Core Ideas for Developing Smart, Sustainable and Healthy Cities: Insights from PIRE

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PIRE International Exchange
US Team in China, 2014
Cities & Sustainable Development

- **80% of global GDP** produced on just 2% of the land surface.
- **60-80% of global energy consumption**
- **75% of carbon emissions**
- **More than 75% of the world’s natural resources**
- Cities mainly depend on the import of **finite material resources** from outside their boundaries.

A Sustainable economic development will depend on **DECOUPLING** growth from escalating resource use and ensuring equitable distribution of the resulting benefits.

*Source: UNEP 2011*
Urban Infrastructures are Important: The focus of our PIRE

Rapid and Large Scale Urbanization world-wide in emerging economies ➔
Large Infrastructure and material requirement
Photo: Bai et al., 2014
PIRE Research Focus: Urban Infrastructure Systems

**Key Concept:** Infrastructure is the link between economic activity, environmental sustainability of cities (resource use, pollution, waste) and health risks posed to urban residents by infrastructure-environment interactions.

**Essential Infrastructures**
- Energy Supply (Electricity & Fuels)
- Buildings
- Transportation
- Food Supply
- Water Supply
- Sanitation & Waste
- Public Spaces
What is Smart + Sustainable + Healthy?

Data
Information
Knowledge
Wisdom for people to act
Three Core Ideas for Developing Smart Sustainable & Healthy Cities

1. Understand spatial patterns and trajectories of cities today - to begin urban infrastructure transformations of the future

2. Clarify high-level decisions points in designing cities and infrastructures of the future

3. Create knowledge and wisdom for people to respond, adaptively manage and govern urban infrastructure systems
1. Understanding Cities of Today
1a. Characterizing city typology and economic structure are important

Analysis of 239 cities by economic structure in China

\[
\log(\text{GDP in 1,000 RMB}) = 1.342\log(\text{pop in 1,000}) + 7.996
\]

\[
\log(\text{GDP in 1,000 RMB}) = 0.992\log(\text{pop in 1,000}) + 10.436
\]

\[
\log(\text{GDP in 1,000 RMB}) = 0.869\log(\text{pop in 1,000}) + 11.756
\]

Industrial cities: remain small (2.2m)

Ramaswami et al., 2016
1b. Spatially visualize areas of priority: people, infrastructure disparities, and high consumption

Electricity consumption (kWh)

Firewood Consumption (kg)

% Household with waste water connected to closed drainage: red areas, poor drainage

Nagpure et al
1c. Enhance policy understanding of infrastructure, environment (pollution) & health risks through public data and models

Spatial patterns of Air Pollution in Agra from Burning of Waste and from Dung Cake burning as it impacts discoloration of the Taj Mahal

Lal et al., 2016
2: Clarify High Level Decision Points for Designing Future Infrastructures & Cities
2a. Prioritize meeting the basic needs of all residents and provide equal opportunities that expand human capabilities.

In many Asian and African cities >30% population lives in slum/informal settlements without adequate infrastructure.

Source: Urban Health Research Center (UHRC)
2b. Infrastructures in future cities will need to be many times more energy and material efficient while also advancing human well being.

Delhi Metro.  
Source: The Hindu
2c. Prioritize systemic urban infrastructure innovations around land use, compact activity footprints, eco-industrial parks, food-energy-water nexus

- Smart exchange of materials and energy between urban sectors/eco-industrial parks

- Yixing, China: From Prof Shi, Lei, Tsinghua University
- Mysore, India from Prof Marian Chertow, Yale University
2c. Recognize value in leapfrogging in certain technologies while also re-conceptualizing traditional ways of doing things

Smart Waste Segregation by Kabadiwalas

Widespread cellphone usage in India: Leapfrogging
2d. Innovations in finance and governance are as important as innovations in technology; they co-evolve together

Co-evolutionary framework
Source: T J Foxon, 2011
2e. Stimulate discussion and generate decision-criteria around distributed versus centralized infrastructure

Centralised water treatment at Sonia Vihar, New Delhi

Decentralised waste water treatment in Gurgaon

District Energy solutions
Source: Cornell Utilities
3. Create knowledge and wisdom for people to act
3a. There will be a diversity of solutions in different cities and neighborhoods. Support pilot testing & learning from all models.

New Moti Bagh; Private sector/PPP operated. Low to High Tech

Gaursons Township, NOIDA; Private sector operated, High Tech

All India Kabadi Mazdoor Mahasangh; Contract with government; Low Tech

Defence Colony RWA; Community managed; Low Tech
3b. Provide two-way communication between the infrastructure users and providers

• Grievances, participation, demand response, e-governance, e-consultation
3c. Enhance information sharing across multiple levels of governance and across multiple sectors to improve human capacity to respond and adapt

• “A city becomes a smart city only if people respond to, and act upon the data being gathered”

Emergency Management and Research Centre (EMRI), Gujarat
Source: GVK EMRI

Ahmedabad Heat Action Plan
Source: NDMA
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Thank You!
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