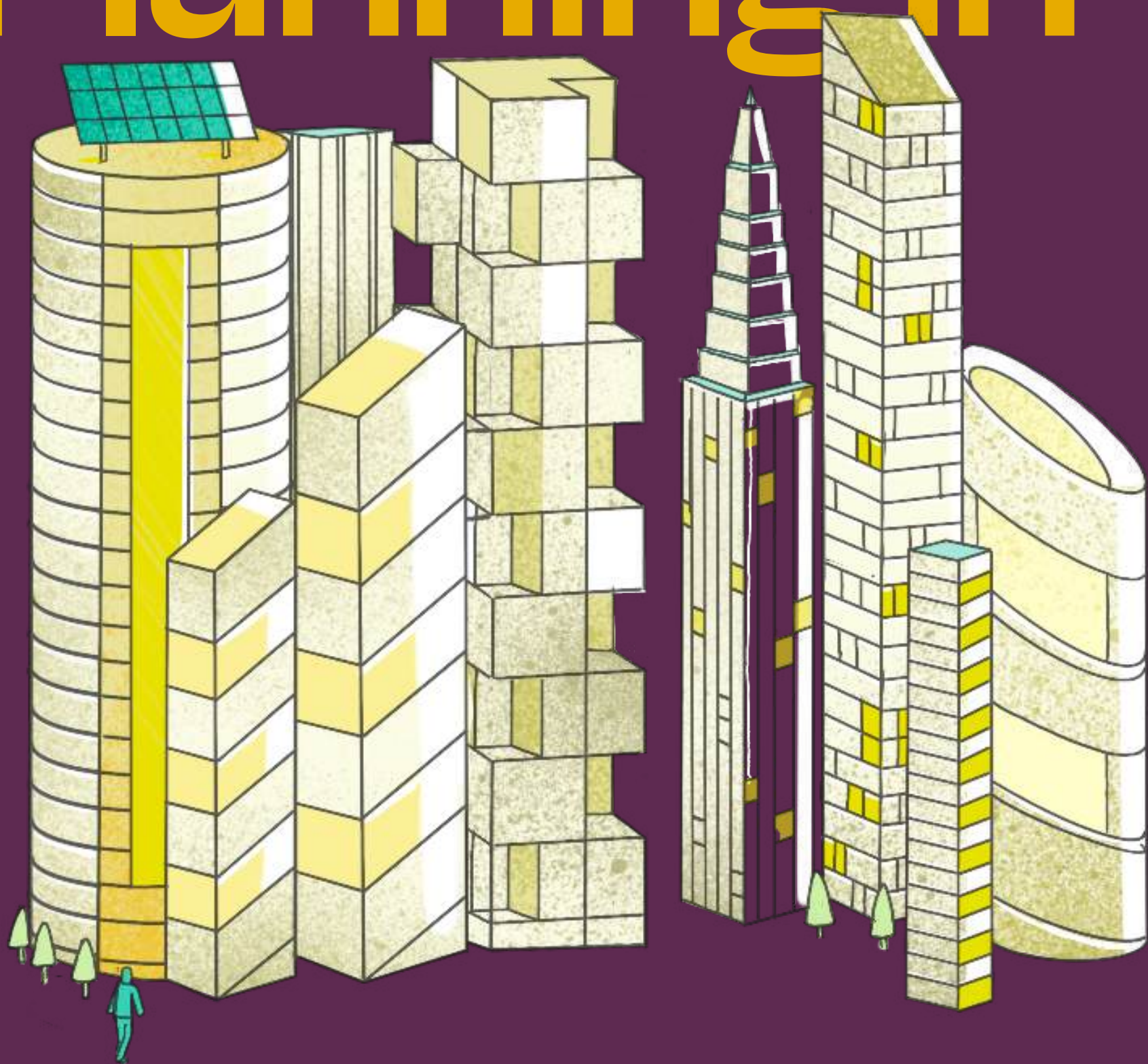


Integrating AI for Climate-Resilient Urban Planning in China

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China faces significant challenges in addressing climate change while pursuing economic growth and development. As the world's largest carbon emitter, China has a crucial role to play in advancing global climate action.

