

VIEWPOINT
CRIS TURNER

The Urban AI Paradox: Balancing the Digital Future with Our Physical Reality



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Navigating the AI paradox is not about choosing between technological progress and environmental stewardship. It is about integrating them. We must solve the physical footprint of the digital world to unlock the immense potential of AI to decarbonise our physical world.



In the grand timeline of urbanisation, we are navigating a transition as pivotal as the industrial revolution. For centuries, cities were defined by physical infrastructure—roads, bridges, aqueducts, and power grids. Today, a new layer is being woven over the concrete and steel: a digital fabric of data, machine learning, and artificial intelligence (AI).

The challenges facing modern cities—from shifting demographics to the existential threat of climate change—are too complex for linear solutions. They require the exponential problem-solving capacity of AI. However, as city leaders and technologists, we must be clear-eyed about the "AI Paradox": the very technology that holds the key to solving our most pressing urban climate challenges requires significant physical resources—energy and water—to operate.

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The Physical Footprint of a Digital Future

AI holds tremendous potential for the operation of smarter cities. However, analysing complex datasets such as traffic light flow or weather

patterns requires computation, and computation requires resources. Answering the challenges of urban environments demands data centre infrastructure capable of operating responsibly.

The hardware requirements behind data centres are vast, and securing the physical footprint of digital cities means optimising these resources. Instead of treating hardware as disposable, the industry must develop resilient, circular economies for servers and infrastructure. At Google, this looks like engineering hardware with modular cores that can be disassembled, repairing servers, and integrating refurbished components into necessary upgrades. Currently, we divert 84% of global data centre operations waste from landfills.

Similarly, computational energy creates heat that must be balanced with responsible cooling solutions. Operators deploy water, air, or hybrid cooling systems dependent upon localised environmental data. For example, water cooling is highly effective, utilising less power and releasing fewer carbon emissions than traditional air cooling. Yet, in areas facing watershed stress, or places where the local grid offers clean energy to power air chillers, pivoting to air cooling is the more responsible approach. Further, committing to water replenishment projects, such as Google's target of 120% freshwater replenishment by 2030, transforms operational necessities into local community benefits.

Potential for up to 10% less emissions with optimised traffic lights



Green Light optimises traffic lights to reduce vehicle emissions in cities, helping mitigate climate change and improving urban mobility.
Image: Google

Ultimately, building the infrastructure for urban AI necessitates building sustainably. That is why Google is working hard to advance clean energy (more information can be found in our 2025 Environment Report).

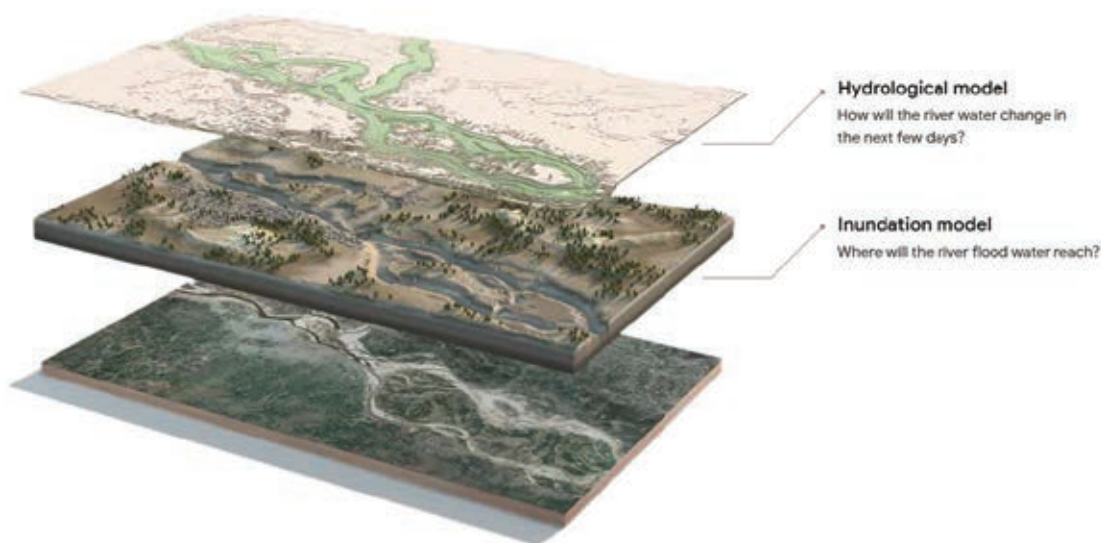
The AI Return on Investment: Decarbonising Mobility

