The Future of Urban Science

New Horizons in Research on Human Settlements

Dr. Anthony Townsend - September 2015

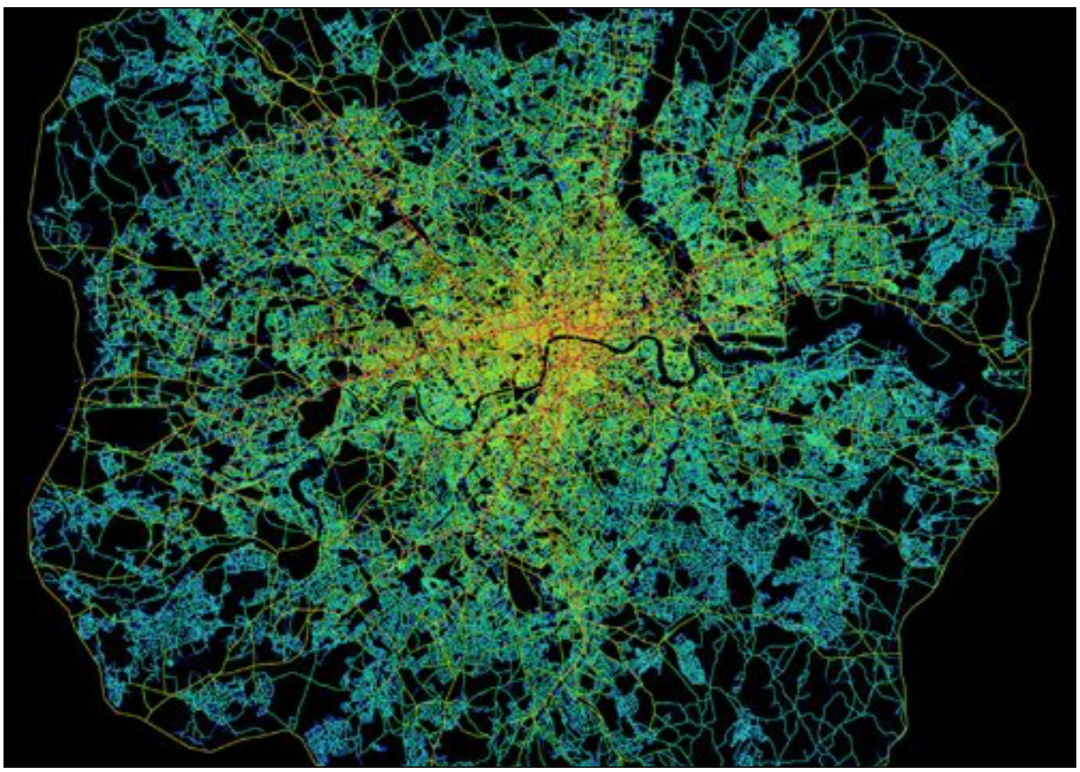


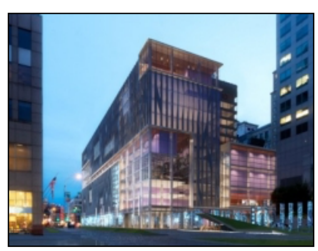
Image: Centre for Advanced Spatial Analysis

Introduction

Over the last year, the *Cities of Data* project at New York University's Rudin Center for Transportation Policy and Management and the Data & Society Research Institute has explored the rapidly expanding global urban science movement. We define urban science as an emerging domain of research at the intersection of science and design, drawing on new disciplines in the natural and information sciences, that seeks to exploit the growing abundance of computation and data. In a series of publications, we explored:

- The history of earlier waves of scientific interest in cities and 'colonization' of urban research by other disciplines,
- The projected scale of urban science and informatics research institutions, which we forecast to grow to an investment of some $2.5 billion globally through 2030,
- The search for new research models that leverage digital platforms for citizen participation in urban research, and the risks and benefits of a citizen urban science movement.

In this final report, we build on this work to develop four scenarios of how urban science might unfold in the coming decades. These speculations are designed to inform policy, philanthropic support for research, and institutional research and development strategy. Foresight is critical to inform strategy for defining and advancing urban science in an effective manner over the critical coming phase of evolution of this nascent movement.



