

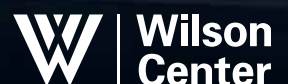


DAWN OF THE SMART CITY?

PERSPECTIVES FROM
NEW YORK, AHMEDABAD, SÃO PAULO, and BEIJING



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WHAT ARE SMART CITIES?

Schuyler Null

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RAPID GROWTH AND ENVIRONMENTAL CHANGE are creating new challenges for urban areas around the world. By 2050, as many as 7 out of 10 people on Earth will live in cities, with the vast majority of growth occurring in today's developing countries.¹

From climate change adaptation and crime prevention to the integration of new residents, much is being asked of municipal governments. At the same time, new technologies—from data collection and real-time monitoring to sophisticated “control centers”—are being developed that could transform urban decision-making and city management. Led by a cadre of information technology companies, the use of such technologies to help cities adapt to 21st-century challenges is called “smart cities.”

IBM, Cisco, Siemens, and other large companies see applications for their business in providing computer networks, distributed sensors, and data analytics to expand the tools of city planners and ease growing pressures. Some see smart cities as a paradigm shift equivalent to the spread of electricity in the 20th century. Cities not only produce much of the world's wealth and innovation but also a tremendous amount of information, which if harnessed could save money, time, and space, while also making people safer and more productive.

Alongside these largely top-down initiatives, smart technologies could also help every-day citizens be heard above the din of municipal politics and bureaucracy by creating more opportunities for participation and making city processes more transparent and responsive. If cities make the data they collect widely available, anyone could use it to create innovative solutions to complex problems.

But there are also fears that technocratic solutions will be crippled if they do not account for the realities of local politics; too much focus on efficiency will lead to sterile, stifling environments; and the expense and upkeep of such systems will further divide cities along class lines.

From New York to São Paulo, Beijing, and Ahmedabad, this short collection of essays examines lessons learned about the application of smart city technologies in four countries experiencing profound demographic, environmental, and economic transformations. How can smart technologies help New York prepare for the next Hurricane Sandy? Can they ease social tensions in Brazil's sprawling cities or unclog India's swarming streets? And will they make urban agriculture a reality in China?

¹ “Urban Population Growth,” World Health Organization, accessed May 20, 2014, http://www.who.int/gho/urban_health/situation_trends/urban_population_growth_text/en/.

BRINGING JANE JACOBS INTO THE 21ST CENTURY: SMART CITIES ARE MORE ENGAGED CITIES

Alexandros Washburn

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IN THE CORPORATE WORLD, there has been significant interest in applying new sensing and analytics technologies to improve the operation of urban systems, a concept some have called “smart cities.” Meanwhile, in an age of austerity and environmental change, local governments want desperately to find efficiencies and become more resilient. Yet the two seldom meet. If we want to change that, the private sector has to step back and understand that a city’s infrastructure is merely one component in a system of systems, including political and cultural systems that cannot be circumvented or optimized by technology, no matter how ingenious or ubiquitous. We must therefore find ways for these new technologies to integrate with and enhance public processes such as they are.

Every city, every culture is different. Hong Kong makes choices differently from New York. Singapore has an enviable ability to get things done. Rome has *la dolce vita*. While the contexts differ significantly, a commonality is the need for a political balance between top-down authority and bottom-up community input. Smart cities use sensors to gather data and algorithms to make sense of it. To the degree that data gathering can facilitate bottom-up input, and integration can inform top-down decision-making, a smart city approach can work in parallel to the political process to help find the balance between bottom-up and top-down more quickly and involve more people, helping cities and their citizens cope with changing times.

“TO GOVERN IS TO CHOOSE”

There is no universal definition of a smart city, though not for lack of trying. In 2007, a group of European technical universities made a game attempt to define six characteristics, 31 factors, and 74 indicators of “smartness.”¹ A more recent European Commission definition focuses on goals rather than standards, defining smartness as anything resulting in better public services and lower energy use.² American urbanist Alex Marshall focuses on the enabling technologies, calling smartness, “the marrying of the city...to the telecommunications revolution.”³ In practice, cities such as Songdo, South Korea, claim the title based on embedded communication networks, while Rio de Janeiro bears the descriptor based on its new “Center of Operations,” which collates data from around the city onto a wall of screens.

Command and control is a common theme in smart cities. But while control of devices is a technological question, control of societies is political. As John F. Kennedy said, “to govern is to choose.” Therefore, a smart city is one that makes better choices.

There is a notion that cities grow haphazardly, always changed by someone else. In reality, cities are changed

1 Center of Regional Science, *Smart Cities: Ranking of European Medium-Sized Cities*, Vienna University of Technology, 2007.

2 “Smart Cities,” European Commission, accessed May 2014, <http://ec.europa.eu/digital-agenda/living-online/smart-cities>.

3 Alex Marshall, “Big Data, Big Questions,” *Metropolis Magazine*, February 2014, <http://www.metropolismag.com/February-2014/Big-Data-Big-Questions/index.php>.



by the choices of their citizens, even if that decision is to abdicate choice. Many realize a vague need for positive change, but many more feel powerless when confronted by the enormous complexity, lack of political transparency, and high cost of even a small public project. This puts a gap between those who change a city, and those whose lives are changed by it. Perhaps the most important application of smart technologies is to help close that gap by increasing the speed and accuracy of municipal decision-making and expanding public participation.