The use of artificial intelligence (AI) in urban planning and development holds promise for mitigating these challenges in a sustainable manner.¹ By utilizing AI, China can help reduce the impacts of climate change, such as extreme weather, urban heat islands, and air pollution that disproportionately affect vulnerable groups. If implemented effectively, AI-driven solutions in urban planning and green space development can help China meet its ambitious goals of peaking carbon dioxide emissions by 2030 and achieving carbon neutrality by 2060.²

Moving forward, China will need to foster enabling conditions, manage socio-economic impacts, and continually improve AI systems to realize the full benefits of AI for climate action and sustainable development.

In this paper, we discuss the following five elements:

- 1.** actors,
- 2.** applications,
- 3.** enabling environment,
- 4.** socio-economic impacts, and
- 5.** future paths,

focusing on the intersection of AI and climate action in China, particularly within the urban planning context

1

Actors



China has been increasingly focusing on the intersection of AI and climate action, particularly in urban planning.

Several key actors and institutions lead the conversation and drive progress in this area. These include the Chinese government, domestic industries, global technology companies, and research institutions. Collaboration between these actors is essential for successfully implementing AI-driven climate action initiatives.

The National Development and Reform Commission (NDRC), the top planning agency in China, is responsible for formulating and implementing strategies for economic and social development, including efforts related to AI and climate change. The Ministry of Science and Technology³ plays a key role in promoting research, development, and innovation in China. It often collaborates with other government agencies and stakeholders to support AI and climate action initiatives. The Ministry of Ecology and Environment (MEE) is responsible for environmental protection and climate change policies, including the development of low-carbon cities and the promotion of green technologies, such as AI.⁴

The government typically sets the agenda, but it sometimes consults with leading private companies, especially to invite suggestions in strategically important areas such as AI and climate action. China's approach to economic governance involves a high degree of governmental involvement. The government's recent regulatory actions against large tech firms aim to ensure fair competition and data security and prevent the misuse of AI. For example, in July 2022, the Chinese government fined Alibaba Group's affiliate, Ant Group, 7.12 billion yuan (USD 985 million) for violations of laws and regulations related to corporate governance, consumer protection, and anti-money laundering.⁵

While these regulations may initially constrain the private sector's flexibility, they are also expected to provide a transparent regulatory environment that could, over the long term, encourage more robust and responsible AI applications, including for climate action. For instance, the government's push to develop AI technologies for renewable energy and green transportation has increased private-sector investment in these domains.⁶

In the private sector, Alibaba,⁷ a major Chinese technology company, has developed several AI-driven applications to tackle climate change, including its City Brain project, which aims to improve urban planning, traffic management, and energy efficiency in cities. Tencent,⁸ another leading technology company, has invested in AI and green technologies to address climate change, focusing on urban planning and smart cities. Likewise, Baidu, a prominent search engine and technology company, has been focusing on AI research and development, including projects in areas such as autonomous vehicles, smart cities, and climate action.⁹ IBM has collaborated with Chinese partners to provide advanced AI technologies and solutions for climate change, including smart city and urban planning initiatives. Similarly, Microsoft has been working with Chinese stakeholders to advance AI-based solutions for climate change in urban planning, energy efficiency, and emissions reduction.¹⁰

Among academia and research institutions, Tsinghua University has been actively involved in AI and climate action research, with a particular focus on urban planning and sustainable development. Likewise, Peking University has been conducting research on AI and climate change mitigation, specializing in urban planning and policy development. The Chinese Academy of Sciences (CAS), a leading scientific research organization in China, has been at the forefront of various AI-driven climate action projects, particularly in urban planning and sustainable development.

Additionally, NYU Shanghai Key Laboratory of Urban Design and Urban Science¹¹ provides research direction in planning for the growth of climate-responsive low-carbon cities in the context of GHG mitigation and planning for environmentally sensitive urban blue and green infrastructure using social sensing techniques. These institutions play a crucial role in augmenting technical expertise among scientists and engineers while the government funds and supports their research initiatives.

