CENTRE FOR CLIMATE ENGAGEMENT
HUGHES HALL
UNIVERSITY OF CAMBRIDGE

EXPERT BRIEFING

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Digitalisation and climate risk

An expert briefing with Dr Daoping Wang*

Briefing Highlights:

- **Digital technology enables the collection, management and processing of vast amounts of data to better understand climate risks and develop response strategies.**
- **Digital technology supports a more holistic understanding of processes and impacts on communities, economies and nature.**
- **Early warning systems and monitoring processes are fundamental and, although the technology needed to support early warning systems is well-developed, it is under-used.**
- **Government intervention is needed to enhance data standards and rules around data ownership, as well as to accelerate creation of data-sharing platforms to realise climate benefits.**

CCE Expert briefings

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* **This briefing, with Dr Daoping Wang, explores how digital technologies can help to understand and mitigate against climate risk.** Dr Wang is a Lecturer in Risk, Environment and Society at King’s College London and was previously a Hoffmann Fellow for the Fourth Industrial Evolution of the World Economic Forum, based at the Centre for Climate Engagement, Hughes Hall, University of Cambridge. Dr Wang's research focuses on the role of technology at the critical intersection between risk, environment and society.

Introduction

Climate change poses increased risks for organisations across all sectors from reduced crop yields to higher insurance costs, more restricted access to finance and disruption to business operations, product transportation and supply chains. However, the impact on each sector will be different. Understanding the risks and modelling the impacts is essential for developing appropriate sector-specific climate mitigation and adaptation strategies.

Digital technology will increasingly support this process, helping us to collect vast amounts of data, identify patterns and simulate the impact of different responses. This will enable us to take a holistic approach to developing solutions that maximise benefits for society, the economy and nature, and minimise response costs.

Four functions of digital technology

Digital technology encompasses a range of devices, systems and resources that enable data collection and management, to identify patterns, make predictions and automate processes. It can have an important role in helping to understand, control and mitigate climate risk, if technologies are selected and combined in the appropriate way. Daoping Wang identifies four main groups of technologies based on their function:

- **Data collection and processing**: These technologies form the foundation, supporting collection, storing and management of the data that other groups of technologies use. This technology group encompasses cameras, sensors and space technology for data collection, as well as 5G and blockchain enabling secure transfer of data between locations.

- **Prediction**: Technologies like machine learning and quantum computing, as well as digital twin systems that integrate multiple digital technologies can help to analyse collected data, run simulations and make predictions on likely outcomes.

- **Control and automation**: This group of technologies, which includes smart robotics, is designed for controlling systems and processes, especially enabling them to react to climate events, such as increased temperature or humidity, based on earlier predictions.

- **Visualisation and interaction**: The final group includes large language models, such as ChatGPT, that help to increase efficiency through interaction.

Monitoring and early warning

Combined, these technologies can help to better understand and predict both acute risks, such as the potential for flash flooding following a storm, and chronic risks, including how much sea levels are likely to rise in different areas. Digital technologies can then help to mitigate and adapt to these risks through better building design, urban planning or changes to agricultural practices. For example, a decision may be taken to alter the route of a new train line, based on intelligence about heat distribution, that avoids areas at risk of increased temperatures in order to minimise the potential for rails to crack or melt.

In all cases, monitoring and early warning systems are needed to alert us to changes in conditions that might give rise to adverse events, as early warning is fundamental to our ability to react.

Wang identifies monitoring and early warning as a priority for investment worldwide. Some countries have made greater use of early warning systems than others, but none has fully embraced the capability of digital technology to alert us to climate risks. He notes that technology in this area is more developed than in other areas, such as prediction and visualisation systems.

“I want to highlight the importance of monitoring and early warning systems. Early warning systems are crucial for effective response strategies and have a high investment benefit-cost ratio. There are numerous models ready for deployment, but their implementation remains inadequate in many countries,” Wang commented.

There are significant returns to be generated from investing in early warning systems. A recent report from the Global Commission on Adaptation indicated that every dollar invested in early warning would generate average benefits of $9. This results from avoiding losses from climate damage, as well as economic benefits from increased productivity and innovation. Under some conditions, the benefit-cost ratio could significantly exceed 12:1.

Daoping Wang remarked, “For countries with deeper digitalisation, moving from hazard forecasting to impact forecasting is another important priority”. Hazard forecasting traditionally provides information about impending hazards, for example that heavy monsoon rains are in Pakistan and are expected to last for more than a month starting. However, for businesses, this type of information often falls short of providing effective and proactive risk management.

The ability to take early action hinges on understanding the potential impacts of these hazards on human lives, livelihoods, properties and the broader economy. Impact forecasting addresses this need by detailing the expected consequences of hazards, for instance that the transport of certain commodities is likely to be disrupted due to flood-induced road closures. This approach marks a significant advance in early warning systems, ensuring that warnings are not just communicated but are also actionable, enabling a targeted and timely response.

