for AI applications for good, as well as create strategies and policies to encourage responsible innovation; the private sector, which can set up research labs and foster the development of a start-up environment; academia, which can offer specialized technology degrees and provide pathways for students to turn their research into products; and civil society, which can participate in the development of AI for good initiatives and advise on ethical considerations.

6.2.6 Conclusion

As AI becomes increasingly embedded in the infrastructure of public policy, development and humanitarian action, its opportunities and challenges grow in tandem. While AI holds immense potential to accelerate progress towards the SDGs, its benefits and risks remain unevenly distributed. To ensure AI technologies support rather than undermine human and planetary well-being, a systems-level approach is needed that integrates ethical, inclusive and sustainable design and deployment practices into the heart of global governance frameworks.

The five pathways outlined in this report – data quality, access and governance; infrastructure and access; digital literacy and talent; responsible AI policy; and ecosystem development – emerge from persistent challenges observed in current AI deployments across low- and middle-income contexts. Drawing on global policy trends and region-specific experiences, they offer a blueprint for an equitable digital future. Together, they reinforce the necessity of embedding human rights, environmental sustainability and inclusive participation into the operational and ethical core of AI systems.

More broadly, this research has shown 10 applications of AI for good that can have meaningful impacts on human and planetary well-being. These applications have been developed by numerous participants in the dynamic and diverse AI for Good community (see Annex A). The next few years are sure to reveal significant advances in both the development of AI and the policies that will guide it. The objective of this report is to provide direction for AI to evolve towards beneficial and responsible solutions.

7

Annex A: Bios and interview summaries

7.1 Robotics

1) **Nicolas Simon** – Founder and President of Wandercraft

Nicolas Simon founded Wandercraft, a French company that develops hands-free exoskeletons for impaired people, in 2012 due to his personal connection through family members to Charcot-Marie-Tooth, a disease that causes nerve damage and muscle weakness. His work led to the introduction of the first commercial self-balancing exoskeleton that uses AI to facilitate movement for people with mobility impairments.

Simon shared that the field of AI robotics is moving from model-based algorithms to AI- and neural network–based algorithms that will allow robots to manage obstacles, go up and down stairs, and mimic human behaviour. This includes the development of purely autonomous systems that do not require input from their users. He expressed the need for functions in robotic devices that mitigate risks and the establishment of guidelines around the baseline assumption that devices will fail. To bridge gaps in understanding and encourage adoption by professionals, he advocated for increased knowledge sharing initiatives on the benefits of AI in the medical field and structured communication on where it can add value.

2) **Davide Scaramuzza** – Professor and Director of Robotics and Perception Group at the University of Zurich

At the University of Zurich, Scaramuzza's research explores the convergence of robotics, computer vision and ML to develop vision-based autonomous navigation micro drones to be used in GPS-denied environments to address real-world challenges. In 2012, he co-founded SUIND, which develops drones that use remote sensing for precision agriculture to reduce chemical usage and promote healthier crops. He received a PhD in Robotics and Computer Vision at Eidgenössische Technische Hochschule Zurich in 2008.

Scaramuzza discussed how drones allow the deployment of preprogrammed, autonomous inspection and 3D mapping of bridges regularly or even every day, a task that has traditionally only been completed once every few years. This demonstrates how the application of drones permits the reallocation of human labour to be used to assess information rather than spend time gathering it. He emphasized the importance of defining key terms in the field and sharing best practices on the use of sensors to map environments, and the growing use cases for humanitarian drones. He highlighted that further research is required to increase the quality of images captured by drones during quick flights and cited aerodynamic effects and short battery life as current limitations. He predicts that as GPUs develop, LLMs like ChatGPT and LVMs may become incorporated into drones and transform the way we programme them, reduce barriers of entry and improve human-machine interactions.