Collaboration and competition coexist between the government, private sector, and research institutions in China. While they collaborate on national initiatives, they also compete for talent, funding, and recognition in the field. This duality not only bolsters cooperation but also encourages innovation through healthy competition. China acknowledges the pressing need for climate action and sustainable development.

By leveraging AI in urban planning and creating urban green spaces, the country hopes to make significant strides in mitigating the impacts of climate change. The government, major tech companies, and research institutions actively participate in discussions and actions related to AI and climate change, fostering a collaborative environment.

Although the level of collaboration between these actors may differ based on projects and initiatives, a growing trend towards increased cooperation is evident. Strengthening partnerships between government agencies, industries, and research institutions can expedite the development and implementation of AI-driven climate action initiatives, particularly in urban planning.

In China, the public discourse around the role of tech companies such as Alibaba in urban planning is generally favourable. Alibaba's involvement in smart city projects is often seen as a way to improve efficiency and liability in Chinese cities. For example, Alibaba's City Brain project, which uses AI to optimize traffic flows and public transportation, has received widespread praise.¹²

However, there are concerns regarding the potential negative impacts of tech companies' involvement in urban development.

Some critics point out that tech companies could use their data and technology to create government surveillance systems or to manipulate people's behaviour. Others worry that tech companies could gentrify neighbourhoods or displace low-income residents.¹³ As tech companies become more involved in urban development, it is important to have a public conversation regarding the potential benefits and risks of this involvement.

2

Applications

Emerging applications of AI can be found in optimizing transportation systems, enhancing energy efficiency, monitoring air quality, streamlining waste management, and urban green space planning.

As the country continues to develop and urbanize, we can expect an increase in the use of AI to address a wide range of climate-related challenges.

AI-driven systems have already been deployed in smart transportation and traffic management to optimize traffic flows, reduce congestion, and improve the efficiency of public transportation. This helps reduce greenhouse gas emissions and air pollution. For example, Alibaba's City Brain project uses AI to analyse real-time traffic data and provide intelligent traffic management solutions. This project has led to a 15% reduction in traffic congestion and a significant reduction in air pollution in Hangzhou.¹⁴

Similarly, AI has been effectively utilized to analyse energy consumption patterns, optimize energy distribution, and predict energy demand, enhancing energy efficiency in buildings and urban infrastructure. This has led to a reduction in energy waste and greenhouse gas emissions.¹⁵

Air quality monitoring and pollution control is another area where AI-powered systems have proven valuable. They can monitor and predict air pollution levels and help authorities take timely measures to control emissions and protect public health. For instance, IBM's Green Horizon project uses AI to forecast air quality and provide recommendations for pollution reduction.¹⁶

Additionally, AI can be used to optimize waste collection routes, improve recycling processes, and reduce the environmental impact of waste disposal. Smart waste management systems can create a cleaner and more sustainable urban environment. Urban green space planning is another sector where AI-driven tools can analyse satellite imagery, land use

data, and environmental factors to identify suitable locations for urban green spaces. These tools can help urban planners create greener and more climate-resilient cities. Furthermore, there are untapped opportunities and future growth areas for AI applications in climate-relevant sectors.¹⁷

Climate-adaptive infrastructure is another area where AI can design climate-resilient infrastructure, considering factors such as projected sea-level rise, extreme weather events, and urban heat island effects. This can help cities prepare for and adapt to the impacts of climate change. In water management, AI can be applied to monitor and manage water resources, including through flood forecasting, leakage detection, and optimization of water treatment processes. This can contribute to more sustainable water management practices in urban areas.

AI can also optimize urban farming practices, such as vertical farming and hydroponics, by analysing light, temperature, and water usage. This can lead to more sustainable food production in cities and reduce their reliance on distant agricultural areas. Furthermore, AI-driven platforms can engage and educate citizens on climate action, allowing them to participate in decision-making and contribute to sustainable urban development.

Several noteworthy cases demonstrate the application of AI in China's urban planning and development of green spaces.

