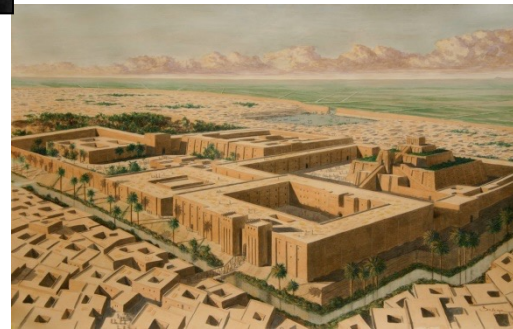
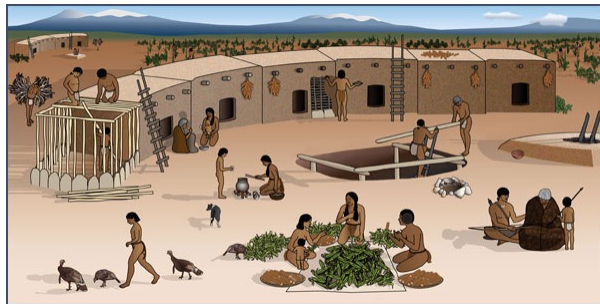
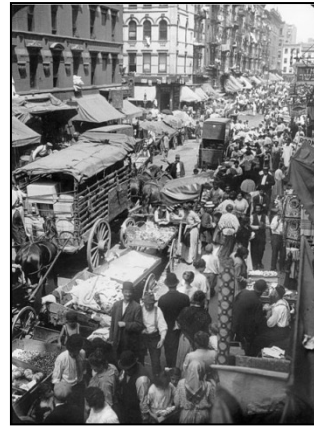


Urban Sustainability Science: Development and Opportunity



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Themes

- *Urban Sustainability Science* = *Urban Science* + *Sustainability Science*
- *Convergence Research*
- **What do we robustly know about *urbanization*?**
- *Cities as Complex and Networked Systems*
- **Research Frontier**
- **Urban adaptation to climate change**
- **Ongoing urbanization in China: *challenges* and *opportunities***

Urbanization = % of country's population residing in urban settings.

Why so much interest about cities?

- Urban areas are centers of production, consumption, invention and innovation that generate more than 80% of the global Gross Domestic Product (GDP), and will house nearly 70% of the world's population by the year 2050, almost doubling our current urban population in a very short time.
- Currently: ~ 60% of the world's population lives in cities (USA: 86%, China: 63%; European Union: 80%; India: 35%; Brazil: 88%)

Urban Sustainability Science

- ***Sustainability Science***: studies the interactions between natural and social systems, and how those interactions affect the *challenge of sustainability*: meeting the needs of present and future generations while substantially reducing poverty and conserving the planet's life support systems.
- Research relevant to the goals of sustainable development has long been pursued from bases as diverse as geography, geochemistry, ecology, economics, climate science, oceanography, and political science.
- Research program transcends the concerns of its foundational disciplines and focuses instead on understanding the complex dynamics that arise from interactions between human and environmental systems.

Urban Sustainability Science

- Many academic disciplines---urban economics, economic geography, urban sociology, regional science, urban ecology, archaeology, anthropology, city and regional planning, complexity science, systems science---have studied the city and the process of urbanization for many decades. Many insights have been accumulated.
- **Urban Science**: the comparative, analytical and empirical study of cities, urban systems and urbanization across time and geography.
- **Urban science** is on the cusp of becoming a well-defined field that while building on accumulated insights is studying a shared set of phenomena, developing theory, identifying underlying principles, using new data and existing data in novel ways, and integrating knowledge on urban areas.

The City as a Unit of Analysis

- “The urban environment that humans are so busily creating is many things: a biological environment, a social environment, a built environment, a market environment, a business environment, and a political environment. It includes not only the versions of these environments that exist inside a single city, but also those that are emerging from the interaction between cities. Our understanding of the urban environment will draw on existing academic disciplines, but it will also develop its own abstractions and insights.”