3) **Olivier Lambercy** – Adjunct Professor and Deputy Director of the Rehabilitation Engineering Laboratory at Eidgenössische Technische Hochschule Zurich

At ETH Zurich, Lambercy's principal research interest is in the development of machines, tools and robotic technologies to support therapy for patients recovering from neurological injuries that impact the nervous system, such as strokes. He received a PhD at the National University of Singapore in 2009, in collaboration with Simon Fraser University in Canada and Imperial College London.

Lambercy explained that he develops systems that permit patients to continue their therapy programmes independently after discharge to better regain lost functionality. He shared that the most prominent use of AI within the rehabilitation engineering and assistive devices field is to analyse signals received from humans to decode muscle or brain activity and assess movement components data to detect a patient's intention to move. More specifically, he said AI allows robots to analyse how much force a patient exerts during rehabilitation therapy and adjust the difficulty of the exercise according to the patient's level of success. Robots can also raise flags if the exercise is completed incorrectly. He explained that these tools allow rehabilitative therapy to be personalized according to a patient's capabilities and provide increased performance feedback to therapists. He said the reproducibility of results and clarification of a robot's decision-making process will be key factors in encouraging clinicians and therapists to build trust in robots.

4) **Selma Šabanović** – Associate Dean for Faculty Affairs and Professor of Informatics and Cognitive Science at Indiana University

Šabanović studies the design and use of social robotics, particularly socially interactive and assistive robots used in healthcare domains and personal spaces. She received a PhD in Science and Technology Studies at Rensselaer Polytechnic Institute in 2007. In 2010, she founded and directed the R-House Laboratory for Human-Robot Interaction research at IUB.

Šabanović noted that collaborations with local healthcare facilities through standalone engagements or long-term partnerships provide knowledge sharing opportunities for researchers and healthcare professionals to explore new use cases for SARs, and reveal areas for further development. She highlighted that participatory studies provide information on what kinds of tasks people want to use robots for, challenges in design constraints, how the use of robots impacts social or organizational dynamics, and privacy concerns. She cited the importance of defining a robot's role to set expectations on its interactions with humans. She mentioned that the community is beginning to view robots as more social and needs to consider their relational implications, such as how a robot's disclosure of personal information can impact a human's social relationships. When asked about risks, she said that there have been many standards implemented around robotic safety, but guidelines around the social, emotional and relational effects of these technologies require more attention. Lastly, she called for more inclusive participation from communities where robots are not being developed, to ensure their perspectives can be considered during the design process.

5) **Shelly Levy-Tzedek** – Director of the Cognition, Ageing and Rehabilitation Laboratory and Associate Professor in the Department of Physical Therapy at Ben Gurion University

Levy-Tzedek's lab studies the effects of age and disease (e.g., Parkinson's disease and stroke) on the control of body movement and the employment of robots to facilitate rehabilitation. She was selected as one of Israel's most promising 40 under 40 professionals by the *Marker Magazine* in 2016. She received a PhD in Biomedical Engineering at the Massachusetts Institute of Technology in 2008.

Levy-Tzedek spoke about her commitment to encouraging critical thinking about how robots for "good" is defined, transparency in how their impact is measured and the establishment of safeguards against harm to humans. Her interest was inspired by a concern that robotics and embodied AI can be over-romanticized without enough emphasis or transparency around their potential harm. She underscored the need to prioritize opportunities for participatory design to help engineers build technologies that people will use. She believes embodied AI presents a greater risk than social media, emphasizing the need for proactive regulation to ensure developers prevent emotional harm. She said that regulation today primarily focuses on addressing physical harm but should include measures to protect emotional safety as well. She also called attention to the risk of robots manipulating their users, such as coercion to purchase unnecessary software updates, and the lack of oversight in monitoring these unintended consequences. [See page 51 for coverage of the Robots for Good workshop she co-organized during the 2024 AI for Good Global Summit.]