The Sponge Cities Initiative, launched in 2015, used AI in pilot cities such as Xiamen and Wuhan to optimize the design and management of green spaces for enhanced stormwater management and to reduce flooding.¹⁸ While evidence is still limited on the long-term impacts of these emerging applications of AI, the early results are promising. For instance, the 34-hectare Qunli Stormwater Park in Harbin, a city in northern China, is considered a successful example of a sponge city; it collects, cleanses, and stores stormwater while preserving the natural habitat and providing a green public space for recreational use.¹⁹

Liuzhou Forest City, a visionary project in southern China, uses AI to manage greenery, monitor air quality, and optimize infrastructure to combat air pollution and create a sustainable urban environment.²⁰ In Xicheng, AI-powered drones detect and prevent forest fires, protecting valuable green spaces.²¹

AI has significant potential to drive climate action in various urban planning sectors in China. As the country continues to develop and urbanize, the use of AI will likely increase as it is applied to address a broad spectrum of climate-related challenges, ranging from transportation and energy efficiency to water management and community engagement.

3

Enabling Environment

China recognizes the potential of AI in addressing environmental challenges and has taken several steps to promote its development and adoption. Regarding the broader enabling environment, China has made substantial investments in data and digital infrastructures. The country has a vast population and generates large volumes of data, which provides a valuable resource for AI applications. China has been expanding its digital infrastructure, including the development of data centres, Internet of Things (IoT) networks, and 5G technology. These advancements have facilitated the collection, storage, and analysis of large-scale data, which is crucial for AI-driven urban planning and climate action initiatives.²²

China has enacted a series of forward-thinking policies and strategies to propel AI development, including the following:

- *The 14th Five-Year Plan (2021–2025)* delineates specific goals for AI development, reflecting China's commitment to this technological frontier.
- *The Next Generation Artificial Intelligence Development Plan (2017)* underlines China's ambition to become a global leader in AI by 2030. It sets concrete targets for AI research and development and promotes AI adoption in crucial sectors such as healthcare, transportation, and manufacturing.
- *The Made in China 2025 plan (2015)* strives to enhance China's manufacturing sector through the adoption of advanced technologies, including AI. It sets clear goals for the development of AI-powered manufacturing equipment and systems.
- *The Cybersecurity Law of the People's Republic of China (2017)* provides a robust framework for protecting personal data and other sensitive information, with specific provisions concerning the application of AI in cybersecurity.
- *The Data Security Law of the People's Republic of China (2021)* establishes a comprehensive framework for data protection, encompassing both personal data and data related to national security. It includes specific guidance on the use of AI in data security.

In China, data ownership and usage are governed by a complex set of laws and regulations. In general, data is considered to be owned by the entity that collects it, but there are some exceptions to this rule. For example, data collected by the government is considered to be owned by the government.²³

There are also a number of rules and regulations governing the access and usage of public-sector data. For example, the Data Security Law requires that public-sector data be made available to the public, but it also allows for some exceptions. For example, data that is considered sensitive or that could harm national security is not required to be made public.

In terms of privacy and security policies, China has a number of laws and regulations in place to protect personal data. For example, the Personal Information Protection Law requires that companies obtain consent from individuals before collecting and using their personal data. The Cybersecurity Law also contains a number of provisions on data security, such as requiring companies to implement security measures to protect data from unauthorized access and use.

Despite these laws and regulations, data privacy and security concerns persist. For instance, the government has been criticized for its use of surveillance technology to track and monitor its citizens.

There have also been a number of data breaches in China, which have raised concerns about the security of personal data.²⁴ To address them, China has been working to improve its data privacy and security laws and regulations. For example, the Personal Information Protection Law was adopted recently by the government to strengthen the protection of personal data. Moreover, the government also established the National Bureau of Data in March 2023 to further strengthen these legislative measures.

China's data localization policies, including the Cybersecurity Law (2017), the Data Security Law (2021), and the Personal Information Protection Law (2021), necessitate that critical information infrastructure operators store data within the

country. Though these regulations aim to enhance data security, they might limit global collaboration in the AI and climate change sectors due to restrictions on cross-border data sharing.

