Sida

Climate Tech

THEMATIC BRIEF

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This brief aims at explaining the potential of linking/using climate tech to reduce vulnerability and increase resilience to climate change amongst the poorest segments of society as well as exploring how to contribute to mitigation measures and a just transition for developing countries/for all.

As the Intergovernmental Panel on Climate Change shows, climate change is no longer a distant threat, but a reality that threatens the livelihoods and opportunities of the most vulnerable and marginalized social groups and communities. The intense fires in the Amazon, the Arctic circle and California, the continued loss of biodiversity, degradation of important ecosystems, and the emergence of novel diseases of animal origins all illustrate the complex risks and impacts associated with these changes.

Sensors, satellite technologies, autonomous drones, Internet of Things (IoT) and applications of artificial intelligence are at the verge of altering how we communicate, collaborate. These technologies could, if developed with a clear direction and used responsibly, help the world accelerate innovations that would support a transition to climate mitigation, help protect and steward key ecosystems, and help the most vulnerable achieve a just and prosperous future within planetary boundaries.

Technological innovation and change are closely associated with scientific breakthroughs, economic development, and the prospects for global sustainability (Arthur 2009; Folke et al. 2020; Westley et al., 2011). The last decades of rapid changes on our planet such as demographic change, increased connectivity through (amongst other) digital technologies, and increased emissions of greenhouse gases known as the "Great Acceleration" have all been underpinned by stunning technological advances (Galaz 2014). COVID-19 seems to have accelerated current trends towards increased digitalization and automation, both in the private and public sector, in various parts of the world. Planetary change, and technological innovation and diffusion will play a key role in defining the prospects for sustainability and the achievement of the SDGs.

These forces of change are not isolated, however, interplay in ways that reinforce the use of digital technologies and Artificial Intelligence to help tackle, and innovate in the face of rapid climate change and biodiversity loss. Such innovations are likely to emerge both in the private and public sector, and in society in general. Whether this potential really will materialize, and to the benefit of whom, is still an open question.

The portfolio of technologies that could help societies achieve a stable and just climate future is very diverse, and span from clean energy sources to replace fossil fuels, to climate resilient farming practices through the application of data-driven analysis and mobile technologies (Hawken, 2017; Falk et al., 2020). A number of studies have shown the vast opportunities provided by digital technologies including AI to help achieve ambitious climate action, improved conservation and stewardship of ecosystems, disaster risk reduction, and the whole span of Sustainable Development Goals (SDGs) (GFDR, 2021; Vinuesa et al., 2020; Rolnick et al., 2019). There is also a growing number of interesting applications of digital technologies and AI that focus explicitly on supporting the most vulnerable through e.g. improved early warning systems, innovative financial mechanisms, and mobile-based health applications.[1]

While technological advances are key to help communities, governments and others achieve sustainability ambitions, history teaches us that their deployment redistributes both risks and opportunities on people as well as the environment.

1 USAID. (2018). Reflecting the Past, Shaping the Future: Making AI Work for International Development.
GFDRR. (2021). Responsible AI for disaster risk management. https://doi.org/10.1007/978-1-4842-6385-3_8

Such positive and negative impacts can be both direct and indirect. For example, while data-driven farming could help farmers increase their production thanks to improved weather predictions and accessible market information[2], access to such technologies cannot be taken for granted to be accessible to those who need it the most due to the lack of data infrastructure, and/or associated costs[3]. Advanced AI-models can be powerful tools to find new patterns in "noisy" data, but can also and result in increased carbon emissions due to energy consuming computing. The world's growing need for computation and electrification could also on a more general level, result in harmful environmental activities such as extractive mining of the minerals needed for batteries and hardware.

Risks and impacts can be more indirect as well. Uses of data-driven analysis for e.g. the allocation of social welfare or health resources that might seem rational from the outset, may also impact negatively on already vulnerable social groups.[4] Advanced data-driven tools can also result in increasingly precarious working conditions, for example through digital tools designed to control the work flow of employees. In extreme cases, the deployment of new technologies such as "big data" and AI-systems can even be used intentionally to surveil and discriminate against certain ethnical groups or political opponents. Supporting the development and uses of these technologies, at the same time as risks such as these are dealt with proactively and continuously hence is key.