SMARTER LAND-USE REVIEW

Though not as cutting edge as the gleaming digital solutions imagined by many smart city advocates, New York's procedure for public review of new development is a pragmatic example of how smart technologies can improve public participation in an important city process.

The Uniform Land Use Review Procedure (ULURP) is a charter-mandated sequence of government actions and public reviews invoked any time a major change to the built environment of New York is proposed.⁴⁴ It is a mediating process that emerged from the epic battles of the 1960s between Robert Moses, the city's unelected but all-powerful master builder, and Jane Jacobs, an influential writer and community activist, over whether to demolish swaths of Greenwich Village to build an

expressway across Lower Manhattan. Jacobs took on Moses publicly and with a grant from the Rockefeller Foundation wrote *The Death and Life of Great American Cities*, which became the cornerstone of community-based city planning. The ULURP process recapitulates their top-down vs. bottom-up face-off, alternating official votes and public comments at open hearings with the intent of reaching a compromise at the end of a multi-month time frame.

ULURP does a decent job reaching a balance between community and administration, but overall the process is too slow. When you include the preparation time before a proposal enters ULURP and the window for challenge by the courts after, it can take a decade from deciding what to build to actually building it. Smart city technologies have the potential to accelerate the process in several ways; first, through visualization.

City planners should have freely available, digital models of the city in place that can visualize changes from any perspective and at a uniformly high standard of resolution. Any citizen should be able to point their smart phone's camera at a building site and see the proposed change to their neighborhood in augmented reality. Now they must wait in line to see an architect's rendering from a pre-chosen perspective at a pre-arranged public hearing. No context, no exploration. This is a barrier to public participation, and when there is not enough information to form an informed opinion, the answer from many is "no," slowing the whole process down.

⁴⁴ "Uniform Land Use Review Procedure," City of New York Department of City Planning, accessed May 2014, http://www.nyc.gov/html/dcp/html/ap/step5_ulurp.shtml.

Second, city planners and developers should be able to compute system effects in real time. To understand exactly how a major new building, park, or piece of infrastructure will affect the area around it, the public process requires an environmental impact statement. Most of these statements are hundreds if not thousands of pages of numbing text, used by proponents to insulate the project from court challenges by proving that nothing was hidden during the approval process. Why not use smart technology to convert a disclosure document into a design document? Technology allows for building highly detailed computational as well as visual models of our environment and then running proposal scenarios in real time. The results of such modeling can and should influence design, and there's no reason it cannot be an open process.

COASTAL RESILIENCE: THE NEXT BIG CHALLENGE

One need not look very far for an example of why the potential for smart city technologies to improve the speed and effectiveness of ULURP is so important. In 2012, Hurricane Sandy caused \$42 billion in damage to New York City, including flooding my own house in Red Hook, Brooklyn.⁵ In an era of climate change, every new building project must also help the city adapt to new environmental rigors—and quickly. Sea level is rising. What were once labeled “100-year storms” now occur with increasing frequency.⁶ Indeed, when it comes to environmental impact statements, we cannot hide behind findings of “no significant impact;” we have to actively build resilience, rather than just avoid doing harm. This is the next big decision facing New York and the 1 billion people around the world who live in coastal cities.⁷

5 Thomas Kaplan and Raymond Hernandez, “Cuomo, in Aid Appeal, Cites Broad Reach of Storm,” *The New York Times*, November 26, 2012, <http://www.nytimes.com/2012/11/27/nyregion/governor-cuomo-says-hurricane-sandy-was-worse-than-katrina.html>.

6 IPCC Working Group I, *Climate Change 2013: The Physical Science Basis*, UN Intergovernmental Panel on Climate Change, September 2013.

7 Suzanne Goldberg, “At-Risk Cities Hold Solutions to Climate Change: UN Report,” *The Guardian*, April 11, 2014, <http://www.theguardian.com/environment/2014/apr/11/cities-solution-climate-change-ipcc>.

At the Stevens Institute of Technology, we founded CRUX, the Coastal Resilience and Urban eXcellence Center, to help tackle this challenge. Smart technology is central to our work for gathering data, communicating with the public, and modeling complex decisions.

First, we are expanding the definition of the smart city to include water. We have a network of sensors on piers and buoys throughout New York Harbor telling us the direction, velocity, salinity, and height of water in a high-resolution, real time grid. Using this data and a complex hydrodynamic model, we can predict with 95 percent accuracy the interaction of winds and waves, giving us the ability to assess storm surge vulnerabilities upland.

Second, we are installing sensors on land through our “Smart Hoboken” program. Flooding from Hurricane Sandy stranded 20,000 people in the city.⁸ Our goal is to build a network that can monitor the capacity to deal with storm surge and storm water, provide disaster period data, add transparency to the daily operations of the city's infrastructure, and make this information available to citizens and city officials alike.

Third, we want to build a computational model of Hoboken that can go beyond representing the physical to also include the social. How do we, citizens, make decisions, whether personal or collective? The model, like a game engine, will allow us to make choices from our perspective, and, if we are successful, visualize the effect of those choices on our built environment. This form of agent-based modeling can be run repeatedly and each time we learn something new about projects or policies we are proposing. Over time, the parameters themselves, in the sense of zoning or building codes, can become “laws that learn.” Using these smart technologies, there is the possibility of significantly elevating the degree of complexity considered in important city decisions.

8 Star-Ledger and NJ.com Staff, “Hurricane Sandy: Flooding, Evacuations, Power Outages and More—Latest Updates,” *NJ.com*, October 31, 2012, http://www.nj.com/news/index.ssf/2012/10/hurricane_sandy_nj_updates_pho.html.

