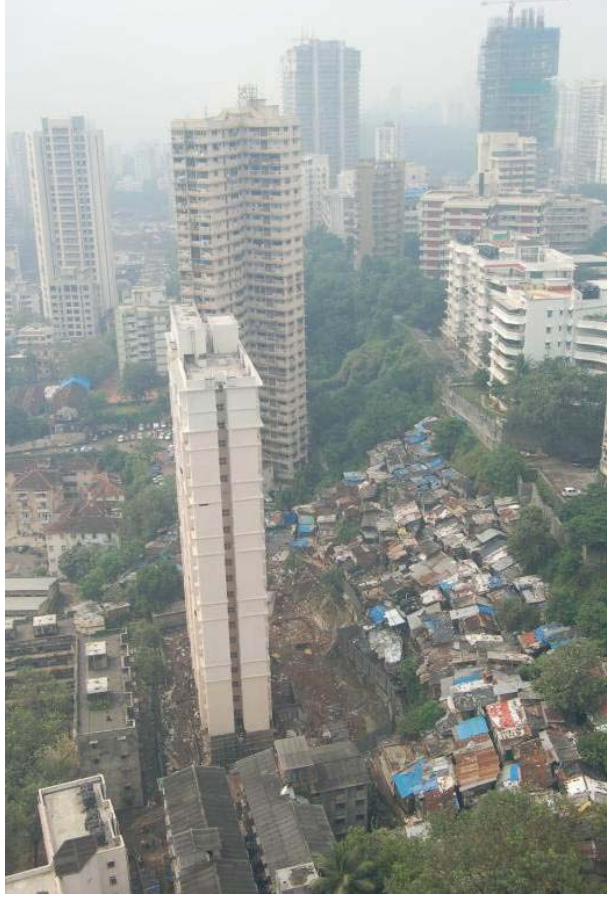

How Science, Technology and Innovation Can Help Address Challenges to Sustainable Urban and Peri-Urban Development

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Current Studies on Science, Technology and Innovation
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Outline

- The challenges of urban and peri-urban development, especially in developing countries
- How science, technology and innovation can help meet the challenges; examples
- Barriers
- Recommended ways to overcome barriers

……talk will cover background and one example

The Challenges of Urban Development

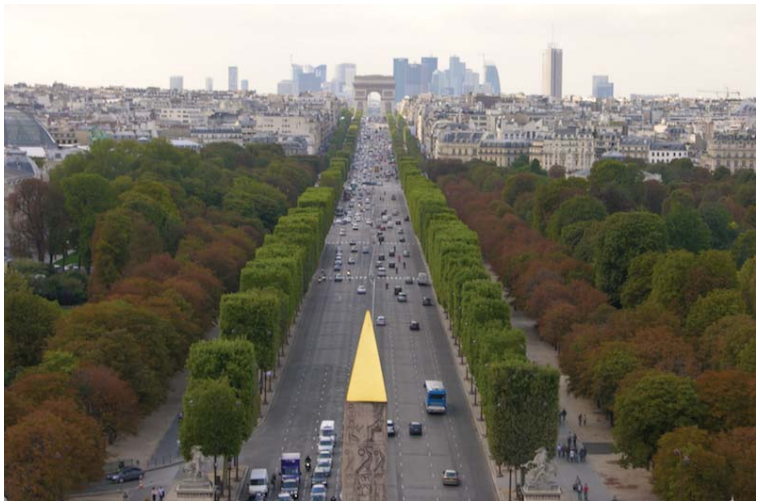
The majority of the world's population is now urban.