Paul Romer (2018 Nobel Prize in Economics)

<https://paulromer.net/the-city-as-unit-of-analysis/>

Urban Sustainability Science

- **Urban Sustainability Science**: developing the science (theories, models, methods, data) to understand the drivers of and interactions among natural, human-built, and social systems integrated in *urban areas* and *urban systems*.
- Needed to assess the sustainability outcomes in urban systems, and how urban development affects human and planetary well-being across spatial (local to global) and temporal scales.
- **How can cities continue to play their role as engines of social and economic development while facilitating the transition to sustainable development?**

<https://www.nsf.gov/ere/ereweb/ac-ere/sustainable-urban-systems.pdf>

Convergence Science

- What **type of science** is urban sustainability science?
- *Convergence science* (research): inspired by the need to address a specific question or challenge, whether it arises from scientific curiosity or pressing societal needs.
- It entails integrating knowledge, methods, and expertise from different disciplines and developing novel frameworks to catalyze scientific discovery.
- As experts from different disciplines pursue common research interests, their knowledge, theories, methods, data, research communities and languages become increasingly integrated.

Cities

- *Cities (urban areas): agglomerations (or concentrations) of individuals who reside, work, move about (and in and out), **interact** and share infrastructure within a delimited physical location.*
- Cities are the absence of physical space between people and companies; cities represent ***interactions, proximity, density, closeness.***

Independent invention of urbanization



Mesopotamia: 4500 BCE Hindus: 3300 BCE Egypt: 3150 BCE

Andes: 3200 BCE China: 2600 BCE Mesoamerica: 1200 BCE Cahokia: 1100 BE

Cities Across Time and Geographies

- There is a general recognition that cities share a number of organizational, social and economic characteristics and play similar functional roles in human societies regardless of size, geography, time or culture.
- Despite being separated by thousands of years of cultural, social and technological development, settlements of past and contemporary societies seem to share enough in common that the term “city” can meaningfully refer to concentrations of humans at different points in time.

Cities: networks (social, physical, transportation) embedded in physical space.

The essence of urbanism is not physical space per se, but frequent and intense social interactions among a diversity of individuals and organizations within a space.

Important characteristics of a city:

- *Scale*
- *Density*
- *Diversity*
- *“Mixing”*

Properties of spatially proximate social interactions

Properties of spatially proximate social interactions that promote increasing benefits for the people and activities involved:

- they facilitate effective communications (thereby facilitating sharing of ideas, learning, and copying)
- they generate trust in relationships;
- they help in socializing;
- they involve personal stimulation and motivation.

Foundational Assumptions of Urban Science

- The productivity and quality of individual-level efforts are mediated and enhanced through interaction with others (social networks).
- Human interactions are exchanges of material goods and information that take place in physical space.
- Any human activity can be thought of as generating benefits and incurring costs (especially the costs of moving people and things in physical space).
- Human effort is bounded.
- Human agglomerations serve to *mix* populations.

Consequences of the Assumptions

- People arrange themselves to *balance* the benefits of social interaction with the costs of “moving around” (spatially and socially).
- Socioeconomic outputs are proportional to *interaction* rates.
- As connectivity among individuals increase, they get more of what they need and want through social contacts (*division of labor*).
- As agglomeration and density increases, so does specialization.

What do We Know About Urbanization?

- Despite the many different urban episodes and experiences across time, there are *strong empirical regularities* connecting the important attributes of cities.
- Urbanization has been a force for socioeconomic development
- As cities increase in population size, they become denser.
- Larger cities (population wise) are more productive and inventive.
- Denser cities are more productive and inventive.
- Larger cities are more efficient with regards to infrastructure needs.
- Larger cities support a greater diversity of skills and facilitate specialization.

Various Countries, 1955-2010



Source: <http://marroninstitute.nyu.edu/blog/urbanization-passes-the-pritchett-test>

Agglomeration Effects

- Cities as systems that emerge from the interplay of centripetal and centrifugal forces; specifically, the socio-economic advantages of concentrating human populations in space vs. the associated costs of doing so.
- These are known as “agglomeration effects”, and they constitute foundational concepts for explaining the emergence and persistence of cities everywhere.
- Urban agglomeration effects reflect the systematic changes in average socio-economic performance, land-use patterns, and infrastructural characteristics of cities as functions of their size.