While we must hold ourselves accountable for the energy AI consumes, we must also examine the "return on investment" regarding the carbon AI prevents. The World Economic Forum has noted that widespread adoption of digital technologies and AI could reduce global emissions by 20% by 2050 in the highest-emitting sectors—energy, materials, and mobility—by enhancing carbon-intensive processes, improving energy efficiency in buildings, and deploying and managing renewable energy.¹

This brings us to the bridge between digital consumption and physical impact. The energy spent training a model is a fixed cost; the energy saved by deploying that model to optimise a city's transportation network is a recurring, compounding benefit.

Consider the traffic light. In many cities, signal timing is outdated, leading to unnecessary stop-and-go traffic that spikes emissions. Traditionally, fixing this would require expensive hardware sensors and manual counts. AI changes the equation. Through partnerships with cities like Boston, Rio de Janeiro, and Jakarta, we are using AI to model traffic patterns at intersections with Project Green Light. Utilising advanced machine learning, we are able to recommend adjustments to city traffic engineers that can have a huge impact on reducing wait times and emissions. This project is now active in over 20 cities globally with a significant and growing pipeline. In Boston, Massachusetts, early implementation at diverse intersections helped reduce stop-and-go traffic by up to 30%. By smoothing the flow, we are actively stripping carbon out of the transportation sector.

Similarly, we are empowering individual citizens to act through Eco-Friendly Routing in Google Maps. By using AI to analyse road incline, traffic congestion, and constant speeds, we can suggest routes that consume the least amount of fuel or energy. Since its launch, this feature is estimated to have helped prevent more than 2.9 million metric tonnes of carbon emissions—roughly equivalent to taking 650,000 fuel-based cars off the road for a year.



Using AI to make critical flood forecasting information universally accessible.

Image: Google

Environmental Intelligence: Making the Invisible Visible

Beyond mobility, AI creates a new form of "environmental intelligence" that allows cities to adapt to a changing climate. A truly liveable city is a healthy city, yet threats like air pollution are often invisible and hyper-localised.

To address this, we have moved beyond simple monitoring to ecosystem-wide solutions. City leaders often tell us they are "drowning in data" but struggling to operationalise it. In response, our approach with Air View+ in India has been to shift the focus from reactive maintenance to predictive foresight. Instead of relying solely on sparse government stations, we helped create a city-wide network of low-cost sensors. We then combined this granular sensor data with AI models to provide a real-time, hyperlocal view of air quality.

This approach transforms raw data into a governance insights engine. It empowers city administrators to move beyond simply "knowing" a problem exists to actively "acting" on it—identifying hotspots to design targeted interventions, whether that's rerouting heavy traffic, planning green barriers, or issuing

health advisories to specific neighbourhoods. This model has also been deployed successfully in Dublin, Ireland, and across cities in Brazil, where the combination of Air View+ and Google's transportation data (including distances travelled by vehicle, transit, cycling and walking) are being used to directly influence governance. For instance, Google's transportation data was instrumental in shaping Boa Vista's new Urban Mobility Law, and was used by the City of Recife, Brazil to obtain ISO 37120 (Smart Cities) certification, setting precedents for how our data empowers cities to implement new, climate-conscious policies and unlock new investment and funding.