7.2 Geospatial

6) **Maria Antonia Brovelli** – Professor of GIS at Politecnico di Milano

Brovelli's principal research interests are in the fields of geomatics and open-source GIS. She is the coordinator of the Copernicus Academy Network at Politecnico di Milano (PoliMi), Head of an Interdepartmental PoliMi lab called GeoLab, and a member of the School of Doctoral Studies in Data Studies at Roma "La Sapienza" University. She also serves as President of the United Nations' Global Geospatial Information Management Academic Network and Co-Chair of the United Nations' Open GIS Initiative. She lectured on GIS at ETH Zurich from 2006 to 2011 and served as Head of the Geomatic Laboratory of PoliMi from 1997 to 2011. She received a PhD in Geodesy and Cartography from PoliMi.

Brovelli noted that gaps in data can introduce bias in models that overestimate what is happening in the developing world and reduce consideration of developing regions that have less available data. She stated that the United Nations should encourage transparency in data and software, particularly through open-source models, so that anyone can verify their contents to mitigate bias. She argued that there is a dangerous tendency to overly rely on AI-based methods, even when traditional methods may be more appropriate in certain scenarios. To address this, she recommended teaching people how to qualify the results from AI-based methods and developing confidence in whether the solutions can be trusted.

7) **Pengyu Hao** – Information Technology Officer in the Digitalization and Informatics Division, FAO

Hao's work at FAO focuses on identifying crops using time series remote sensing data. He received a PhD from the Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences in 2017.

Hao discussed how FAO workers use AI for remote sensing data processing in order to identify crops and develop agricultural indexes, alongside filling gaps when data is missing or gathering new data to compare with existing, but unreliable data. He touched on the use of AI for direct data analysis, such as in developing a toolkit that forecasts diseases affecting humans and livestock. He explained that the emergence of AI in remote sensing has changed the work performed by analysts, which now focuses on designing algorithms to evaluate the performance of AI methodologies. He recommended AI solutions that are highly visual and easy to use without technical skills to help higher-level management grow more comfortable adopting AI in their work.

8) Monique Kuglitsch – Innovation Manager at Fraunhofer Heinrich Hertz Institute

Kuglitsch's research investigates past climate change, extreme weather events and resilience to natural disasters. In addition to her position as Innovation Manager at Heinrich Hertz Institute, she is the Chair of the Global Initiative on Resilience to Natural Hazards through AI Solutions. Previously, she served as the Chair of the Focus Group on AI for Natural Disaster Management and managed operations for the ITU–WHO Focus Group on AI for Health.

Kuglitsch anticipates AI adoption in the geosciences space to grow as use cases provide greater understanding around natural hazards, improve forecasting and detection capabilities, and develop trustworthy decision-making abilities, through interpretable and explainable AI. She cited issues with transparency as the greatest risk to be addressed when establishing AI standards. This includes transparency about the tools and data used by AI models, particularly to assess their vulnerability to biases. Highlighting that academic researchers provide essential contributions to the Focus Group on AI for Natural Disaster Management for deploying models and standards, she emphasized the need for mechanisms and resources to encourage their participation, especially experts in the Global South.

9) Rohini Sampoornam Swaminathan – Climate and Environment Data Lead at UNICEF

Swaminathan is an expert in geospatial analysis and risk management with a background of over 13 years of international experience in humanitarian and development sectors. She currently serves as the Climate and Environment Data Lead at UNICEF, was previously Head of the Geospatial Unit at the WFP, and has also assumed diverse roles in UNDP, WHO, UNOSAT and NASA DEVELOP.

Swaminathan spoke on the wide potential of GeoAI to organize massive, extremely complicated global climate data and operationalize it into a form that is suitable for decision makers to use. She conveyed that GeoAI could have a transformative effect on the scale and speed at which data is assessed compared to the process of standard GIS analysis, therefore allowing for more timely decision-making. She cited AI use cases for filling data gaps on historical hazards to examine regional or national data and generating chatbots to help people interact with this data using simple, natural language. Finally, she expressed the need for forums and open discussion groups where experts can gather to consider what AI solutions can be practically used, its ethical limitations, and what purposes they serve to avoid overestimating AI capabilities.