Cities as Knowledge Generators

- The most important urban advantage comes from speeding the flow of ideas.
- Cities are considered the well-spring of invention and innovation* because they facilitate the generation of new ideas, the combination of existing ideas and enable old ideas to be transformed into new ideas.
- The generation of new ideas is a social process: social interactions a crucial component of the process.
- Main reason why the advantages to individuals, activities and firms of agglomerating in cities outweigh the disadvantages.

*: *invention*: creation of something new; *innovation*: the diffusion of an invention

Cities and Economic Growth

- The main drivers of socioeconomic development and economic growth is *knowledge* (its generation, recombination, modification), *learning* and the acquisition of new *skills*.
- These processes are facilitated by physical proximity.
- *Formal* knowledge vs. *Tacit* Knowledge (skills, ideas and experiences that people have but are not codified and may not necessarily be easily conveyed in writing).
- Effective transfer of tacit knowledge generally requires extensive personal contact, regular interaction and trust. This kind of knowledge can only be revealed through practice in a particular context and transmitted through *social networks*.

Cities as Complex and Networked Systems

- In the Anthropocene* nature and society have become intertwined in a globally interconnected, *complex adaptive system*. <https://www.annualreviews.org/doi/pdf/10.1146/annurev-environ-012420-043621>
- Cities are open, *complex*, self-organising, adaptive and evolving formations that are embedded in broader social, ecological, economic, technical, institutional and governing structures.
<https://www.wcrp-climate.org/WCRP-publications/2019/GRAA-Cities-and-Climate-Change-Science-Full.pdf>
- To understand cities we must view them not simply as places in space but as systems of networks: the relations connecting objects, individuals, activities, processes, and infrastructure. Thru these connections flow matter, energy and information.

<https://link.springer.com/article/10.1007%2Fs11067-019-09453-w>

Urban Systems and Regions

- Urban systems are network systems.
- Urban systems are regional, national and international in scale.
- Urban systems are dependent on rural systems for the provisioning of food, energy, water, and other materials and natural resources, while rural systems are dependent on urban systems for markets, goods and services.
- Urban and rural systems are also connected by ecological processes that both influence and are influenced by human behavior.

Research Frontier

- How can urbanization continue to be a principal driver of socioeconomic development without causing irreparable damage to human well-being and the natural environment?
- How can the processes of innovation and growth unleashed by urban environments lead to more equitable and environmentally positive development?
- How does the interplay between technological change and fundamental social processes affect the sustainability of urban systems?
- How do we measure and compare the sustainability of urban and non-urban social systems?
- What features of cities and urban systems affect energy consumption?

Urban Adaptation to Climate change

- *Climate change adaptation* is the process of adjusting to current or expected climate change and its effects.
- Adaptation aims to moderate or avoid harm by changing, modifying, amplifying or ceasing socioeconomic behaviors, processes and infrastructure use.
- A recent IPCC report highlights the urgent need for policies to be developed and actions taken for the implementation of adaptation to climate change.
- Climate change adaptation will principally affect cities.

- Many cities of the developing world are growing particularly rapidly, but in those places, the downsides of density are acute.
- There are many ways in which successful cities are failing their poorer inhabitants.
- Growing income inequality is seen in many urban areas: why?

Urban discontent might not reflect a failure of the social city, but rather the shortcomings of policies.