The systemic view

Using digital technology helps us to collect and process more data more quickly, potentially enabling faster decision-making. It can also help to increase accuracy of data collection and processing, monitor systems and processes remotely and reduce labour intensity of some tasks via automation. But for Wang, the most significant benefit of the digital approach to climate risk modelling is the way that it affords a holistic, or systemic, view of an issue or event.

To date, we have tended to look at the impact of our changing climate, climate mitigation and adaptation strategies on communities, economies or nature in isolation. Digital technologies enable us to take all three systems – human, economic and natural – into account when planning. “We can build large models to investigate the interactions between different systems,” Wang comments. From there, we can simulate a range of options and approaches to identify the solution with the optimum benefit for all three before investing in building anything, or taking action that could have irreversible consequences for nature or the climate.

AgroClimate’s Strawberry Advisory System is one example of how digital technology can help to consolidate disparate datasets to better manage agriculture for the benefit of both farmers and nature. As temperature and humidity levels change, strawberry farmers in Florida have been using increasing amounts of fungicides to control Anthracnose and Botrytis fruit rots, leading to increased fungicide run-off and pollution of water systems, greater incidence of fungicide resistance in plant pathogens and higher costs for farmers.

However, improved data collection has enabled a better understanding of the conditions that result in an outbreak of Anthacnose or Botrytis fruit rot. AgroClimate then tracks weather patterns and alerts farmers via the Strawberry Advisory System when the risk of fruit rot is high. As a result, farmers only need to spray crops when there is a potential for disease rather than weekly throughout the season. This saves money and reduces the potential environmental damage associated with high fungicide use.

Investment and the role of government

No farmer has the resources to invest in a monitoring and alert system that is as complex as the Strawberry Advisory System, particularly in countries like China where there are large numbers of smallholder farmers. Furthermore, few companies can justify investing in the collection of vast amounts of climate-related data to deliver a single application, e.g. alerting farmers to periods when levels of pests or plant pathogens are high. For Wang, this is where governments have to step in to accelerate the uptake of digital technologies to address climate risks.

It starts with investment in **data standards**. We need to agree the right data structure, as well as appropriate formats and approaches for data collection. When preparing the data, we need to leverage digital technologies, such as blockchain, to ensure data transparency and reliability. Without that, we will be unable to compare data sets from across multiple sectors and understand how changes in temperature, rainfall or pollution levels impact anything from growing conditions to urban flood risks.

A second fundamental building block is the **data infrastructure or marketplace**, enabling vast amounts of data to be stored and shared. Governments could look to build the core data infrastructure themselves, potentially funding it through a levy on a specific sector. Alternatively, they could create incentives for commercial organisations to come together and build a common data platform. Wang noted that multiple players within an industry vertical could pool data without creating competition issues, as each company would be looking for insights into climate risks related to their specific part of the value chain.

There also needs to be clear rules on **data ownership** to protect the rights of citizens whose data is collected, and to ensure organisations know how they can process the data and commercialise insights.

Digital education and engagement

Wang also advocates for widespread public education and engagement in support of digital technologies. People need to understand what data is being collected and processed, as well as how it benefits us all in reducing climate risks. Education and learning in how to use technologies - such as ChatGPT - effectively also needs to increase, so that people are not left behind as the labour market inevitably evolves.

Large language models have drawn a lot of criticism in recent months for the amount of power they use and the emissions they produce. Wang notes that these emissions are relatively small by comparison with the major climate risks we face. He believes it is better to produce some emissions from computer modelling to enable us to identify approaches that cut emissions rapidly, and respond quickly to increasing climate impacts, whilst also supporting economic growth and nature restoration, rather than not to conduct the simulation at all.

Computer models are developing all the time, even helping to identify ways to improve their own efficiency. “So we can improve the efficiency of the algorithms at the core of the data technologies. In my research, I have found this can reduce power use to maybe one-thousandth of the power and with it the carbon cost.” Coupled with the transition of data centres to renewable energy, the emissions associated with large language models is set to decrease in coming years.

This will also reduce the cost, making simulation and data modelling more attractive to business.

Conclusion

Digital technology encompasses a range of devices, systems and processes that help us to collect, manage and process data about the impacts of our changing climate on industry and society. This starts with collecting vast amounts of data on systems and processes, including weather patterns, crop yields and the impact of extreme weather events on urban infrastructure, enabling us to model responses. It also enables us to identify patterns that could provide an early warning of future adverse conditions, whether that is extreme weather events or an increase in pests and plant pathogens.

However, despite the maturity of the technology and the potential benefits on offer, we have been slow to exploit the potential of climate-related monitoring and early warning systems. One reason may be the need for extensive investment in data infrastructure which is beyond the reach of most companies.

Policy intervention is needed to create the foundation to enable the collecting, sharing and exploitation of data, while widescale public engagement will help to educate society about the climate benefits that can be realised with better use of digital technology.