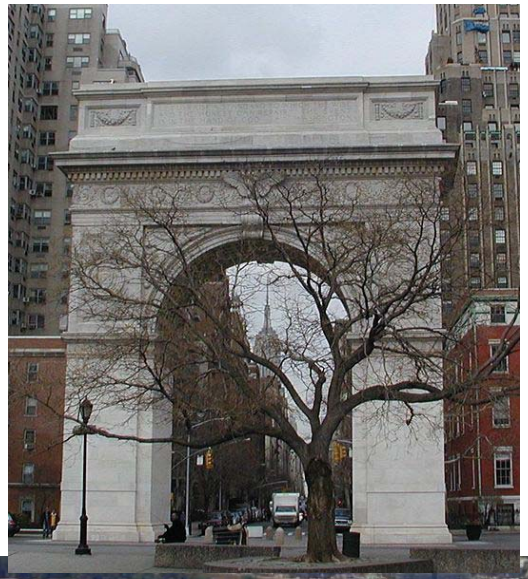
- The urban population share is growing and will reach ~ 60% by 2025.

- Metropolitan area growth is affecting nature, the built environment, and society in profound ways – problems and opportunities

- Needed: effective strategies to improve urbanization processes and social, economic, and environmental outcomes.

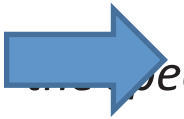
Copying Paris, New York, … Silicon Valley?





Factors Driving Metropolitan Growth and Expansion

- Migration, immigration, natural increase, longer lives
- Employment opportunities, higher incomes
- Better education, health care, other services
- Displacement and flight from conflict, natural disasters, crises
- Technologies that accommodate a variety of building types, activities
- Government policies – redevelopment of center, annexation of fringe