The regulations mandate that companies operating in China store data locally, obtain user consent before collecting and using personal information, and protect data from unauthorized access or disclosure. The implications of these policies for the AI and climate change sectors are still under discussion. Some experts argue that these policies could impede the development of AI and climate technologies by making international collaboration more challenging. Conversely, others maintain that these measures could foster the creation of more secure, privacy-friendly technologies.²⁵ The long-term impacts of these policies remain uncertain, but they will undeniably influence how companies function within China.

China has also prioritized science and innovation funding to support AI research and development, such as the National Key Research and Development Program, which provides financial support for AI-related projects. Additionally, the government has set up research institutes and initiated collaborations with academic institutions to enhance research capacity in AI.

In terms of the policy environment, China has implemented comprehensive strategies and policies to promote AI development to address climate change. The country's 14th Five-Year Plan (2021–2025) included specific targets for AI development, emphasizing its application in areas such as transportation, energy, and environmental protection.²⁶ The government has also introduced policies and strategies, such as the New Generation Artificial Intelligence Development Plan, which aim to make China a global leader in AI by 2030.

However, despite the progress made, there are still adoption-related challenges in China's enabling environment. One challenge is the lack of adequate financing mechanisms for AI startups and innovative projects. While China has established funding programmes, accessing capital remains a significant obstacle, particularly for smaller organizations and startups. Efforts are being made to improve access to financing through

venture capital funds and public–private partnerships. For example, through government-backed funding programmes that provide financial assistance, grants, and loans, China strives to support startups, small businesses, and entrepreneurs.²⁷ However, more work is needed to ensure equitable access to funding.

Another challenge is unequal digital access, especially in rural areas. Although China has made significant strides in digital infrastructure development, there is still a digital divide between urban and rural regions.²⁸ Limited internet connectivity and access to digital technologies hinder the adoption of AI solutions in rural areas, where addressing climate change challenges is equally important. Bridging this digital divide is crucial to ensure equitable access to AI technologies and their benefits across the country.

Smaller enterprises, particularly those operating in the AI and climate sectors, often face financing challenges due to a lack of collateral, perceived elevated risk, and limited operational history. These issues can be amplified in industries such as AI and climate technology, which tend to be capital-intensive and high-risk. Unlocking more financing for these enterprises presents both challenges and opportunities. Major hurdles include a lack of investor awareness about the potential of AI and climate technologies and the absence of standardized data and metrics for assessing the performance of these technologies.

China has made substantial investments in digital infrastructure encompassing data centres, IoT networks, and the deployment of advanced 5G technology. This funding has helped create a strong foundation for developing China's digital economy. The Chinese government has also partnered with private companies to leverage the resources and expertise of the private sector to accelerate the development of China's digital infrastructure. Further, the government has implemented a number of policy incentives to encourage the development of digital infrastructure, such as tax breaks, subsidies, and preferential access to land and resources.²⁹

Increasing interest from impact investors and the growing availability of government grants and loans targeting

these sectors have opened up opportunities in this field. The government can play a crucial role in further mitigating various challenges and leveraging opportunities. It can offer grants and tax incentives, foster a conducive environment for venture capital and crowdfunding, and facilitate collaborations between large tech companies and smaller startups. These initiatives would leverage the strengths of both parties and could significantly contribute to the growth and success of smaller enterprises in the AI and climate space.

China's emerging regulations on AI, including explainability and accountability, are likely to have a significant impact on the activities of technology companies and how AI and the climate space evolve. One of the most significant impacts of these regulations is likely to be an increased focus on the development of explainable AI (XAI) technologies. Another impact of China's AI regulations is likely to be an increased focus on the ethical implications of AI technologies. These regulations require technology companies to consider the potential ethical impacts of their AI systems and to take steps to mitigate these risks. This is likely to lead to a more responsible and ethical approach to AI development and deployment, which could have a positive impact on AI and climate action.