We have to actively build resilience, rather than just avoid doing harm. This is the next big decision facing New York and the 1 billion people around the world who live in coastal cities.





And here it is best to return to first principals. A city is its citizens. We may delegate decisions to increasingly aware and responsive technology, but we should never abdicate. We must maintain strategic direction and the responsibility for implementation.

I believe this is the most powerful potential of smart city technologies—enabling ordinary citizens to affect their city to a degree they may never have thought possible by becoming informed participants and stakeholders, willing to take on political, financial, or design decisions that will change their city for the better. Jane Jacobs once said, “Cities have the capability of providing something for everybody, only because, and only when, they are created by everybody.”⁹ In effect, by making city processes more transparent and engaging, we can finally bring that notion to fruition.

“Cities have the capability of providing something for everybody, only because, and only when, they are created by everybody.”

9 Jane Jacobs, *The Death and Life of Great American Cities* (New York: Random House, 1961).

THE GREAT MIGRATION: HARNESSING TECHNOLOGY FOR BETTER URBAN TRANSPORTATION IN INDIA

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TODAY LESS THAN ONE THIRD OF INDIANS live in cities. However, those cosmopolitans generate more than 58 percent of the country's GDP and urban areas account for 90 percent of government revenues.¹ What's more, these proportions are expected to grow to 40 percent of the population generating nearly 70 percent of GDP over the next two decades. By 2050, India will surpass China as the most populous country in the world² and by 2030 it is projected to have 68 cities with more than 1 million inhabitants, 13 with more than 4 million, and 6 megacities with populations exceeding 10 million.³ This unprecedented urbanization will create havoc for civic infrastructure.

India is already challenged in terms of scaling urban facilities to meet growing demands for more and better water, public safety and security, transportation, and electricity. The gap between urban haves and have-nots grows seemingly ever-wider, threatening social cohesion and broader development.

City leaders grappling with these challenges should focus on high impact areas first. Transportation is one of the biggest infrastructure challenges for cities at all

stages of development; it affects all layers of society and can have tremendous benefits. It is also a challenge that the concepts and technologies behind "smart cities" are well suited to address, using networked sensors and flexible technologies to understand, plan, and adjust infrastructure quickly.

SNARLED TRAFFIC

India's transportation sector is large and diverse, contributing 4.8 percent of GDP.⁴ Roads accommodate 90 percent of the country's passenger traffic and 65 percent of its freight. But demand far outstrips supply. Personal transportation has grown 10 percent in the last decade while parked vehicles, roadside hawkers, and pavement dwellers have steadily encroached on roadways and junctions.⁵ In five of India's megacities, almost one third of the urban road space is taken up by illegal parking, according to police.⁶ Roads and streets account for only 16 percent of the total developed area, compared to 28 percent in the United States.⁷ The costs of such congestion—in terms of efficiency, carbon emissions, accidents, fuel, stress, and lost work hours—are massive.

1 Sanjay Kumar Singh, "Urban Transport in India: Issues, Challenges, and the Way Forward," *European Transport* 52 (2012): 1.

2 Sreeja VN, "World Population to Increase to 9.7B by 2050; India Will Overtake China as Most Populous Nation: New Study," *International Business Times*, October 2, 2013, <http://www.ibtimes.com/world-population-increase-97b-2050-india-will-overtake-china-most-populous-nation-new-study-1413620>.

3 Shirish Sankhe et al., *India's Urban Awakening: Building Inclusive Cities, Sustaining Economic Growth*, McKinsey Global Institute, April 2010.

4 Transport Research Wing, Ministry of Road Transport and Highways, *Working Group on Roads for the National Transport Development Policy Committee Final Report*, Government of India, May 2012.

5 Sanjay Kumar Singh, "Urban Transport in India: Issues, Challenges, and the Way Forward," *European Transport* 52 (2012): 3.

6 Bangalore Police, interview with author, March 2014.

7 Sudarsanam Padam and Sanjay K. Singh, *Urbanization and Urban Transport in India: The Sketch for a Policy*, Central Institute of Road Transport, India, 2002.



In response, the government has implemented several strategies, including expanding bus systems, metro rails, and monorails. A massive city modernization scheme, the Jawaharlal Nehru National Urban Renewal Mission (JnNURM), was launched in December 2005 with a budget of \$20 billion and has achieved significant progress by adding 15,260 buses across the country.⁸ In Pune alone, the increased number of buses has led to a 23 percent reduction in vehicles on the road.⁹

“THE PEOPLE’S WAY”

One success story of JnNURM has been the Ahmedabad Bus Rapid Transport System, known as Janmarg or “the people’s way.” Ahmedabad, a city of more than 5.5 million people, is one of the many lesser-known, but rapidly growing metropolises in India. Before the Janmarg, a subsidiary of the municipal corporation, began operation in October 2009, commuter options were very limited, but since then, the bus system has grown from 12 kilometers of route to 45.¹⁰

The system is equipped with a number of innovations that allow it adjust to demand in real time. The buses are

all tracked using an automated vehicle location system which feeds data to a transport management center that predicts arrival times. Similarly, a vehicle scheduling and dispatching system helps operators with scheduling, route optimization, and terminal management. And fleet managers are able to track passenger information to spot trends in usage, increase or decrease the number of buses in circulation, and introduce new routes. They can also make announcements across the entire network.