Urban Adaptation to Climate change

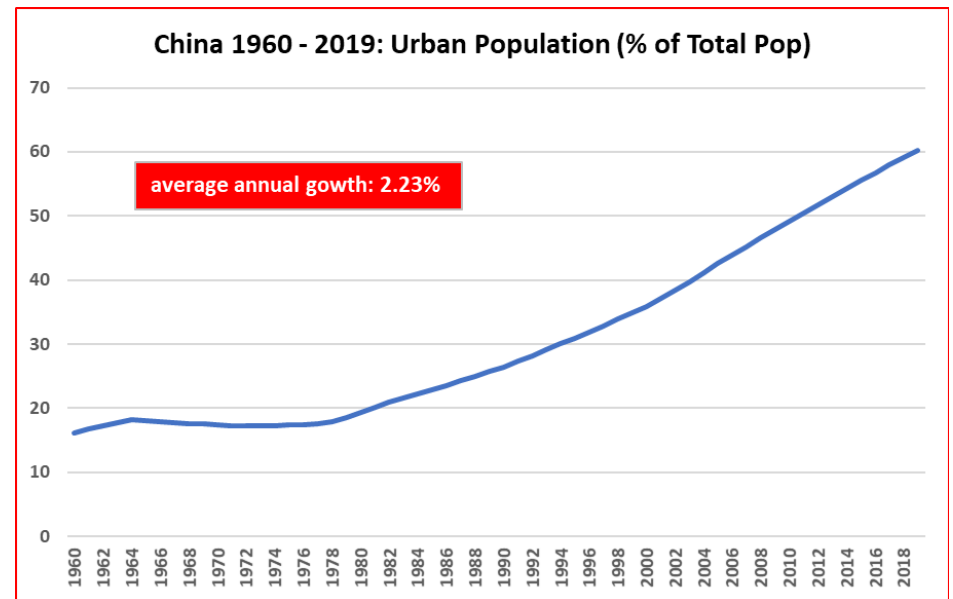
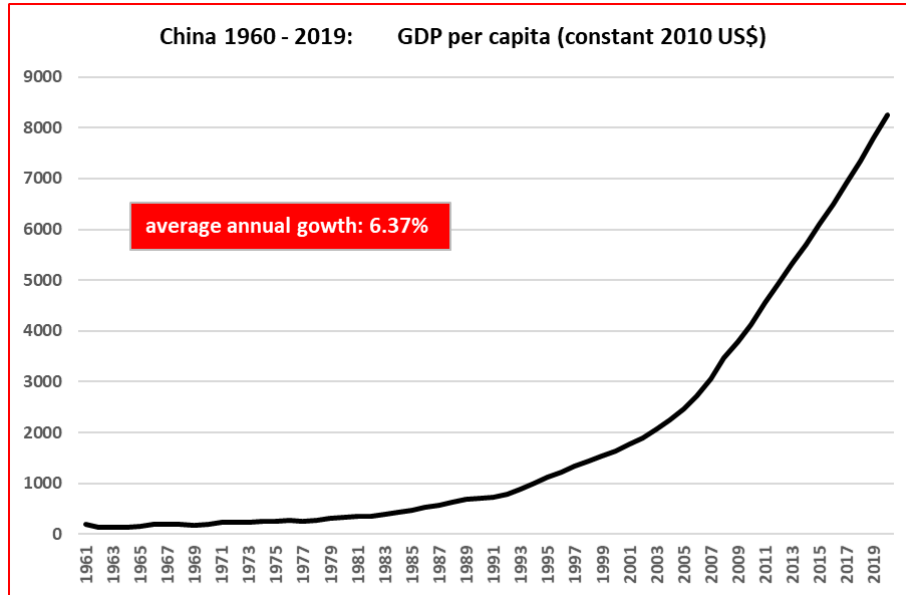
- Cities have the potential to be major catalysts of climate change adaptation.
- Cities pose a challenge for climate change adaptation but can be an important part of the solutions for sustainable development and climate change.
- *What features of cities, urban systems and urbanization facilitate adaptation? How can adaptation by urban environments be improved and accelerated?*