Birth of a new urban science : *The University of Chicago's Array of Things; Singapore-ETH's Future Cities Laboratory; New York University's Center for Urban Science and Progress; Boston Mayor Marty White addresses the Boston Area Research Initiative.*

Methodology

These scenarios were developed using the alternative futures methodology initially developed at the University of Hawaii in the 1970s and widely employed in long-range forecasting by futures research organizations around the world.

The alternative futures method is premised on the observation that any plausible, internally-consistent scenario narrative can be grouped into one of four archetypes:

- **Growth:** A future in which current key conditions persist, including continued historical exponential growth in certain domains (economics, science and technology, cultural complexity, etc.) Also known as PTE, or "present trends extended".
- **Collapse:** A future in which some conditions deteriorate from their present favorable levels, and some critical systems fail, due to a confluence of probable, possible, and wildcard factors.
- **Constraint:** A future in which we encounter resource-based limits to growth. A sustainability regime emerges, slowing previous growth and organizing around values that are ancient, traditional, natural, ideologically-correct, or God-given.
- **Transformation:** A future of disruptive emergence, "high tech," with the end of some current patterns/values, and the development of new ones, rather than the return to older traditional ones. This is a transition to an innovation-based regime of new and even steeper GROWTH.

This approach addresses a number of shortcomings in more widely used scenario development methods, such as the Shell model, which involves a straightforward process of first identifying the two most important and uncertain variables, positing two possible futures for each, and then constructing four scenarios representing the four possible permutations. While this method is widely used in more bounded strategic planning exercises, its effectiveness is crucially dependent upon variable selection. This fundamental limitation makes it less suitable for exploring implications and strategies to deal with more complex, uncertain futures.

Overrun

Urban science stages a takeover of urban studies and planning research and education, pushing out existing experts and remaking institutions.

In a seminal 1978 essay, "Economics and Contiguous Disciplines", Nobel laureate Ronald Coase highlighted the accelerating metastasis of his field. Yet as his fellow economists subdued their critics with weaponized methodologies, Coase's warnings went unheeded in subsequent power struggles. "The reason for this movement of economists into neighbouring fields is certainly not that we have solved the problems of the economic system," he wrote. "[I]t would perhaps be more plausible to argue that economists are looking for fields in which they can have some success." Since then, economics has become an ever-more dominant framework for study and understanding of the social world.

Despite the headline-grabbing findings of the 'new wave' of urban scientists in the 2010s, few thought the same would happen in urban studies. While universities launched a building boom of new research groups, and national governments ramped up funding for urban science, urbanists expected to fend off and eventually assimilate the physicists much as they had successful done with economists a generation before. Planning schools tended to be messy, tolerant places, too diverse for any one group to get the upper hand intellectually. And their professional focus made indoctrination difficult — planning students attend graduate school to gain tools to make the world a better place, not to be spoon-fed intellectual dogma.

But by 2019, the signs of a coup were gathering. Four of the elite American planning schools — UC-Berkeley, Penn, UCLA and MIT — had appointed urban simulation and informatics experts as department chairs. It was clear these were defensive moves responding to the explosive growth of enrollment and research funding at new institutions like NYU's Center for Urban Science and Progress, Arizona State University's partnership with the Santa Fe Institute, University College London, ETH, and Delft University of Technology.

The most important driver was the widespread prioritization of urban science and technology as a national economic competitiveness issue globally. While the UK had been the first to shape policy around urban technology as an export growth market in 2013, Singapore and Israel were the first countries to explicitly link local planning, budgeting and governance to the larger goal of accelerated technology development. In a 'smart city race' reminiscent of the space race, the US, China and India all re-directed substantial portions of their defense, climate mitigation, and biomedical research towards intersecting areas of urban science. The thinking was that big data and predictive analytics, which had delivered so much in the private sector, would 'trickle up' to national governments through successful deployments in large cities.

