Bylined Article

Bridging the Computing Gap to Transform Natural Disaster Prediction

Carlos Cordero, Chief Technology Officer, Fujitsu Technology Solutions

Devastating flash floods struck several regions across Europe in October 2024, serving as a stark reminder of nature's unpredictable fury. The most destructive were in central Europe and towards Eastern Spain.

In regions such as Valencia, communities were overwhelmed by unprecedented rainfall, exceeding a year's worth in a matter of hours. Such events led to over 400,000 people being affected and as a result there was tragic loss of life across the continent. The speed and intensity of these floods, often with little to no warning, highlight a critical challenge for modern meteorology: predicting and preparing for increasingly extreme weather events that unfold faster than current technology and infrastructure can keep pace.

The answer lies not in a single technological breakthrough, but in the convergence of high-performance computing, artificial intelligence (AI) and quantum processing. As we stand at the threshold of a new era in computational capability, the future of disaster prediction depends on our ability to effectively harness these technologies.

The Scale of the Challenge

Natural disasters exact an enormous toll on human life and economic stability. Between 40,000 and 50,000 people a year are killed by disasters, from earthquakes and storms to floods and droughts. In the United States alone, 27 individual weather and climate disasters each caused at least $1 billion of damage in 2024.

The flash flooding experienced across Europe is an unfortunate example that highlights a critical limitation in current prediction capabilities. Despite their sophistication, traditional weather forecasting models lack the computational granularity needed for hyperlocal, rapid-onset events. The current supercomputing infrastructure requires scientists to model weather patterns at spatial resolution of several kilometres or even down to hundreds of meters in complex environments, which is too broad a scale to predict phenomena like flash floods accurately.

The Mathematics Exist, But Computing Power Doesn't

Fundamental mathematical models for weather prediction have existed for many years. The bottleneck isn’t our understanding of atmospheric physics; it’s our computational limitations. Today’s weather modeling requires scientists to make compromises on granularity due to the limited processing power available. This translates directly into reduced prediction accuracy for localized extreme events.

Consider the air quality modeling challenges encountered in Barcelona, where poor air quality regularly forces city-wide mobility restrictions. Attempts to create predictive models that could enable targeted area closures rather than blanket city shutdowns have failed, simply because the computational resolution was too coarse. This same principle applies to disaster prediction.

The Quantum-HPC Hybrid Future

An emerging solution combines next-generation supercomputing, AI and quantum processing. Fujitsu's Fugaku supercomputer, designed to reach exascale performance, represents a crucial step toward the computational power needed for meter-level weather prediction.

However, even exascale computing alone won't solve the challenge. The integration of quantum processors, particularly as we approach the 50,000 to 100,000 qubit systems expected within the next five years, will enable us to offload specific computational tasks that are particularly suited to quantum processing. Machine learning algorithms, which are computationally intensive and increasingly central to modern weather modeling, represent prime candidates for quantum acceleration.

This hybrid approach acknowledges that quantum computing won't entirely replace traditional high-performance computing. Instead, quantum processors will handle specialized calculations, and classical supercomputers will manage the bulk of the computational workload. We anticipate that this division of labor will dramatically reduce the time required for high-resolution weather modeling.

Beyond Prediction: Building Resilient Infrastructure

While improved prediction capabilities are crucial, technology alone cannot prevent geographical disasters. Even with precise 30-minute weather forecasts, evacuating hundreds of thousands of people remains logistically impossible. The actual value of enhanced prediction technology lies in its ability to inform long-term infrastructure planning and disaster mitigation strategies.

Advanced modeling capabilities will enable local governments to understand the specific vulnerabilities of their regions and implement targeted infrastructure solutions. In many cases, better predictive models could have revealed the flooding potential years earlier, enabling the construction of water management systems that may have prevented or mitigated the disaster entirely.

This represents a shift from reactive disaster response to proactive risk mitigation through data-driven urban planning and infrastructure development.

The Trust and Quality Imperative

As we develop more advanced prediction capabilities, we must maintain unwavering focus on data quality and model reliability. The challenge facing all AI and machine learning applications, including weather prediction, is ensuring clean and reliable training data. Many current large language models suffer from quality issues due to training on unvetted internet data. Weather prediction models face similar challenges.

This is why Fujitsu's partnership with Cohere represents more than just a commercial agreement. It reflects a commitment to clean, reliable AI technologies. Cohere's approach to data curation and model training aligns with Fujitsu's philosophy that reliability must precede deployment, particularly in applications where human lives depend on accuracy.

The development of synthetic data generation capabilities may resolve many of these quality issues, enabling models to be trained on verified, high-quality datasets rather than relying solely on historical records that may contain errors or gaps.

A Cautiously Optimistic Timeline

Based on current technological trajectories, we anticipate that practical quantum-enhanced weather prediction systems could emerge within five years. Fujitsu's Fugaku, combined with quantum processors in the 50,000+ qubit range, should provide the computational foundation needed for meter-level weather modeling.

However, realizing this potential requires careful, methodical development. Unlike some sectors that rush to deploy AI technologies with uncertain reliability, disaster prediction requires rigorous validation and extensive testing. The cost of false predictions – whether false alarms that cause unnecessary evacuations or missed warnings that leave populations vulnerable – is too high to accept unproven technologies.

The path forward for natural disaster prediction lies in the thoughtful integration of quantum computing, high-performance computing, and AI. While we cannot prevent natural disasters, we can significantly enhance our ability to predict and prepare for them. More importantly still, we must utilize those predictions to build more resilient communities.

With each natural disaster, it reminds us that we're racing against time and nature. Every advance in computational capability brings us closer to a future where disasters like this can be anticipated, prepared for, and potentially prevented through smart infrastructure planning. The technology to achieve this future is within our grasp. We stand at a critical juncture where the convergence of quantum computing, next-generation supercomputers, and AI offers a transformative solution - now we must build it responsibly.

References:

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Carlos Cordero
CTO, Fujitsu Technology Solutions

Carlos Cordero has been CTO of Fujitsu Spain since 2016. Since joining the company, he has promoted, with his strategy, projects aimed at building an integrated value proposition that enhances the digital transformation of companies.

Carlos Cordero has studies in Medicine and Surgery from the San Pablo CEU University and has extensive experience of more than 30 years as a manager in the Information Technology sector. His professional career includes highly responsible positions in different companies, such as vice president and CTO of Iberia at Capgemini or Corporate Director of Alliances at Indra.