The scope for digital instrumentation, intelligence, and integration into various aspects of transportation has expanded tremendously. By embedding sensors, cameras, and dynamic signage into existing physical infrastructure, many variables can be adjusted on the fly. Flexible tolling options can be implemented to levy a higher toll during peak hours and lower fares during lean times, encouraging efficient use and reducing congestion and commute times. And through integrated fare management, commuters can buy one ticket or a smart card for passage through multimodal transportation systems—trams, buses, trains, and taxis—without having to wait in queues. Each of these inputs, in turn, feeds into a central system where managers monitor and predict traffic patterns and incidents.

The results of the Ahmedabad Bus Rapid Transport System have been encouraging. Citywide usage has grown from around 18,000 people a day to nearly

8 Dario Hidalgo et al., *National Investment in Urban Transport: Towards People’s Cities Through Land Use and Transport Integration*, Shakti Sustainable Energy Foundation, July 2012.

9 Radheshyam Jadhav, “Experts Back Buses for Easy Commute,” *The Times of India*, November 6, 2013, <http://timesofindia.indiatimes.com/city/pune/Experts-back-buses-for-easy-commute/articleshow/25279287.cms>.

10 “Ahmedabad Bus Rapid Transit System, Janmarg,” UN Framework Convention on Climate Change, http://unfccc.int/secretariat/momentum_for_change/items/7098.php.

Traffic cameras, tracking systems, and command centers should be able to improve the quality of other city functions, like accident detection and emergency response, law enforcement, water infrastructure, and disaster management.



130,000.¹¹ Half of the passengers were users of cars, motorcycles, or three-wheeled auto rickshaws. Travel speed has improved from average peak speeds of 17–18 kilometers per hour to 24.¹² Air pollution has declined (some of the buses run on compressed natural gases) and accident rates are lower.

INCENTIVIZE AND CROSS-LEVERAGE

Ahmedabad's Janmarg is a proven model, having been awarded a number of national and international honors including an "Outstanding Innovations in Public Transportation" award from UITP, Germany, and it could be replicated elsewhere in India.

Nationwide, public transport accounts for only 22 percent of urban transport, far below the basic service standard of 50 percent (New York) and the best-in-class standard of 82 percent (Paris, Curitiba) worldwide.¹³ Through JnNURM, or similar nationwide efforts to expand urban infrastructure, there is a tremendous opportunity to incorporate smart technologies that not only improve personal mobility but bring all the associated positive side effects of reduced congestion, a smaller carbon footprint, less gasoline usage, improvements in productivity, greater economic opportunity, and lower accident rates.

Matching the increasing demand for India's roads and railways cannot be done through increased supply alone. It is a challenge that calls for harnessing new technologies to build smarter, safer, more efficient, and more resilient transportation networks. The government can help by recreating the approach used in Ahmedabad and finding ways to incentivize similar investments. For example, introducing performance measurements that reward results rather than funding disbursement will push city managers towards finding efficiencies rather than spending on the simplest options.

The government should also explore ways to cross-leverage these smart technologies. Traffic cameras, tracking systems, and command centers should be able to improve the quality of other city functions, like accident detection and emergency response, monitoring and sharing suspicious activities with law enforcement agencies, and water infrastructure and disaster management (flood warnings and the integrity of pipes).

Transportation is just one challenge India will face over the next 30 years of explosive urban growth, but it is a sector of critical importance. Emerging smart technologies can play a transformational role in how India's cities adapt and improve, creating safer, more efficient, and more responsive systems.

11 "Ahmedabad Bus Rapid Transit System, Janmarg," UN Framework Convention on Climate Change, http://unfccc.int/secretariat/momentum_for_change/items/7098.php.

12 Chetan Vaidya et al., *Ahmedabad Bus Rapid Transit System: Urban Transport Initiatives in India: Best Practices in PPP*, National Institute of Urban Affairs, March 2011.

13 Sudhir Chowdhary, "Planners Will Use IT to Make Cities More Livable," *The Financial Express*, March 25, 2013, <http://www.financialexpress.com/story-print/1092813>.

SÃO PAULO: THE SEARCH FOR A SPATIALLY SMARTER CITY

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SÃO PAULO IS THE EPITOME OF URBAN CHAOS. A bustling 20-million-people metropolis that accounts for one fifth of GDP, it is Brazil’s economic powerhouse.¹ However, while its economy has changed rapidly over the last three decades from manufacturing into a service and knowledge-based economy, the city’s landscape and spatial organization have not kept pace. The city core is still dominated by large pockets of underused and abandoned areas, remains of former industries, which contrast with its sprawling edges. These spatial imbalances are fostering major problems: social segregation, insecurity, and crime; poor work-life balance and clogged traffic arteries; and a lack of public spaces that fractures and degrades city life.

While the transformation of São Paulo into a “smart city”—through the adoption of new technological tools and the expansion of physical infrastructure—is the order of the day for many stakeholders, what matters first and foremost for the future of the metropolis is its spatial reorganization, lest these new technologies become accessories to the chaos.

INDUSTRY AND LANDSCAPE

In the first half of the 20th century, the landscape of São Paulo was transformed through the development of industry. In recent decades, industrial activity shifted

away from the central areas, but factories, chimneys, warehouses, and industrial plots of land remain in their original location. During the 1990s, São Paulo’s core actually shrank as population growth concentrated in the outskirts (see Figure 1). Today, urban sprawl has expanded the total area of the metropolis to 8,500 km², a consequence of intense migration, poverty, and land costs, among other factors. The city’s infrastructure, which has not kept up with economic change and urban growth, is increasingly inadequate.