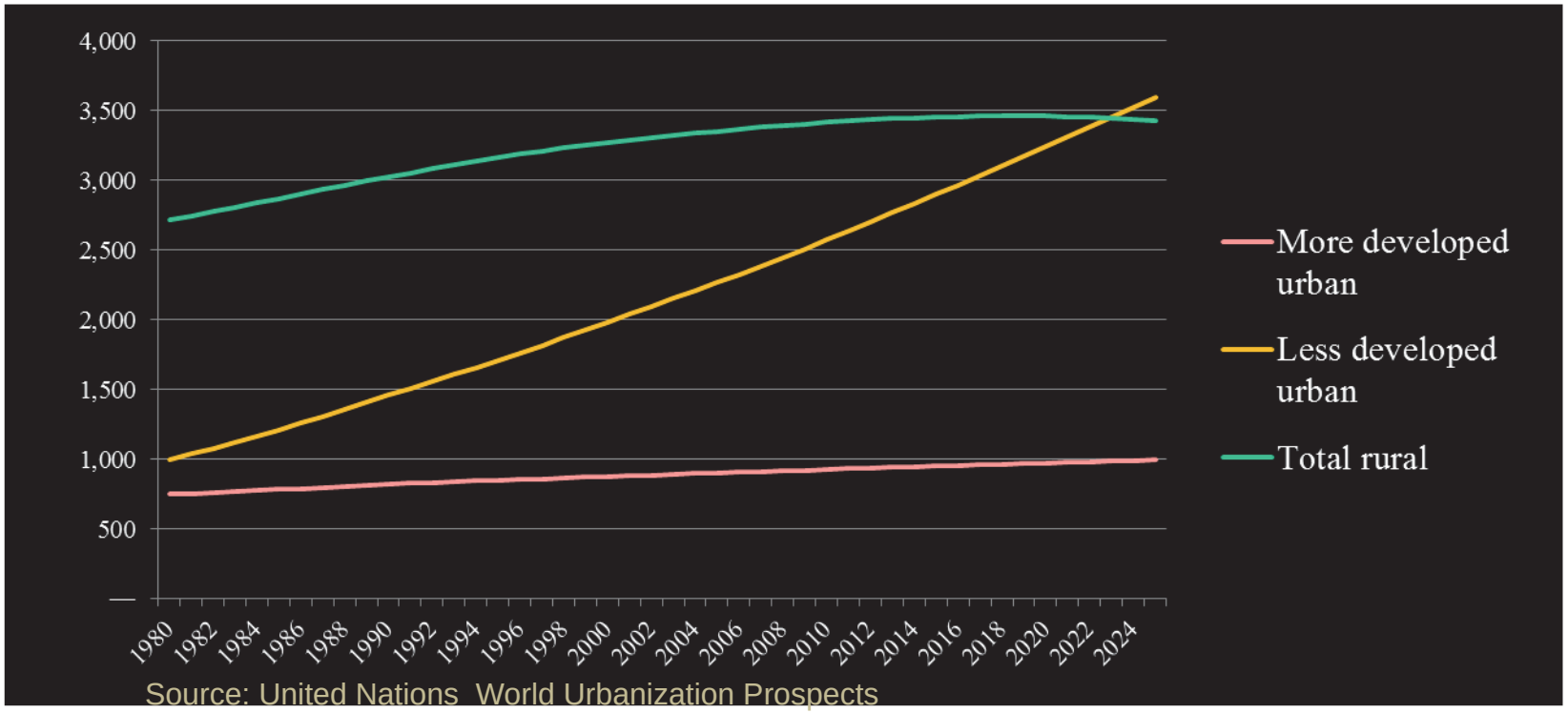


…pecifics are diverse (push and pull)

Developing Countries: Hotspots for Urban Growth

- Growth rate is slowing; still, ~98% of urban population growth in the next 30 years will occur in cities of developing countries.
- urban population of these countries: 2.5 billion 2009, 5.2 billion 2050
- 3 in 4 children born today will live in a city in a developing country