<https://www.ipcc.ch/report/ar6/wg1/>

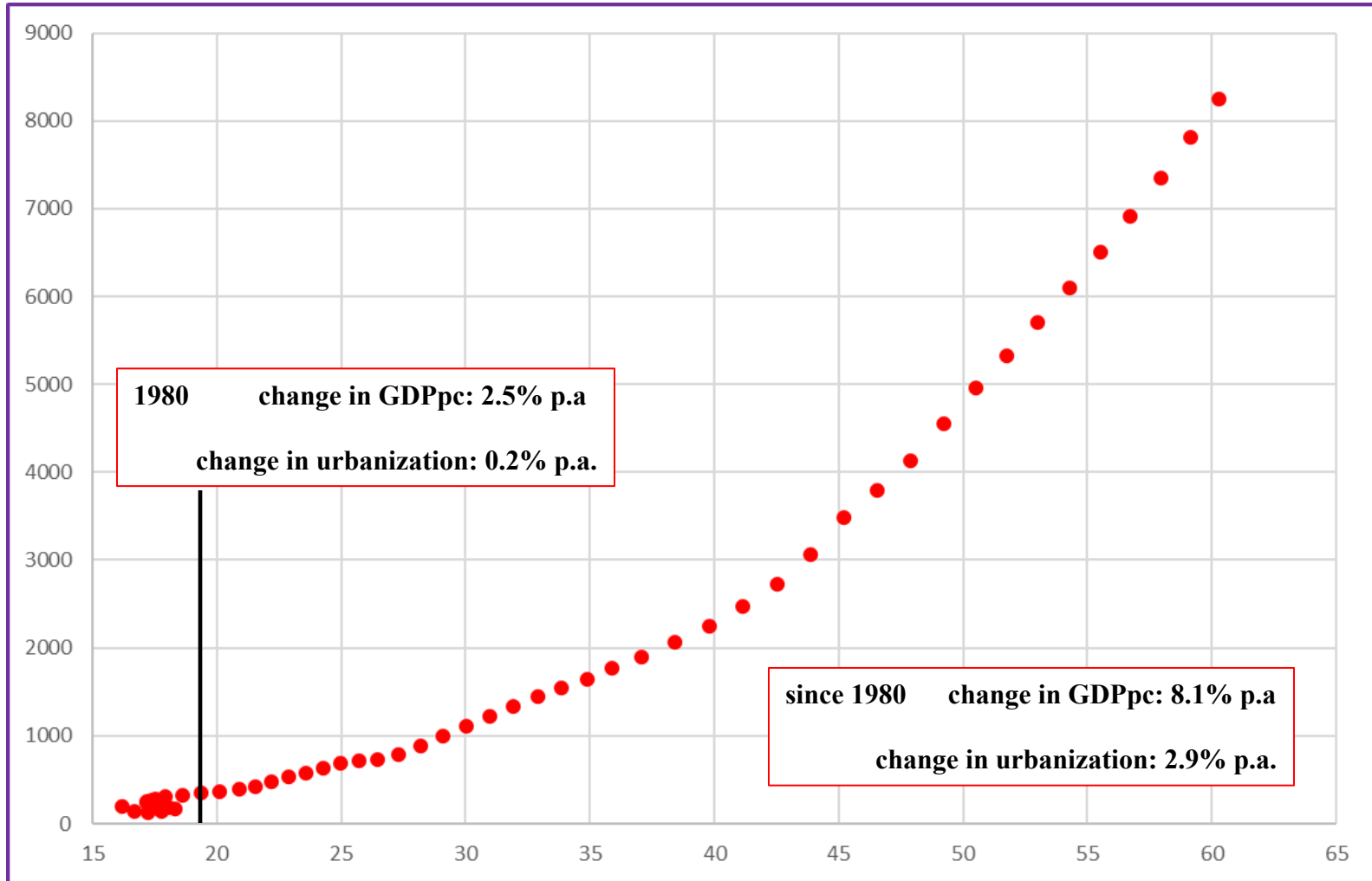
China: Urbanization and Development

- China is one of the clearest examples of the relationship between urbanization and socioeconomic development.
- China since 1960: *the greatest urbanization story the world has ever seen.*
- In 2011, the urban share of the Chinese population surpassed 50% for the first time (reaching 51.3%), compared to 17% in 1960. [63% in 2019]