By 2030, urban scientists — researchers focused on cities but primarily with backgrounds in natural and information sciences — were clearly setting the agenda for urban research in most countries. They dominated university faculty, senior staffs at funding organizations, and key senior policymaking positions in government. And while some critics derisively likened the field's new face to psychohistory, the predictive social science of sci-fi legend Issac Asimov's classic 1950s *Foundation* novels, the new guard delivered enough early wins to persuade a skeptical public. Urban science was off and running, and had satisfied most of Kuhn's (1970) views of a new scientific paradigm - it was generating new theories not covered by other disciplines, it had galvanized a core group of researchers working on unique methods, and it had formed processes to collectively evaluate its own work. Most importantly, it shared a set of common principles centered on the belief that cities were, albeit extremely complex, fundamentally tractable sociophysical phenomenon that could be measured, deciphered, and predictively modeled.

Still there were cracks in the edifice of urban science. The rapid, unchallenged ascendance of data-driven research left a number of gaps unfilled. Urban science groups lacked the capability to evaluate the impacts of their work, as they did not actively engage with policy analysis and evaluation researchers to understand the organizational or regulatory consequences of their work. Ethical and legal concerns over the potential discriminatory impacts of computer-assisted policymaking mushroomed at an alarming rate, yet there was little appetite or capacity to address them. Critics began to question the rise of a new urban planning technocracy that was being created, bigger and more powerful than any before. Urban scientists had policymakers attention — but if their soothsaying machines failed, the results could be catastrophic.

Bubble

After initial excitement and early promise, the investment boom in urban science has little to show for its outlays.

For a decade, the world had known that Jakarta was a ticking time bomb, a perfect storm of rampant and unplanned urbanization in one of the highest-risk regions for catastrophic impacts from climate change. In 2020, a series of devastating floods laid waste to the megacity, killing 80,000 and leaving over 2 million homeless.

Renewed hope came in the form of a monumental, if somewhat self-serving, commitment from the Singaporean government, which committed to a crash program of technical assistance and resilience mitigation. The island nation's bureaucrats brought not only industrial infrastructure engineering and public sector administration prowess, but a capacity for urban research unrivaled anywhere in the world — the result of a decade of close collaboration with ETH, the Swiss technical university, at its Future Cities Laboratory.

Over the next five years, the satellite lab they established, the Future Cities Laboratory Jakarta, spun up the largest and most sophisticated urban observatory the world had ever seen. Over 250 researchers, with more than $100 million in annual funding provided by the consumer tech giants Google, Apple, Amazon and UberFedEx, which were all in one way or another transforming themselves into latter day versions of the 'traction monopolies' that had dominated the utility and transportation infrastructure of American cities in the early industrial boom. The lab was the pinnacle of a wave of investment in urban science and informatics that had started in 2010 in academia, spilled over into the private sector and now had the developing world's basket-case megacity governments squarely in its crosshairs. The fate of 25 million people rested on the efforts of a few hundred brilliant scientists and the ten thousand or so elegant equations they thought described the sprawling madness visible from the lab's 360-degree view above the skyline.

And for a while, things made sense. Between the Singaporeans laying down new rules on the front lines and the Apple lobbyists pushing hard behind the scenes — the company had decided abruptly in 2018 to move all of its manufacturing here from China, expatriate its earnings, and essentially take over the country — the long-hoped-for shift to autonomous electric vehicles was rapidly planned out and put in motion. If Apple and the urban scientists could reprogram Jakarta's peri-urban landscape through autonomous vehicle technology, the sky was the limit. *Wired* ran a cartoon lampooning Tim Cook as the new John Rockefeller, growing richer on the back of the world's urban poor.

But Apple wasn't alone getting into bed with the urban scientists. With Google stamping out solar-powered, self-driving new towns throughout the Americas, and Baidu retrofitting China's tofu buildings — while computer scientists have always borrowed terminology from urban planning, it was now utterly clear that the future of the computer industry was architecture and infrastructure, not consumer devices. In 2012, Intel had staked the first corporate smart city lab in London to the tune of $5 million. In 2015, Uber hired away more than half of Carnegie-Mellon's carefully-assembled world-class robotics faculty. By 2020, the funds funneled to smart city research by industry dwarfed anything seen before.