Global Population Estimates and Projections (Millions of People

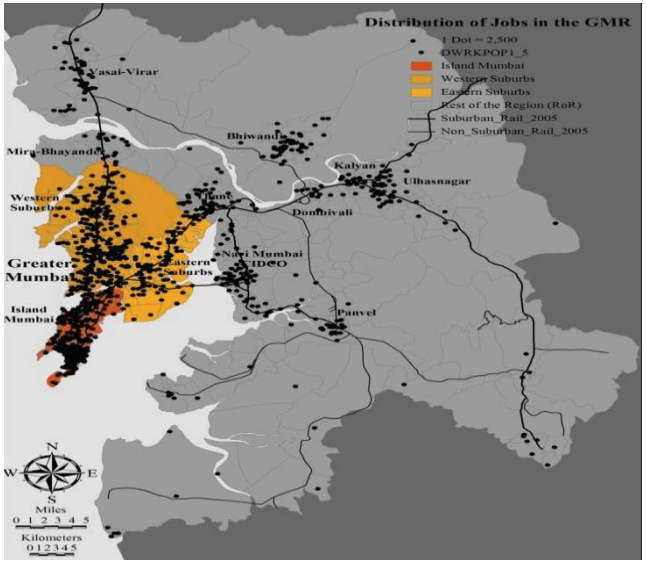


Source: United Nations World Urbanization Prospects

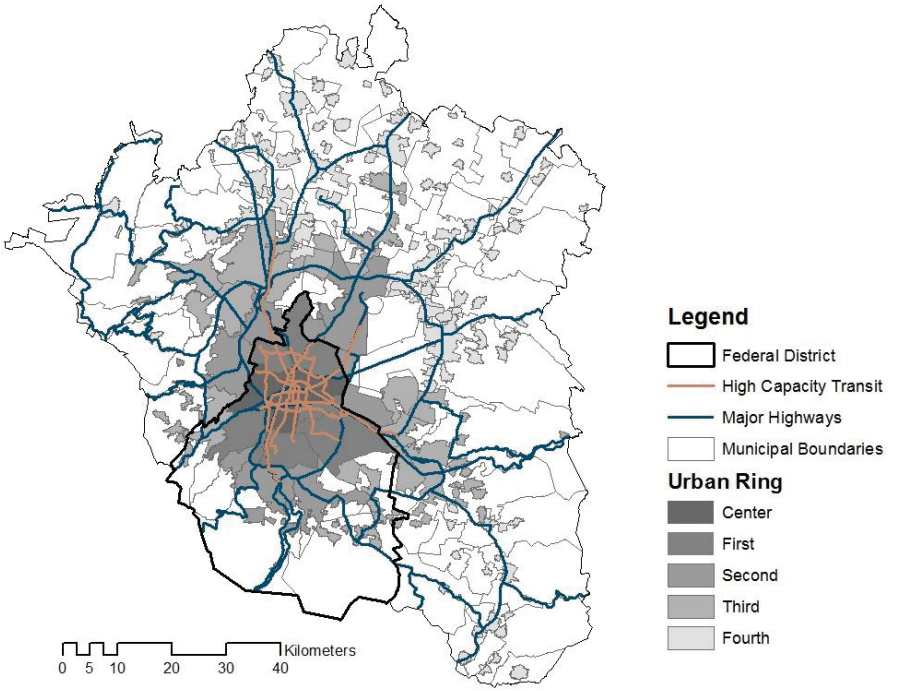
Varieties of Development: India

Varieties of Development - China

Urban growth patterns - India



Urban Growth Patterns - Mexico City



Consequences of Urbanization

- Many can climb out of poverty, enjoy a higher standard of living

BUT

- Not evenly shared

AND

- Haphazard growth; congestion, pollution, difficult living conditions

Concerns about Current Growth Patterns

- Vulnerability (economic, social, environmental) of an often sizeable portion of the urban population –tied to informality but also may include some of the population that is not
- Public health risks
- Impact on environmentally sensitive lands
- Loss of forests, environmental diversity
- Loss of agricultural lands, food security risks
- Urban/rural conflicts
- Dependence on motor vehicles in emerging urban structure
- Informal areas: lack of / limited infrastructure, urban services; physical, financial, political issues in providing them
- Peri-urban areas: difficulties providing timely and reliable urban services
- Questions about institutional capacity for serving new growth areas
- Pollution and GHG emissions increases
- Rights , voice of new urban residents

Challenges for Urban Decision-Makers

- Shelter – quality, security of tenure, affordability, distance to jobs
- Infrastructure – availability, quality, reliability of water, sanitation, transportation, power, telecommunications
- Services – Access to education, health, welfare services
- Public safety, security, health – from natural and manmade disasters, crime, disease
- Democracy and participation – status and rights of "newcomers"
- Growing energy demand – costs and environmental issues
- Pollution – air, water, solid waste
- Traffic congestion and traffic safety, especially with rapid motorization
- Finance – Access to funding to make things happen - government and entrepreneurs

Informality as a Special Challenge

- Informal settlements, housing, jobs
- Estimates that 40-60% of residents in LDC cities participate in informality in some way (base of pyramid argument)
- Range of circumstances for participants – live in in informal housing but work in formal employment, or vice versa; may use informal transport or depend on informal laborers….
- Range of responses from government and other stakeholders, from efforts to formalize or provide support, to benign neglect, to hostility and conflict
- Potential for entrepreneurial creativity – foothold for escaping poverty
- In most cases situation makes provision of infrastructure, public services more complicated – e.g., how to bill for services if no formal/legal address?

Peri-Urban Development as a Special Challenge

- Locus of growth often beyond city borders, reach of urban service districts
- Context varies widely, from state-led relocations to developer-driven speculative prti development to informal or illegal development
- May occur in jurisdictions with modest institutional capacity for urban management
- Densities often low, development spotty, single use (housing or industrial park, e.g.) – but not always
- Conflicts between agricultural and urban interests - can improve employment opportunities but also can threaten livelihoods
- Political conflicts and concerns about decision-making
- Problematic results: poor transport access, lacking or poor quality urban services such as water, sanitation

Proposition: STI Can Help Meet the Challenges

- *Science, technology and innovation (STI) can help to address urban challenges through new forms of urban infrastructure and services and better urban management, delivering a better environment, higher resilience in the face of risks, improved resource efficiency, cost savings, and new employment opportunities.*

- *STI should be sustainable:*
  - *Affordable / economically sound*
  - *Environmentally positive*
  - *Socially equitable*

.

Luckily, there are many options!