DIGITALIZATION, AUTOMATION AND ARTIFICIAL INTELLIGENCE FOR CLIMATE ACTION ('CLIMATE TECH')

The rapid evolution of computer processing power, sensors, a new generation of algorithms, and advancements in robotics has led to an alleged pending "Fourth Industrial Revolution" with large possible repercussions for individuals, societies and the economy all over the world (Schwab 2017). How these technologies are applied may well determine the future of climate stability and sustainability for all. **In this brief, we refer these technologies as 'Climate Tech', technologies developed and used with the explicit purpose to help people, governments and others address the sources and impacts of climate change.**

This includes technologies with the intention to monitor the impacts of climate change, to help reduce emissions, to support climate adaptation, and those with the goal to inspire climate innovation and transformation.

It is difficult, if not impossible, however, to pinpoint to one specific technology associated with "climate tech". On the contrary, many technological applications for climate action often combine developments in satellite technology and data, with mobile technology, sensors, data-analysis or other technological innovations to accelerate and augment the agency of communities and organizations to tackle climate change.

Advances in artificial intelligence (AI) plays a key role in this context. AI can in combination with advances in other technologies, lead to important breakthroughs in the way people understand, monitor, and adapt to climate change. While still nascent, AI is already today being applied to understand our changing climate and ecosystems. This includes applications of AI for refined modeling of the climate system; marine monitoring combining satellite data with "deep" learning algorithms; and applications of "deep learning" to bridge data gaps in countries with limited official statistics of importance to address vulnerability and poverty. Such new methods and data can for example, support the design of social welfare programs,[5] and to support aid organizations and others coordinate relief efforts after natural disasters.[6]

While still nascent in terms of both scale and impact, applications of AI and other associated technologies could be viewed as examples of technological "niche-innovations". Such innovations are capable of rapid upscaling and have an effect on the climate system, people and on ecosystems all over the world. As a result, policy-makers, businesses, civil society, investors and others need to be able to assess and balance potential risks and benefits of developing and applying such technologies in complex social, economic and ecological settings.

2 Jiménez, D., Delerce, S., Dorado, H., Cock, J., Muñoz, L. A., Agamez, A., & Jarvis, A. (2019). A scalable scheme to implement data-driven agriculture for small-scale farmers. *Global Food Security*, 23(May), 256–266. https://doi.org/10.1016/j.gfs.2019.08.004

3 Galaz, V., et al. (2021). Artificial intelligence, systemic risks, and sustainability. Technology in Society, 67, 101741. https://doi.org/10.1016/j.techsoc.2021.101741

4 Obermeyer et al.,2019; Mitchell et al., 2021.

5 Blumenstock, J. E. (2016). Fighting poverty with data. Science, 353(6301), 753-754.

6 Blumenstock, Joshua. "Don't forget people in the use of big data for development." (2018): Nature, 170-172.

Box 1. Digitization and AI for climate action and sustainability

The business sector is moving quickly to experiment with applications of technologies like robotics, IoT and AI for precision farming (or digital farming), forestry, city planning and marine extraction as a means to make more efficient use of resources such as energy, and water.

It is estimated that nearly 12 million IoT sensors will be installed and in use on farms around the world by the year 2023. Investments in agriculture technology for precision farming reached a new record of $1.5 billion in 2017, and since 2012, venture capital investment in agricultural technologies has grown by 80 percent annually. The precision forestry market could grow from USD 3.9 billion in 2019, to reach USD 6.1 billion by 2024. Moreover, it is forecasted that global "smart city" AI software revenue alone will be $5 billion annually by 2025, and the global smart cities market size is expected to reach USD 460+ billion by 2027 (numbers from Galaz et al. 2021).

Early estimates indicate that the benefits of applications of AI and associated technologies for sustainability in general could be considerable, with an estimated decrease in global emissions of about -4%, and an increase of global GDP of about +4,4% by 2030 (Herweijer et al. 2019). These benefits emerge as the result of more efficient uses of scarce resources like energy through for example AI-enabled distributed energy grids, higher productivity in for example agriculture, providing more food using less resources, and the automation of labor-intensive tasks). It should be noted that the benefits of these technologies are strongly skewed to the benefit of wealthier countries, with the largest estimated benefits for North America and Europe (Herweijer et al. 2019). These estimates however, are based on modeling efforts including their embedded assumptions, and thus contain considerable uncertainties.