But what started as a boom quickly turned to bust, and it became clear that urban science was the latest in a long line of scientific funding bubbles — cognitive neuroscience, recombinant DNA, and so on — that have pulled researchers away from promising research towards fundable topics.

In Jakarta, the disappointments mounted. While the auto-EV network grew, it just couldn't seem to match supply and demand, and integration with the power grid was a disaster — people, power, and pod cars never seemed to be in the right places at right time to sync up. No one could figure out why the models weren't working. Meanwhile, the larger edifice of big data was starting to unravel. The Google Flu Trends fiasco of 2015 had only been the beginning. Soon, one after another the miracles of the data science priesthood were found wanting upon closer examination.

It wasn't just research that suffered, a generation of urban science graduates, educated in hastily-assembled master's degree programs in the 2010s could talk a 'big game about big data' as one critic put it, but couldn't deliver the kinds of results that were being promised. Like the post-war planners of 1950s suburbia, who had mostly been trained simply to enact zoning codes and lay out subdivisions, they were working from a limited playbook.

Integration

As urban science produces new research talent and techniques, they complement rather than compete with existing efforts and approaches.

The emergence of any new field both depends on, and is reflected in, the development of social networks that link researchers and their institutions together. The re-formulation of urban planning into urban studies in the 1960s and 1970s formed around new linkages between social science, activists and planners. The reconstitution of urban studies into urban science in the 2010s and 2020s grew out of a similar process of integration with a new group of migrants from the physical and information sciences.

It began with some meetings. Two successive “Workshops on Big Data and Urban Informatics” funded by the National Science Foundation held the University of Illinois at Chicago in 2013 and 2014, and mostly attended by data-focused researchers from traditional urban planning and studies departments highlighted the critical mass of young faculty looking to take the field in a new direction. Around the same time, two convenings of an embryonic network of data-focused urban research groups in 2015 - in New York and London - helped lay the groundwork for a new journal of urban informatics.

In the second half of the decade, urban research and education began to institutionalize these changes — nearly every urban planning school in the US and Europe launched some kind of urban informatics or smart cities program. The impetus for the shift was the need to incorporate scientific thinking into urban planning and design education, rather than see students flock elsewhere for it.

Seeking models that would preserve the positive aspects of planning research and practice traditions — a careful attention to the nuance of place, an ability to deal with uncertainty and poor information, and an ability to articulate and advocate for non-quantifiable community values, its broader ability to navigate the conflicts between science and design — urban researchers were drawn to the translational research framework which the National Institutes of Health had adopted a decade earlier to accelerate innovation in biomedicine. Often summarized as ‘from lab bench to bedside and back’, this model seeks to foster the multidirectional and multidisciplinary integration of lab science, clinical trials and large population studies with the long-term aim of improving public health. As Michael Mehaffy, an urban designer in Portland, Oregon, argued, “A doctor doesn't spend all of his time in a research lab, but he relies on scientific knowledge to guide his decisions on a case-by-case basis. The art comes in the form of tailoring diagnoses and prescriptions for each individual patient.” In urban research, some began referring to a ‘studio to sidewalk’ pathway equivalent of biomedicine’s translational approach.

But while traditional and new science-driven approaches to urban research and education began to work together, there was lingering frustration on both sides of the fence that what was started was not finished. For the scientists, some progress had been made in restoring fundamental steps in the scientific process of testing, comparing findings with others and disseminating results — somewhat neglected in urban research for years. But unlike the overhaul of urban research and planning practice that occurred in the 1960s and 1970s, existing institutions had simply adapted. As a result, while new science-driven collaborations between researchers and city governments were producing real gains, they were mostly short-term and marginal, not transformative. Urban science was working, but it had turned out more workmanlike and less revolutionary than anyone had envisioned.

Enigma

The city, much like the human brain, turns out to be a scientific mystery that only becomes more complex and mysterious as we probe it more deeply.