10) Andrew Zolli – Chief Impact Officer at Planet Labs

Zolli's work focuses on the application of satellite imaging for sustainable development, humanitarian aid and the acceleration of action to address global issues. Planet Labs has designed and built the largest constellation of earth-observing satellites in history. Zolli served as the Chair and Interim President of the Garrison Institute from 2015 to 2017, and currently serves on the International Board of Directors of Human Rights Watch. He is the author of the book *Resilience: Why Things Bounce Back*, which advances the global dialogue on how people and systems can withstand disruption.

Zolli conveyed that AI plays a key role in harmonizing raw data to make it available for use by humans, such as through the creation of models that track planetary variables to monitor the SDGs. He shared applications of Earth-observing technology for forest conservation, including an algorithm that can detect pre-indicators of deforestation in Brazil and send automated, AI-generated reports to the environmental police. He asserted that developers have an affirmative responsibility to ensure the ethical use of these tools, and that they must calibrate their models to reduce the potential for abuse. He envisions a future where AI models analyse satellite imagery to index geospatial data and develop queryable models using LLMs, in order to equip policymakers with vast amounts of information that can guide real-time and predictive decision-making.

11) Rui Kotani – Disaster Risk Reduction Coordinator at the Group on Earth Observations Secretariat

Kotani's work supports global intergovernmental partnerships on disaster risk reduction, discussions on risk knowledge and improvements in climate information and early warning systems. In her role at the Group on Earth Observations Secretariat, she serves as the point of contact for the Early Warnings for All initiative. Prior to this, she served as Associate Senior Administrator at the Japanese Aerospace Exploration Agency from 2020 to 2021 and as a Science and Technology Specialist for the Firm Capability and Innovation Global Practice at the World Bank from 2018 to 2020. She is a participant in the GEO working group on Disaster Risk Reduction, Climate Change and Capacity Development.

Kotani explained AI's ability to manage massive Earth observation datasets to assess the exposure of critical infrastructures and masses of people to potential natural hazards. She spoke on the importance of open data in creating trustworthy solutions and providing results that are not skewed due to misinformation. She noted that AI technologies for early warnings and climate adaptation can be very broad, but the lack of cooperation between stakeholders contributes to missed opportunities for cross-sectoral application. She emphasized that technology providers must work with local communities, governments and beneficiaries to overcome doubt and co-develop effective AI-driven data products. As such, she recommended the provision of more mechanisms that allow beneficiaries and potential users of emerging technology from developing countries to attend knowledge sharing.

7.3 Communications networks

12) Paul Harvey – Lecturer in Autonomous Systems at the University of Glasgow

Harvey's work explores the design and performance of operating systems, embedded systems and autonomous systems. He currently serves as the Vice Chair of the Focus Group on AI-Native for Telecommunication Networks and served as Co-Chair of the Focus Group on Autonomous Networks. He received a PhD in Adaptive Runtime Systems from the University of Glasgow in 2015.

Harvey spoke about his research integrating autonomous operation into networks and raised questions regarding what metrics should be considered when granting trust in autonomous networks. He pointed out the pressure on members of the existing workforce to improve their skills and training according to how modern systems work. In particular, he emphasized the growing demand to learn code and gain proficiency in ML algorithms. He expects the role of automation in communications networks to increase within the next two to three years, including greater integration of digital twins to validate and improve them, as well as the utilization of LLMs and generative AI.

13) **Francesc Wilhelmi** – Research Engineer in the Radio Systems Research Group at Nokia Bell Labs

Wilhelmi's principal research interests are in the development and evolution of Wi-Fi technologies, ML and AI-native networks. Before joining Nokia Bell Labs, he served as a researcher at Centre Tecnologic de Telecomunicacions de Catalunya. He received a PhD in Information and Communication Technologies in 2020 from Universitat Pompeu Fabra.