"CLIMATE TECH" IN ACTION

New technologies can, if developed and applied responsibly, offer important opportunities for social inclusion, climate action and sustainability. A number of interesting recent examples show the diversity of approaches and applications in this domain (e.g. GFDRR 2021; USAID 2018). The combination of AI-analysis and mobile technologies for example, is now being used to support small family farms in Mexico to help them navigate weather and market turbulence (CGIAR, 2021). By combining satellite images with AI, governments and civil society can help overcome critical gaps in ecological and poverty data, and make sure that financial resources reach those who need it the most.[4] Novel methods to analyze social media data, street view imagery and other data sources can also support disaster recovery and help build resilience for the most vulnerable.[7]

Such pilot initiatives are however not likely to scale without a clear direction, strong incentives and funding. As some have noted, the growing interest in initiatives branded as "AI for Good" or similar have resulted in a patchy landscape of initiatives with unclear boundaries, unclear social and environmental effects, and with limited critical reflection of their use on the ground (Cowls et al., 2021). Sida in collaboration with other organizations, is well-placed to help key international collaborators set an *ambitious direction* (e.g. development and deployment of AI in ways that accelerate climate action and prosperity for all within planetary boundaries); create *strategic partnerships* with key organizations that share the same vision; *measurable goals and targets* (e.g. proper integration of all SDGs in evolving AI ethics frameworks; adoption of policies that minimize AI risks to people and planet); *capacity building* that bridges the current divide between research communities and between knowledge, practice and action; and help develop *strong and adaptive incentives* to make sure technology development is responsible and to the benefit of those who need it the most (e.g. through funding calls, developmental evaluations).

UNDERSTANDING BIAS AND RISKS

As the pressures on our living planet and the climate system increases, so does the hope that societies will be able to find technological solutions to deeply complex and challenging social, economic and environmental challenges. There are a number of reasons to remain cautious in attempts to develop and apply novel technologies to address the impacts of climate change. Many times, limited adaptive capacities and social vulnerability is not only the result of lack of technology, but instead the result of deeper issues linked to social inequalities, discrimination, poor governance, and economic precarity.

It should also be noted that the deployment of new technologies such as AI-systems and related technologies like IoT, 5G and robotics very well may lead to accelerated extraction of natural resources, increased pressures on the climate system, and loss of ecosystems. This includes uses of digitalization to accelerate the extraction of fossil fuels, the increased expansion of monocultures on land- and seascapes, loss of biodiversity, and an increased pressure on the raw materials that underpin novel technologies such as rare earth minerals.

7 Global Facility for Disaster Reduction and Recovery (2021). Responsible AI for disaster risk management – Working Group Summary. Deltares, GFDRR, World Bank Group.

A number of studies have also shown the dual aspects of the "digital divide" as it has expanded into new technologies such as AI. The first aspect refers to the lack of global inclusivity in research, development and application of these technologies, which today center around wealthy countries and users. For example, none of the top 10 countries in leading AI-research is currently located in Africa, Latin America or Asia[8]. Studies of technology adoption in digital farming show a similar and growing gap between wealthy and underprivileged groups.[9] The second dimension refers to the unequal distribution of risks and bias that seem to be embedded in some of these technologies, including their applications for policing[10], allocation of health resources[11], and other social areas.[12]

Businesses, development agencies, civil society and governments are well-placed to spearhead not only 'responsible AI' which address potential bias and discriminatory social impacts, but also 'planetary responsible AI' which try to help tackle the repercussions of a rapidly changing climate, at scale. The box below summarizes some key principles to help those who aim to fund, develop or apply AI for climate and sustainability action, and as support to reflect and design policies to guide their work.