- Pedestrian-friendly city designs
- Mixed use development
- Local transit cooperatives
- Advanced traffic management systems / traffic control centers
- Bus rapid transit
- Composting and recycling
- Small-scale water treatment & waste treatment systems
- Water filter jugs
- Collection of night soil, garbage for fertilizer, waste to energy
- Passive solar building designs for lighting, heating
- Increasingly affordable solar cells
- District heating systems
- Mapping and monitoring systems using low cost sensors and satellite images such as Google
- Low cost computers, tablets, smart phones and apps for education, communication, participation, emergency services
- Crowd-sourcing for data and to discoverpublic views on priorities, preferred approaches
- Smart cards and smart phones for ID, payments, SOS
- Collaborative city and regional planning processes involving many stakeholders including the urban poor
- …AND MANY ,MANY MORE

Choosing Among the Options: Some Considerations

- Technological "leaps forward" may or may not match political, cultural institutional realities
- Complexity of managing large systems vs. complexity of managing many diverse systems
- Some of the interventions reach middle class and working poor but not poorest populations
- Some can lead to greater disparities and may show up along racial, ethnic, religious divides as well
- Some may be hard to scale up
- Some may lock in second best approaches
- Combined multi-dimensional strategies have high potential, but take long-term commitment
- Informal settlements require especially creative approaches

Example: Sustainable Development in Chinese Cities

Problems and Needs

- Need for housing for a variety income levels
- Need better access to jobs and services from new housing developments
- Growing motor vehicle use
- Traffic congestion
- Safety problems for pedestrians, bikes
- Air pollution
- Growing energy demand
- Increased GHG emissions

Strategies

- Land use planning to balance jobs, housing, services – reduce trip length and need for motorized modes
- Development layouts and street designs that facilitate walking and biking
- Bus rapid transit (or rail if conditions support it)
- Coordinated feeder services to BRT and rail terminals
- Advanced traffic management to reduce delays, minimize conflicts among modes
- Eco-city designs for runoff, water recycling, etc.

Top Technologies for Urban Planning & Problem-Solving

- **Geospatial tools and data** – satellite maps, GIS layers – for monitoring and tracking on the ground conditions, analyzing the implications, and building scenarios at low cost
- **Simulation and visualization model**ing – for traffic analysis, energy analysis, emissions calculations…. Support tools for multi-faceted sustainable development planning
- **Sensors** that support low cost infrastructure management, from traffic operations to detection of water leaks, power spikes, and weather or problems
- **Smart cards** – for ID, making and accepting payments, allowing for more sophisticated pricing schemes, accumulating data….
- **Smart phones** – for data collection, getting the word out and getting feedback; providing new options for democratic participation and practical ways of notifying the public about problems and opportunities….As costs drop, lower income members of society can participate more readily.
- **Collaborative planning methods** that use social science knowledge about networks to develop new partnerships that are better able to tap the knowledge and social capital of the entire society in addressing urban problems

Case Example: Lookout District, City of Jinan, Shandong Province, PRC : Integrated Multi-Sectoral Approach to Sustainable Development

- Jinan: provincial capital, 4-6 M population
- Growing income and demand for better housing and transportation, goods and services
- Floating population ~ 1-2 M
- Experiencing rapid motorization
- Incentives for government to expand development outward as well as to redevelop central areas
- Looking to (re)develop at Luokou District at north edge of city – village with some farming, some entrepreneurial activities such as recycling, renting out rooms to floating population, some new worker housing, some illegal (unpermitted) new buildings, problems with drainage, access
- Question: how can this be a sustainable development?