Central to this intelligence is the ability to democratise complex environmental data. Google Earth now serves as a no-code platform, allowing city planners to bypass expensive data science barriers. By utilising pre-loaded datasets for land surface temperature and tree canopy coverage, officials can visualise urban heat islands in minutes. This turns a complex climate crisis into an evidence-based urban forestry programme, allowing cities to prioritise cooling the neighbourhoods most vulnerable to extreme heat before the next heatwave hits.

Here are a few ways that Google Earth is being used by cities:



Heat resilience

Identify urban heat islands and target hotspots for tree planting interventions. Pinpoint hotspots, assess community needs, and target interventions for cooling strategies like trees and reflective roofs.



Sustainable building

Accelerate planning with AI-powered tools to evaluate building designs and solar potential for urban development. Plan greener projects, faster, by identifying ideal building locations, accelerating solar analysis, and analysing environmental impact.



EV infrastructure

Layer EV Google Search Interest data with existing charging station locations to identify opportunities for new charger installations. Layer EV demand and infrastructure data into actionable insights to spot ideal locations and plan strategically.



Mobility planning

Visualise traffic patterns with data on vehicle trips and congestion points to improve mobility and safety. Understand traffic movement patterns, pinpoint problem intersections, and target solutions to help reduce traffic congestion.

Images: Google

Resilience also means preparing for the acute shocks of climate change. Through Flood Hub, we are using AI hydrological models to predict when and where riverine flooding will occur, up to seven days in advance. This tool now covers territories home to over 460 million people globally. But data alone does not save lives; delivery does. That is why we collaborate with organisations like the International Federation of Red Cross and Red Crescent Societies to set up "offline alerting networks"—trained community volunteers who translate digital foresight into physical action, warning neighbours who may lack connectivity.

The Governance of Innovation

The transition to an AI-enabled city is not just a technological challenge; it is a governance challenge. If we simply drop black box algorithms (AI models using opaque decision-making processes) onto city departments without a framework for oversight, we risk eroding public trust. We have learned that the most successful smart city projects are those that put people, not technology, at the centre.

For example, in Memphis, Tennessee, city leaders used AI to automatically detect potholes and road assets from video feeds. This helped drastically reduce the time it takes to identify and repair crumbling infrastructure, allowing city crews to focus on fixing problems rather than finding them.

To scale this kind of success responsibly, we must prioritise transparency and equity. We are proud to collaborate with organisations like the United States Conference of Mayors to develop AI guidelines for cities. These frameworks emphasise that AI should be explainable, equitable, and subject to human oversight. City leaders must understand *why* an algorithm recommends a certain traffic pattern or resource allocation.

Furthermore, we must ensure that the benefits of this data revolution are shared. Through initiatives like the Environmental Justice Data Fund,

supported by Google.org, we are helping frontline communities collect and analyse their own data on environmental hazards. When cities use AI, they must ensure the data reflects the reality of all neighbourhoods, not just the connected ones.

The Path Forward: Act Now

The theme of the World Cities Summit in 2026, "ACT Now", feels particularly prescient and is a call to action. We cannot afford to wait for perfect solutions or infinite resources. We must act now, with the tools we have, to build cities that are resilient, efficient, and humane.

AI offers us a chance to decouple economic growth from carbon emissions. It offers us a way to make our grids smarter, our traffic smoother, and our air cleaner. But it requires us to manage the trade-offs responsibly.

For Google, that means continuing to drive energy efficiency in our data centres and pushing the frontiers of carbon-free energy. For city leaders, it means embracing digital transformation not as a vendor contract, but as a strategic capability. By balancing the physical demands of this new infrastructure with its boundless potential for sustainability, we can build cities that do not just survive the 21st century, but thrive in it. 🌱

To find out more about Google's 2025 Environment Report, please refer to <https://sustainability.google/reports/google-2025-environmental-report/>

[1] World Economic Forum, "Digital Tech Can Reduce Emissions by up to 20% in High-Emitting Industries," May 24, 2022, <https://www.weforum.org/press/2022/05/digital-tech-can-reduce-emissions-by-up-to-20-in-high-emitting-industries/>