Box 2. 'Planetary responsible AI" – principles for developing and applying new technologies for sustainability and climate action

- Aims to be regenerative: 'planetary responsible AI' aims to not only help reduce emissions and the use of non-renewable resources, but strives to support climate action, regenerate ecosystem services, and increase resilience. AI-augmented analysis for example, can be used to not only reduce energy use, but also redesign landscapes that support both agriculture at the same time as ecosystem services such as pollination, biodiversity and cultural services. Addresses a clear sustainability challenge: planetary responsible AI is possible when its intended use is to address specific human-environmental challenges. Examples include disaster early warning and response, tackling illegal extraction of natural resources like fisheries and forestry; combatting online climate disinformation, or helps amplify the voices and agency of the most vulnerable.
- Is embedded in local knowledge: planetary responsible AI combines the strengths of data driven analysis with the knowledge of biosphere stewards to help secure a deep social and ecological understanding of the system of interest, such as a local farm area. There is a clear risk otherwise that AI-solutions build on flawed models of ecosystems, proprietary data and/or models, or lead to detrimental social and ecological consequences when applied on the ground.
- Builds unexpected alliances: planetary responsible AI aims to drive innovative solutions and new ways of thinking, and therefore aims to bring together communities that normally don't work together, such as experts on wildlife crime and computer scientists to automate the detection of illegal online trade with wildlife.
- Accelerates experimentation and learning; while AI-technologies might seem adaptable, their real-world applications might require continuous adjustment due to changing circumstances. Planetary responsible AI acknowledges that innovation is destined to sometimes fail, and that these failures are an opportunity for improvement and learning.
- Is based on principles of responsible use[13]; e.g. creates engagement, acknowledges diversity, aims to be open source, builds on human centric design, and is tackles distributional risks and biases proactively.

8 Chan, A., Okolo, C. T., Terner, Z., & Wang, A. (2021). The Limits of Global Inclusion in AI Development.

9 Mehrabi, Z., Mcdowell, M. J., Ricciardi, et al. (2021). *The global divide in data-driven farming. Nature Sustainability.* https://doi.org/10.1038/s41893-020-00631-0

10 Brayne, S. (2020). *Predict and surveil: Data, discretion, and the future of policing.* Oxford University Press, USA.

11 Z. Obermeyer, B. Powers, C. Vogeli, S. Mullainathan, Dissecting racial bias in an algorithm used to manage the health of populations, Science 366 (2019) 447–453, https://doi.org/10.1126/science.aax2342.

12 S. Barocas, A.D. Selbst, Big data's disparate impact, Calif. Law Rev. 104 (2016) 671–732.

13 For details, see e.g. UN Global Pulse (2018). Building Ethics into Privacy Frameworks for Big Data and AI. https://iapp.org/resources/article/building-ethics-into-privacy-frameworks-for-big-data-and-ai/

REFERENCES

Falk, J., O. Gaffney, A. K. Bhowmik, et al. (2020). *Exponential Roadmap* 1.5.1. Future Earth. Sweden. (January 2020.)

GFDRR. (2021). Responsible AI for disaster risk management. Global Facility for Disaster Reduction and Recovery and the World Bank. https://doi.org/10.1007/978-1-4842-6385-3_8

Hawken, P. (Ed.). (2017). Drawdown: The most comprehensive plan ever proposed to reverse global warming. Penguin.

Mitchell, S., Potash, E., Barocas, S., Amour, A. D., & Lum, K. (2021). Algorithmic Fairness: Choices, Assumptions, and Definitions, 1–23.

Obermeyer, Z., Powers, B., Vogeli, C., & Mullainathan, S. (2019). Dissecting racial bias in an algorithm used to manage the health of populations. Science, 453(October), 447–453.

Rolnick, D., Donti, P. L., Kaack, L. H., Kochanski, K., Lacoste, A., Sankaran, K., et al (2019). Tackling Climate Change with Machine Learning. Retrieved from http://arxiv.org/abs/1906.05433

Vinuesa, R. et al. (2020) 'The role of artificial intelligence in achieving the Sus- tainable Development Goals', Nature Communications. Nature Research, 11(1), pp. 1–10. doi: 10.1038/s41467-019-14108-y.

Westley, F., Olsson, P., Folke, C., et al. (2011). Tipping toward sustainability: emerging pathways of transformation. Ambio, 40(7), 762-780.

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