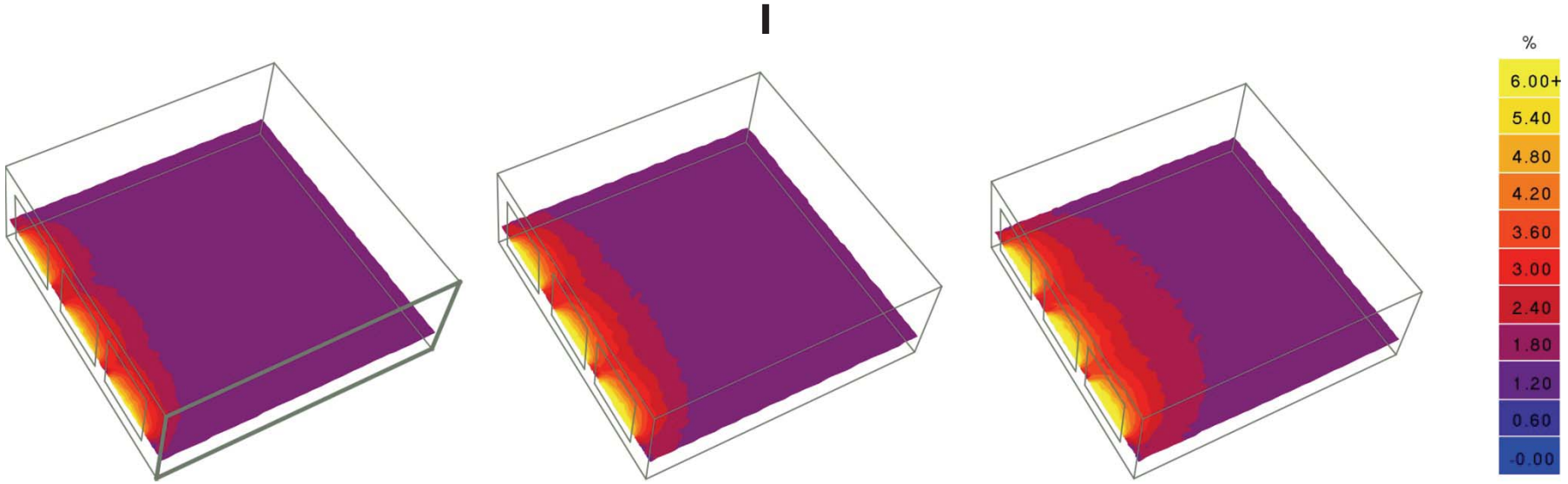
Building Energy Standards: Energy Analysis

	Energy savings	Total energy savings for Luokou (MWh per year)	Annual cost savings per household (at 0.5 RMB/ kWh)	Annual cost savings per household (% of average income)
With new standards*	**68%**	**152,064**	**1,900.8**	**14%**

* adopt standards used in EU and CA - 20cm insulation in walls and roofs, low E double pane windows, window shading building designs

Payback period = ~ 3 years

Using Energy Science to Orient Buildings and Locate Land Uses



15 m (45 ft) street

30 m (90 ft) street

100 m (300 ft) street

Commercial buildings, oriented and designed to maximize daylight access, can benefit from location along wide streets - all floors can make use of daylight for a large share of their lighting needs (NB facing South also culturally important!)

Traffic Issues

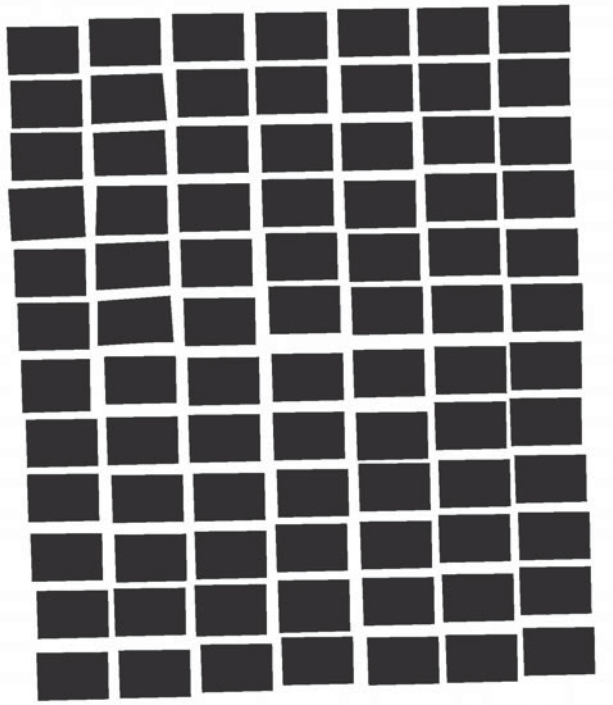
Observed Traffic Throughput Per Lane Per Hour