Wilhelmi said the greatest obstacle to integrating AI into telecommunications and wireless networks is a lack of mechanisms to make AI adaptable enough to withstand environmental changes to operate successfully. He also noted the uncertainty of AI features working reliably as a barrier to adoption. He explained that AI integration into networks progresses slowly because the field of telecommunications develops faster than our capacity to implement changes, leaving little room to experiment with the development of AI and ML features for existing systems. He emphasized the importance of establishing consensus in the standardization process, especially regarding how telecommunications should be governed and what types of AI must be considered in the standards.

14) **Abhishek Dandekar** – Research Associate at Fraunhofer Heinrich Hertz Institute

Dandekar's research focuses on RANs, 5G and 6G network projects, and AI-native networks. Prior to serving in his position at Fraunhofer Heinrich Hertz Institute, Dandekar supported the Information Networking Lab at the Indian Institute of Technology in Bombay.

Dandekar stated that AI and ML pipelines have significant potential to optimize RAN by providing new ways to control and manage network functions. He shared that while AI is frequently cited as a means for energy optimization in networks, discussions often fail to consider how much energy will be required to run the AI systems and where the AI will be located (e.g., within edge data centres in densely populated areas or in the cloud, which demands less energy). He highlighted nonterrestrial networks and nanosatellites as new technologies that can increase access to network connectivity and can address the digital divide. He explained the importance of local startups partnering with small research institutes to overcome operational and capacity constraints by sharing resources, such as GPUs and servers capable of running open-source telecom networks.

15) **James Agajo** – Professor at Federal University of Technology Minna

Agajo's principal research interests include wireless communication, spectrum management, computer system design, and AI and embedded systems. Agajo has lectured and conducted research for over 20 years. He received a PhD in Telecommunication and Computer Engineering at the Federal University of Minna in 2013.

Agajo described how young innovators in Africa are using proficiency in AI technologies to bridge gaps, develop technical skills and increase economic opportunities. He spoke about a project for a hospital in Uganda that utilized LLMs for personal assistants and how his students are taking advantage of similar opportunities to develop AI solutions as consultants. He mentioned the lack of access to consistent power supplies, hardware, data and Internet connectivity as barriers to capacity-building. To address the digital divide, he advised international bodies to place greater emphasis on understanding the different conditions faced by communities in developing countries and urged greater support in accessing knowledge sharing events.

16) Vincent Vanhoucke – Distinguished Engineer at Waymo

Vanhoucke's research covers AI and ML, speech recognition, computer vision and robotics. Before joining Waymo, he founded and led the robotics research team, now part of Google DeepMind, for nearly 17 years. He also serves as a Director for the Robot Learning Foundation. He received a PhD in Electrical Engineering from Stanford University in 2003.

Vanhoucke cited the development of LLMs and multimodal models as key drivers of the AI revolution because of their impact on how robots reason and understand the world. He described how the deployment of robots in semi-structured environments with humans, such as warehouses, increases opportunities to examine human-robot interaction and helps bring robotics to scale. Noting that technology progresses quickly, he stressed the importance of dynamic policy guidelines that can be implemented at a fundamental level initially, then adapted as robotics develop. He explained that this approach will allow policymakers to take a methodological approach in classifying different levels of robotic capabilities and determining policies accordingly.

UNU-CPR
New York (Headquarters)
767 Third Avenue 35B
New York, NY 10017
United States
Tel: +1-646-905-5225
Email: comms-cpr@unu.edu

Geneva
Maison de la Paix
Chemin Eugène-Rigot 2E
Geneva, Switzerland.
Tel: +1-917-225-0199
Email: comms-cpr@unu.edu

ITU
Place des Nations
CH-1211 Geneva 20
Switzerland