One day early in 2026, all across the world, the urban models ground to a halt. Six months later, the forensic work was still unfolding, and little closer to an answer. Was it the sudden 6-inch surge in sea levels, and the massive disruption in cities, infrastructure and activity patterns worldwide that had shifted everything out of calibration? Was it the launch of the alternet, and the massive flurry of spontaneous self-organized machine-to-machine networking that it had enabled? Either way, or another way, the capabilities that city governments had quickly come to rely on for planning with razor-thin margins — the academic geeks had tooled them up with housing and crime forecast engines that were good enough to base budgets on — were gone. The age of Just-In-Time city management had ended abruptly.

Back in 2020, urban science was in its heyday. Luis Bettencourt and Jose Lobo's bestseller *Hive: The Growth and Decline of A Planet of Cities*, had become a kind of secular bible — tracking the seemingly inevitable demographic destiny of human settlement from the Fertile Crescent to a surprising end that sci-fi author Bruce Sterling summed up as "old people, living in cities, staring at the sky in fear". For a while at least, it seemed as if maybe, like trying to knock a doomsday asteroid off its course, we might be able to do something about it.

But the world started to get weird faster than science could keep up. Part of it was just that nature turned out to be more complicated than we ever imagined. Much as had happened in brain science in the 2010s, as our ability to scan cities increased dramatically through the deployment of sensor networks, we began to map out the true vastness of questions that we didn't know the answers to. Every new instrument for mapping the city raised more questions than it answered. We were digging ourselves into a deeper scientific quagmire with each new dataset.

And part of it was our fault. The models used to predict cities, like the machine learning models used in the private sector, had become so complex that they were impossible to understand. But work on legible models, that made decisions in ways similar to human beings, had been neglected because their results were not as good, and return on investment therefore less certain. Despite the fact that people, especially in policymaking circles, trusted them more.

And then there was the observer effect, as old as social science itself. As Michael Batty, one of the founders of urban science had pointed out in 2013, while it was useful to use smart phones as sensors to understand human behavior in cities, those devices were also the instruments of new behavior change. E-taxi service Uber, at first seen as a boon to transportation research, was thought to be measuring travel behavior even while it was in the process fundamentally changing it.

Today, the urban scientists and the brain scientists often pass each other on the street, exchanging forlorn looks. They compare “connectomes” — on the one hand showing linkages between individual neurons and regions of the brain, on the other between urban infrastructure networks — excruciatingly detailed maps that represent a paradox. They are both great leaps in view, but which highlight chasms in science’s understanding of the world. Ironically, even while natural science is developing a newfound capacity to describe the complexity of modern cities, our map of that complexity is growing more vast.

For now, at least, the city would remain an enigma.

Using Scenarios to Explore Urban Futures

The advances in urban research that we confront are not unique to our era, nor is foresight about their implications. In 1948, as he embarked on the Rockefeller Foundation's massive post-war expansion of science funding, Warren Weaver noted that, "[T]hese new [collaborative] ways of working, effectively instrumented by computers will contribute greatly to the advance which the next half century will surely achieve in handling the complex, but essentially organic, problems of the biological and social sciences."[1]

The purpose of these scenarios is to inform strategic discussions about the future of research, education and practice in urban planning and studies as new capacities for gathering, analyzing and visualizing data develop rapidly in the coming decade.

These scenarios should not be treated as predictions, and no one scenario is intended to be a preferred outcome. Each should be considered as potentially likely as the next, and each has winners and losers. Each should also be considered the outcome of decisions and actions taken in the present and near future.

Some key questions to consider as you ponder the implications of these scenarios include:

- What are likely and possible breakthroughs in urban science?
- How might these discoveries be translated into practice?
- How might embedding that knowledge in predictive tools impact both policy formation and operational decision-making?
- What role will citizens play in this scientific and governance reform movement?
- How can we systematically assess the associated risks and unintended consequences of new scientific ideas and their applications?
- Whats are the emerging cultures and belief systems of this urban science and data-driven governance movement?

---

[1] Weaver, "Science and Complexity"

Acknowledgements

The author would like to acknowledge the following organizations for their financial and logistical support for this research:

John D. and Catherine T. MacArthur Foundation

John S. and James L. Knight Foundation

Rudin Center for Transportation Policy and Management, New York University

Data & Society Research Institute