A Previous Plan for the Luokou District

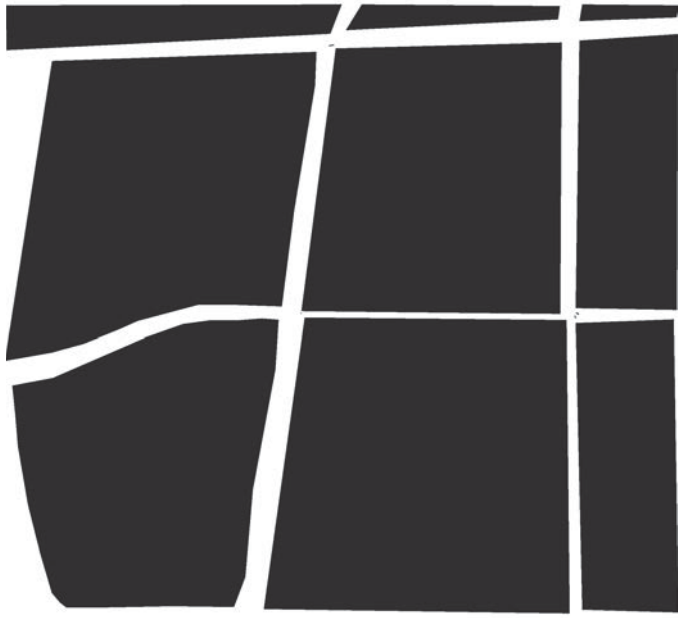
- ~33 superblocks, 5 E-W streets, 7 NS streets