Ironically, it is because of an outdated regulatory framework that froze redevelopment of the city core that São Paulo now has an opportunity to redress its organizational issues on a large scale and become a mixed-use, mixed-income city. In-migration rates have fallen, as have city sprawl rates.² Moreover, the city center, as seen in Figure 2, while still largely underpopulated, has slowly regained density. São Paulo attracts significant public and private investment, which can be used to transform the city, and changes city hall is presently making to the legal framework of the city’s master plan guidelines—Plano Diretor Executivo—offer further opportunities, as it is essentially a reformulation of the paradigm for urban planning.

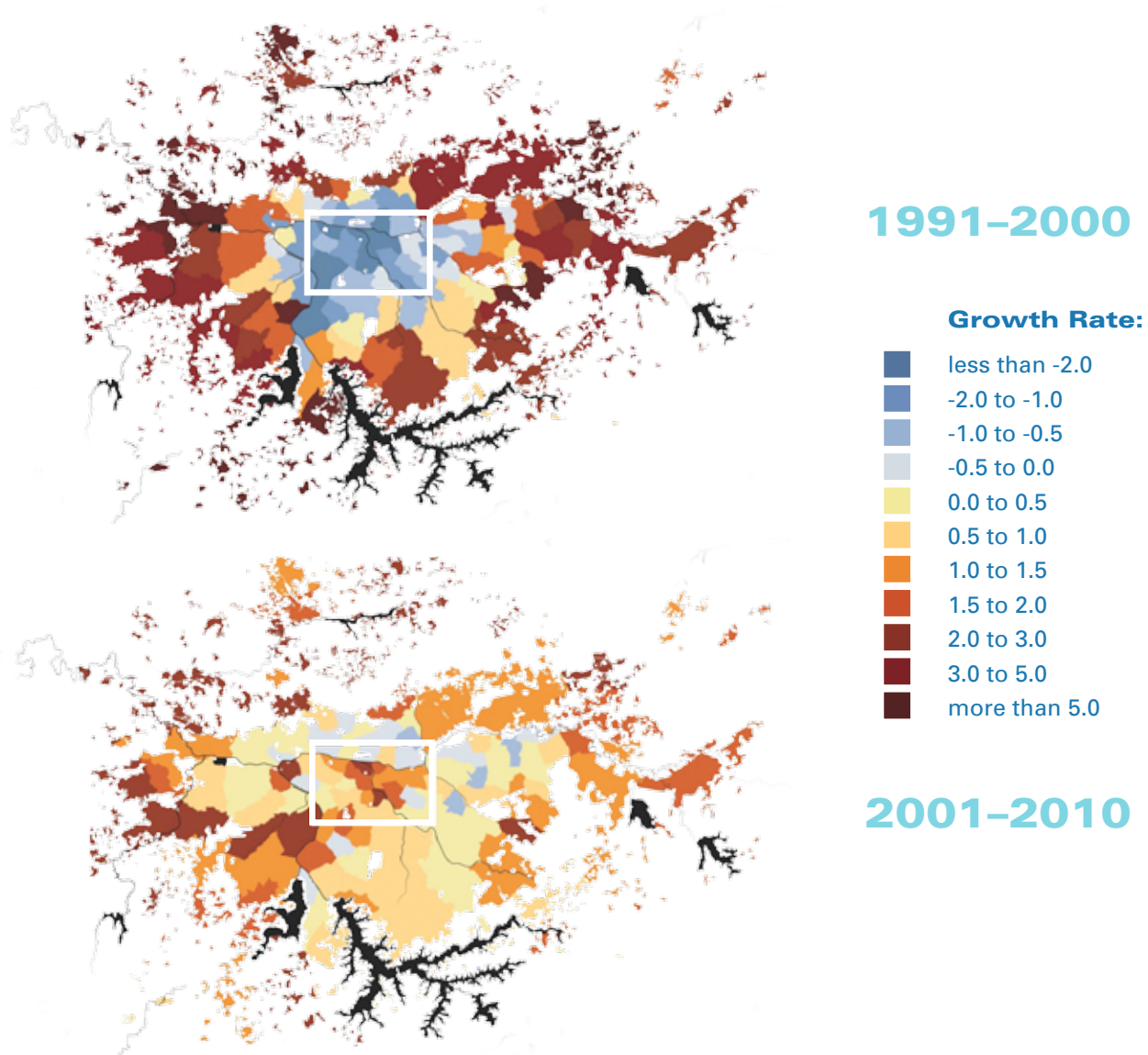
There is an opportunity now to address São Paulo’s problems, harnessing the potential for reinvention that the underused and abandoned areas in the city center

1 Geraldo Aparecido Borin, “O IBEU da Regi o Metropolitana de S o Paulo- RMSP,” accessed April 21, 2014, http://www.observatoriodasmetroplites.net/download/bemestar_saopaulo.pdf.

2 Csaba De k, “S o Paulo” in *Strategic Planning and Urban Projects: Responses to Globalization From 15 Cities*, ed. Marisa Carmona and Rod Burgess (Delft: Delft University Press, 2001).