China has made substantial progress in creating an enabling environment for AI development, particularly in urban planning and climate action. Investments in digital infrastructure, funding for research, and supportive policy frameworks have all contributed to the advancement of AI technologies. However, addressing adoption-related challenges, such as financing mechanisms and unequal digital access, will be crucial in ensuring the widespread and equitable implementation of AI-driven climate action initiatives in urban planning.

4

Socio- Economic Impacts

The socio-economic impacts of AI applications for climate action in China, particularly within the urban planning context, are multifaceted. These applications are likely to address core issues related to managing climate action in urban areas. By leveraging AI, cities can tackle key challenges and promote sustainable development.

AI applications have the potential to address core issues in managing climate action. By optimizing transportation systems, enhancing energy efficiency, monitoring air quality, and improving waste management, AI can contribute to reducing greenhouse gas emissions and improving the overall quality of life in urban areas. Furthermore, AI-driven urban planning can lead to greener and more climate-resilient cities, which can better withstand the impacts of climate change. Thus, AI applications can play a central role in managing climate action and mitigating its adverse effects on urban populations.

AI applications in urban planning and climate action can also influence people's livelihood opportunities. On the one hand, AI-driven innovations can lead to job creation in new and emerging industries, such as renewable energy and smart city technologies. These industries offer new employment opportunities for skilled workers, researchers, and technicians.

On the other hand, the rise of AI may result in job displacement in certain sectors, such as traditional manufacturing and low-skilled labour, as automation increases. Governments and other stakeholders must invest in education and workforce development programmes to ensure that workers can transition to new opportunities created by AI and participate in the growing green economy.³⁰

The rights and equity-related implications of AI applications in climate action and urban planning should not be overlooked.

While AI has the potential to create more sustainable and efficient cities, it is crucial to ensure that its benefits are distributed equitably across different socio-economic groups. For example, AI-driven solutions should be designed to benefit both affluent and underserved communities in terms of access to clean energy, public transportation, and green spaces.³¹

Furthermore, privacy and data protection concerns should be addressed, as AI applications often rely on large-scale data collection and analysis. Ensuring that people's rights are protected while harnessing the benefits of AI is essential for maintaining public trust and fostering inclusive urban development.

AI-driven solutions also have the potential to exacerbate existing inequalities and compromise rights and equity. For example, using AI in urban planning and climate action could lead to the displacement of low-income communities or the creation of "smart cities" that are only accessible to the wealthy. To address these potential consequences, it is important to ensure that AI-driven solutions are designed to benefit all members of society, regardless of their socio-economic status or other factors. This can be done by involving the public in the decision-making process, ensuring that AI systems are transparent and accountable, and investing in programmes that help to mitigate the negative impacts of AI on vulnerable communities.

The socio-economic impacts of AI applications for climate action in urban planning in China are significant and wide-ranging. AI has the potential to address core climate action issues, create new livelihood opportunities, and contribute to more sustainable and resilient cities. However, it is vital to consider rights and equity-related implications to ensure that the benefits of AI-driven solutions are equitably distributed and people's rights are protected.

This will require a collaborative effort between the government, industry, and civil society to balance the opportunities and challenges presented by AI in the pursuit of climate action and sustainable urban development.

AI applications in urban planning and climate action can create jobs in emerging industries such as renewable energy and smart city technologies. For instance, the city of Hangzhou has used AI to improve traffic flows and reduce pollution, creating new jobs in the process.³² While specific details on the number of jobs created are not readily available, the development and maintenance of the AI system, and the need for skilled professionals to analyse and interpret the data collected, have likely contributed to job growth in the technology sector.

On the other hand, AI can also lead to job displacement in some sectors. For example, in the manufacturing sector, AI-powered machines are increasingly being used to automate tasks previously performed by humans. This has led to job losses in the textile and automotive sectors,³³ among others. Therefore, while AI can catalyse job creation in emerging fields, it can also lead to job displacement in sectors that are becoming increasingly automated.

However, it is also important to note that AI's impact on the job market is not solely negative. The displacement of jobs can stimulate the workforce to upskill and transition to more advanced roles that require human intelligence and creativity, potentially leading to the emergence of new professions.