Impact of Block and Street Design
Actual layout – 1 sq. km. each

San Francisco, CA USA

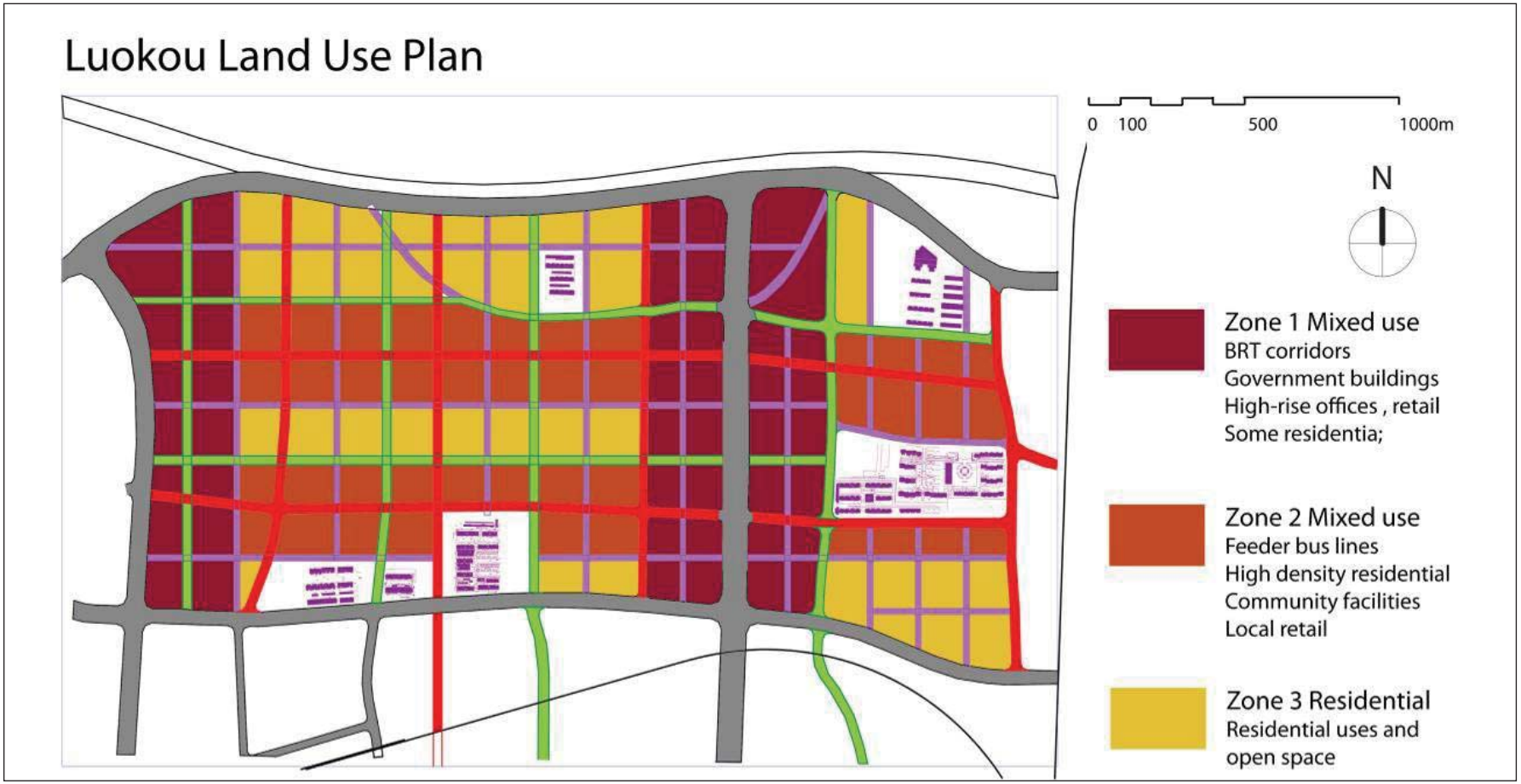


Jinan, Shandong Province, PRC



Large blocks concentrate traffic on a few intersections, smaller ones manage it more easily

Proposed Land Uses and Street Designations



130 blocks, four street classifications, land use matched to transport and designed to meet service needs

Integrating Street Design and Building Design

(using simulation software to illustrate)

Basis for plan

- block face length (~120M) selected to provide comfortable walking distance based on many studies – reduce impulse to dash across midblock
- Streets designed to accommodate walk, bike, and motorized travels, reduces conflicts
- Readily available traffic analysis software used to study traffic impacts, verify acceptable performance
- Building layout and design to maximize opportunities for passive solar heating, lighting, shades for seasonal deflection
- (not shown here): also designed for reuse of grey water, parks and street landscaping to provide for environmentally sound and low cost drainage, water pollution reduction

Barriers and Ways to Handle Them

- Required project teams to work together – planning, transit company, public works, parks – not usual practice
  -- Vice Mayor made this happen, but it remained a difficulty - seemed like a threat to each unit's authority.
- Field work to understand on-the -ground impacts was not routinely practiced – but turned out to be very valuable in identifying important conditions (e.g., drainage problems, mosque important to local residents)
  --Worked with Shandong U. students to document conditions.
- City maps not readily available or to scale.
  --Built maps quickly and easily from Google satellite photos & field data.
- Up front costs of energy efficiency higher than business as usual raised developer objections.

--This one we did not resolve – but options could be developed, e.g., government could simply mandate stronger standards so playing field is leveled, or govt. or developer fronts extra cost and recovers it through a fee over a several year period

The plan did NOT get implemented (yet), but the new processes we set into motion are showing up in other plans and programs

Conclusions

- Challenges are large, but key issues are shared by many: networks of learning from one another can help identify good options
- Many advances in science, technology and overall know-how are offering important new ways of addressing urban problems – both in understanding and documenting the problem and in finding sustainable ways to address it
- Finding ways forward takes institutional innovation as well as technology innovation; both take time, but are worth repeated efforts.

Thanks!

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