Figures 1 and 2: The population growth rate of São Paulo, 1991–2000 and 2001–2010. The white square roughly indicates the central area of the city. (Source: SEADE/IBGE, 2000 and 2010 Census)





present. São Paulo simply cannot afford further social segregation, endless traffic jams polluting the veins of the city, and inadequate solutions to the housing problem, be it socially, economically, or functionally.

REVERSING SPRAWL AND REINVENTING THE CENTER

First among São Paulo's physical distortions is the asymmetry between jobs and housing. The central area of the city concentrates jobs for 17 percent of the population but offers a mere three percent of the housing.³ As a result, people tend to live far from their work, which translates into long commutes, pollution, and overall diminished quality of life. On average, Paulistanos spend a total of 92 minutes getting to work and home every day, longer than in London, New York, Tokyo, Paris, or even Santiago.⁴

In the last two decades, the time spent in transit in Brazilian cities has gone up for the rich and poor alike—by four percent for the poorest, and 15 percent for the wealthiest.⁵ Adding buses, special lanes, or subways to

a network that is already overflowing is hardly a solution in a city where there are already 7 million vehicles for 11 million inhabitants.⁶ Redistributing work and residence in both directions—developing more housing in the center of the city and more mixed use elsewhere—would improve quality of life, decrease traffic and pollution, and create a more sustainable distribution of people in the city.

Affordable housing projects in central areas could be a powerful way for the city to influence this spatial imbalance. *Minha Casa, Minha Vida*, one of the largest national efforts, is a particularly good example of a well-intentioned public policy that has failed to appropriately address the issue. The program is designed to help people with lower incomes afford their own houses; however, the subsidies offered are only enough to pay for construction costs, not to buy land, which drives these new homes to the peripheries of metropolitan areas. In São Paulo and other cities with large favela populations, this only adds to the unbalanced spatial distribution of residences and further contributes to overall social segregation.⁷ The program's R\$ 14.2 billion annual expenditure translates into a negative

3 "PPP de Habitação Propõe Reocupação Mista do Centro de SP," *Valor Econômico*, April 5, 2013, accessed April 21, 2014, <http://www.investe.sp.gov.br/noticia/ppp-de-habitacao-propoe-reocupacao-mista-do-centro-de-sp/>.

4 Thaís Leitão, "Quase 20% dos Moradores de Regiões Metropolitanas Gastam Mais de uma Hora Para Chegar ao Trabalho," *EBC*, October 24, 2013, <http://www.ebc.com.br/noticias/brasil/2013/10/quase-20-dos-moradores-de-regioes-metropolitanas-gastam-mais-de-uma-hora>.

5 "Ricos e pobres perdem cada vez mais tempo no trânsito," *IPEA*, March 12, 2013, http://www.ipea.gov.br/portal/index.php?option=com_content&view=article&id=17212.

6 "Transporte e Mobilidade Urbana," *Nossa São Paulo*, accessed April 21, 2014, <http://www.nossasaopaulo.org.br/observatorio/regioes.php?regiao=33&tema=13&indicador=141>.

7 Frederico Roman Ramos and Ciro Biderman, "Urban Sprawl and Spatial Segregation in São Paulo Metropolitan Region" (paper presented at the 41^o Encontro Nacional de Economia in Foz do Iguaçu, December 10–13, 2013), http://www.anpec.org.br/encontro/2013/files_l/i10-bd5e46f51fb1644c885b4ae711cdacfc.pdf.



Luxury condominiums and favelas share neighborhoods, like in Morumbi, with an ironic lack of *neighborhood* at all, as they coexist separated by walls, security cameras, and fences.

investment in mobility, public security, education, and health, as the populations affected become more isolated.⁸

An equivalent investment in abandoned and underused central areas of cities, especially in São Paulo's case, would enable the government to channel resources more efficiently and create a more compact and vibrant city. The Plano Diretor Executivo, currently being reviewed, has the potential to create the conditions for this to happen. Moreover, a recent public call by the municipal government, the Arco Tietê project, identified an area of 6,044 ha² in the city center for redevelopment.⁹ The presence of a

space nearly the size of Manhattan in the city core demonstrates São Paulo's potential for spatial reorganization and improvement—if only the proper impetus were provided.

COMBATING SOCIAL APARTHEID

The second worrisome spatial distortion in São Paulo is an increasingly territorial and radical form of social division. São Paulo's favela population has grown to approximately 1.6 million people¹⁰ living in an area of 30 km², up from 1 percent of the population in the 1970s to 16 percent today.¹¹

Wealthier areas (middle and upper class alike) are often in close proximity with these settlements, yet proximity does not translate into interaction. Luxury condominiums and favelas share neighborhoods, like in Morumbi, with an ironic lack of *neighborhood* at all, as they coexist separated by walls, security cameras, and fences. Exacerbated by a lack of public spaces, these territorial divisions preclude social cohesion, and instead of generating safety, foster violence, insecurity, and, worst of all, social resentment.

8 Gustavo Patu, "Minha Casa, Minha Vida já Gasta Mais que 30 dos 39 Ministérios," *Folha de São Paulo*, January 9, 2014, <http://dinheiropublico.blogfolha.uol.com.br/2014/01/09/minha-casa-minha-vida-ja-gasta-mais-que-30-dos-39-ministerios/>.

9 "Prefeitura Apresenta as 17 Propostas Recebidas Para o Projeto Arco Tietê," Prefeitura de São Paulo Comunicação, September 9, 2013, <http://www.prefeitura.sp.gov.br/cidade/srsecretarias/comunicacao/noticias/?p=156426>.