China is increasingly recognizing the environmental impact of AI. Its 14th Five-Year Plan (2021–2025) prioritizes the development of 'smart network' infrastructure and a nationwide integrated big data centre system. The plan underscores the need to foster direct links between regional clusters and major cities and promote high-intensity, scalable, and eco-friendly development through tiered and categorized data centre distributions. It also advocates for resource allocation optimization to facilitate efficient development, reflecting China's commitment to mitigating the environmental impacts of AI and data-intensive operations.

In July 2021, China's Ministry of Industry and Information Technology (MIIT) released a Three-Year Action Plan for New Data Centres (2021–2023), steering new data centres towards a green, low-carbon, efficient, and recyclable development path. Similarly, the National Development and Reform Commission's National Integrated Big Data Centre Collaborative Innovation System Arithmetic Hub Implementation Plan,³⁴ issued in May 2021, explicitly proposes to foster green and sustainable data centre development.

Moreover, several Chinese companies are investing in green data centres and infrastructure. For instance, Alibaba has established a data centre in Zhengfei, Inner Mongolia, where over 50% of energy consumption comes from renewable sources, aiding local renewable energy development and accelerating the shift towards a cleaner, low-carbon energy consumption structure.³⁵

5

Looking Ahead

Over the next five to ten years, we can expect the landscape of AI and climate action in China to evolve rapidly, driven by technological advancements, policy interventions, and socio-economic factors.

Several enablers and disrupters may shape the intersection of AI and climate action in urban planning and play a pivotal role in determining the trajectory of these developments.

In the next five years, we can anticipate a continued increase in AI adoption for urban planning and climate action. As the technology matures, we may see more widespread use of AI-driven solutions in transportation, energy efficiency, and green space planning. The rollout of 5G technology and the expansion of IoT networks will likely act as major enablers, facilitating the collection and analysis of large-scale data for AI-based climate action. However, potential disrupters such as economic downturns or geopolitical conflicts could slow the pace of AI development and adoption, impacting the effectiveness of climate action initiatives.

The landscape may see more advanced and integrated AI applications in urban planning and climate action in the next ten years. With the increasing adoption of AI in various sectors, we can expect the development of more holistic and interconnected solutions addressing climate change challenges. For example, AI-driven systems could design entire sustainable neighbourhoods, integrating transportation, energy, water management, and urban agriculture. However, potential disruptors such as breakthroughs in new technologies or unforeseen environmental events could shift the focus of climate action efforts, impacting how AI is utilized in urban planning.

One of the most important policy interventions needed to better align AI trajectories with positive climate action is the development of comprehensive frameworks that support and incentivize the use of AI for climate action. This may include targeted financial support, public–private partnerships, and integrating AI-driven climate action goals into national and local policy agendas. Strengthening data privacy and security regulations will also be crucial to maintain public trust and ensure that AI-driven solutions are implemented responsibly.

Another key intervention is investing in education and workforce development to equip individuals with the necessary skills to participate in the growing AI and green economy sectors. This may involve re-skilling and up-skilling programmes and promoting interdisciplinary education in technology, environmental sciences, and urban planning. Encouraging public engagement and fostering a culture of innovation will also be important in driving the development and adoption of AI-driven climate action solutions.

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About the Project

Commissioned in early 2023 by The Rockefeller Foundation, this project explores the intersection of Artificial Intelligence and Climate Action in Asia. It examines opportunities, challenges and risks across three domains – agriculture and food systems, energy transitions, and disaster response in nine countries – Bangladesh, China, India, Indonesia, Malaysia, Singapore, Thailand, The Philippines and Vietnam.

We assembled a network of regional experts to help guide our investigation and provide context specific insights.

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For additional reports and outputs from this project visit – climateai.asia

About DFL

Digital Futures Lab is an interdisciplinary research collective that interrogates the complex interaction between technology and society in the global South. Through evidence-based research, public engagement and participatory foresight, we seek to realise pathways toward equitable, safe and just digital futures.

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