10 The definition used to measure the population and area of these agglomerations counts first the illegality of the settlement (given lack of ownership of the property on which it is built), irregularity in walkways, size or shape of the plot of land, and lack of essential public services (garbage collection, sewage system, running water, public lighting). "Aglomerados Subnormais Informações Territoriais," IBGE, accessed April 20, 2014, <http://www.ibge.gov.br/home/presidencia/noticias/impressao/ppts/00000015164811202013480105748802.pdf>.

11 Rafael Galdo, "Rio é a Cidade com Maior População em Favelas do Brasil," *O Globo*, December 21, 2011, <http://oglobo.globo.com/pais/rio-a-cidade-com-maior-populacao-em-favelas-do-brasil-3489272>.

The prototype smart cities so far have taught us that even the opportunity to design a city from scratch, with all the modern technology available, can result in dull and artificial environments.

Projects that connect to their surroundings help create real neighborhoods and a better sense of place, fostering a more cohesive society and urban fabric. Lack of public space erodes citizenship, which São Paulo has taken far too long to realize. It is only in the safety of the streets and public space for interaction that a city comes to belong to its citizens.

SÃO PAULO'S TIME TO CHOOSE

São Paulo needs to become a *spatially* smarter city to overcome its social and physical ills. It is not by making the city a Cartesian plane, a predictable set of lines and activities, that it will become the city it ought to be—nor the one its citizens desire it to be. The prototype smart cities so far—South Korea's Songdo and the United Arab Emirates' Masdar—have taught us that even the opportunity to design a city from scratch, with all the modern technology available, can result in dull and artificial environments.¹²

São Paulo must embrace what it has—a vast and underused central area where smart development could start knitting together segregated social groups and commercial zones—to become a city that is more functional and aesthetically consistent with its economic importance and vibrancy. Without these changes, purely technological fixes are likely to be wasted at best and further damaging at worst.

City-making is not a passive process. São Paulo today has the choice between continuing down the path towards what urbanist Mike Davis has termed the “planet of slums”¹³—spiraling inequality accompanied by violence, waste, and chaos—or achieve the “triumph of the city,” as economist Edward Glaeser envisions.¹⁴ These are opposing paradigms that define the current crossroads. Cities are spatial expressions of what we are as a society, and so it is time for São Paulo to decide how to shape its future.

12 Richard Sennett, “The Stupefying Smart City,” LSE Cities, December 2012, <http://lsecities.net/media/objects/articles/the-stupefying-smart-city/en-gb/>.

13 Mike Davis, *Planet of Slums* (New York: Verso, 2007).

14 Edward Glaeser, *Triumph of the City: How Our Greatest Invention Makes Us Richer, Smarter, Greener, Healthier, and Happier* (Penguin, 2012).



URBAN AGRICULTURE MAKES CHINA'S CITIES MORE LIVABLE

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FOR ALMOST ALL OF ITS LONG HISTORY, China has been a predominantly rural society. While in Europe the number of people living in cities surpassed those in the countryside during the late 19th century,¹ China only reached that mark in 2011.² But now that it's come, China's urbanization is at a torrid pace.

Over the next decade and a half, 350 million people, more than the entire population of the United States, will be added to Chinese cities.³ Infrastructure is struggling to keep up, surrounding farmland is being encroached, and pollution is a major public health problem. One-fifth of China's arable land is contaminated⁴ and three-quarters of the surface water flowing through urban areas is unsuitable for drinking or fishing.⁵ From many corners there have been calls for a change to more human-centered development that emphasizes social inclusiveness and environmental improvements *alongside* rational economic growth, rather than dominated by it.

Given China's governance structure, a top-down approach to implementing smart city technologies in this

context might seem like a natural fit. But, like elsewhere, the most promising applications of smart city concepts have started at the grassroots level.

Urban agriculture is the practice of incorporating farming into city areas through mixed land use and innovative techniques that allow cultivation to occur on much smaller plots of land. In China, it's become popular across the country as a means to promote urban sustainability and resilience by bringing food production closer to consumers and reducing its environmental footprint; encouraging awareness of food safety in response to major health incidences; and promoting environmental stewardship as urban air and water pollution proliferate in new cities.

New technologies are assisting with the rise of urban agriculture. Sensors linked to automatic irrigation systems make growing on small plots easier, safer, and more efficient. And farmer cooperatives have unprecedented opportunities to coordinate with one another to buy inputs, specialize their production, and market their products.

As urban agriculture becomes more popular, it's actively reshaping the urban and peri-urban spatial framework, breaking up the monopoly of concrete and strengthening rural-to-urban linkages.

BEIJING SETS AN EXAMPLE

Beijing is one of the early pioneers for integrating urban agriculture into its strategic development plans and acts as a pace-setter in many ways. Recognizing

1 Paul Bairoch and Gary Goertz, "Factors of Urbanization in the Nineteenth Century Developed Countries: A Descriptive and Econometric Analysis," *Urban Studies* 23 (1986): 285-305.

2 Wang Guangtao, ed., *The State of China's Cities 2012/2013*, UN-HABITAT, 2012.

3 Jonathan Woetzel et al., *Preparing for China's Urban Billion*, McKinsey Global Institute, February 2009.

4 Jennifer Duggan, "One Fifth of China's Farmland Polluted," *The Guardian*, April 18, 2014, <http://www.theguardian.com/environment/chinas-choice/2014/apr/18/china-one-fifth-farmland-soil-pollution>.

5 Jian Xie et al., *Addressing China's Water Scarcity*, The World Bank, 2009.



the importance of urban agriculture to sustainable urban development in the late 1990s, Beijing's municipal government launched an official program encouraging multi-function urban agriculture in peri-urban areas by supporting the development of "agro-parks," which not only produce food but also attract tourism and are used as educational tools.

Beijing has developed a wide variety of urban agriculture typologies, creating five zones that govern the type of agro-parks in the city. The "inner urban core" focuses on gardening, landscaping, and exhibition; the "inner suburban plain" specializes in recreational agriculture, which attracts tourism, and precision agriculture, which utilizes smart technologies such as moisture monitoring for automatic irrigation; the "outer suburban plain" emphasizes large-scale, modern agricultural production and processing; the "mountainous" zone is devoted to special fruits and ecologic protection; and finally the "regional cooperation" zone helps bolster food security by facilitating relationships with nearby cooperatives and helping to ensure the quality of imports.

The long-term strategic development of urban agriculture took another step forward in 2004 when a program dubbed the "221 Project" was launched by the city government. The project provides comprehensive guidelines and concrete actions for enhancing urban agriculture in each of the five zones. The first "2" refers to a better understanding of agriculture resources and urban market demands; the second refers to technology application and investment inputs; and the "1" calls for

a single information system that links agricultural production, exchange, and marketing.

Since its inception, the 221 information platform, managed and operated by the Beijing Rural Economic Research Center, has become a powerful network for supporting high-end urban agriculture. It serves as a dynamic knowledge base of best practices and an effective mechanism for quickly disseminating new policies. Citizens can get information about agro-related events and fairs, while farmer cooperatives and other organizations use the network to brand and market their products.

Besides the 221 Project, Beijing has devoted considerable resources to applying new technologies to the urban agriculture sector in order to maximize efficiency and rationally utilize scarce water and land. To capture high seasonal rainfall variation, different types of rainfall harvest technologies are being piloted in the downtown area for watering parks and rooftop plantations. To combat air pollution, which has become such a problem in recent years, a new forest has been started on the outskirts of the city, with a planned area of over 6,000 hectares. Food delivery orders by mobile phone and the internet are being piloted by some working units, bridging a legacy of past planning systems with the new. Drip irrigation systems have been introduced for most greenhouses and large-scale farms within the city. In Shangzhuang, a peri-urban town west of the city center, smart irrigation systems have enabled the return of a well-known rice brand traditionally grown by and for the imperial family.

INSTITUTIONALIZING AND REPLICATING

Despite momentum so far, these gains are vulnerable. To help protect this relatively new sector, the city government has made several moves to begin demonstrating its worth and institutionalizing its practice.

First, the government has begun assessing the ecologic value of urban agriculture in monetary terms. Based on a comprehensive and complex evaluation system with more than 30 variables, an annual report on urban agriculture's ecological value was added to Beijing's statistical year book in 2010. According to its measures, by 2012, urban agriculture—not just in terms of products but also its contributions to the social and environmental fabric of the city—was worth RMB 340 billion a year in Beijing with a growth rate of 6.1 percent.⁶

Second, the city government has started systemically evaluating the performance of its estimated 1,300 agro-parks and helping them improve through a more organized institutional framework.⁷ Urban farmers are encouraged to establish cooperatives to take advantage of their combined scale and bargaining power in buying farming materials and marketing their products. More importantly, through these cooperatives, the government is able to deliver subsidies to further incentivize growth, including selling organic fertilizers and less polluting pesticides at lower prices, both reducing farmers' costs and enhancing food safety.

These types of top-down reforms have helped foster what started as a bottom-up movement. For example, in the suburbs of the city, the Sijiqing town government established a consolidated committee to supervise the area's 10 agro-parks and help organize farmer cooperatives in 2010. Since then, the agro-parks have improved their output through specialization and increased tourism, generating benefits for multiple stakeholders and, most importantly, improving the local environment substantially.

6 Beijing Statistical Bureau, *Beijing Statistical Yearbook 2013*, China Statistics Press, 2013.

7 Beijing Statistical Bureau, *Beijing Statistical Yearbook 2013*, China Statistics Press, 2013.

How China manages the next wave of urbanization will be an important test for a country whose food, water, and other natural resources are already strained to the breaking point.

PAVING THE WAY

Since its dramatic entrance onto the world stage at the 2008 Olympics, China's aspirations to make Beijing a world-class city have not slowed. Urban agriculture proponents have found an ally in the government in this respect, as the sector is seen as a modern, green, and inclusive feature of the cityscape.

Smart city technologies are making urban agriculture more efficient and more viable. Beijing's zoning plan, the 221 Project, and annual assessments of added value are setting an example for other cities to follow and paving the way for more inclusive development of China's urban spaces.⁸

How China manages the next wave of urbanization will be an important test for a country whose food, water, and other natural resources are already strained to the breaking point.⁹ Urban agriculture addresses each of these problems and deserves a prominent place in urban planning.

8 Exchanges with other cities have been organized by various networks, including government departments and NGOs. The RUAF Foundation, headquartered in the Netherlands and a promoter of urban agriculture worldwide, has organized many trips with groups from Shanghai, Chengdu, Tianjin, Wuhan, Nanjing, and others.

9 Jennifer Turner, ed., *China Environment Series 12*, Wilson Center, 2013.

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