China's Success Story is a Story About **Urbanization**



China: Urbanization (x: %) and Economic Growth (y: GDP_{pc}) 1955 - 2019





Deng Xiaoping's Reforms



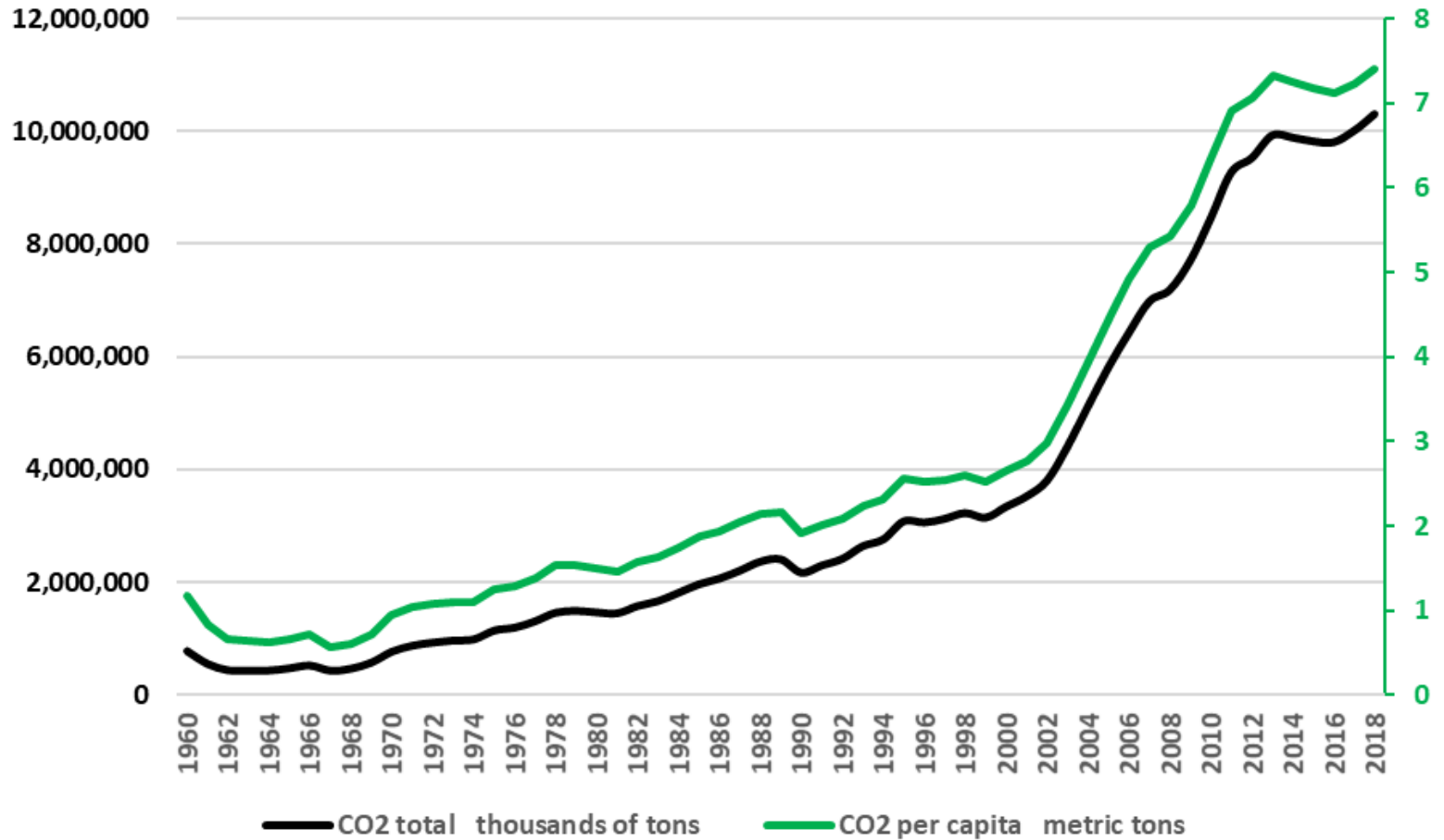
“The beginning of wisdom is to call things by their proper names.” Confucius

- The reforms initiated under Deng Xiaoping's leadership were not only about liberalization of economic and trade policies.
- Formally, Shenzhen was/is known as a *special economic zone* (SEZ). But it would be more informative to describe it as an ***urban experimentation zone***.
- Of the four initial special economic zones in China, Shenzhen was the only big success, but it demonstrated the development consequences of ***urbanization***.

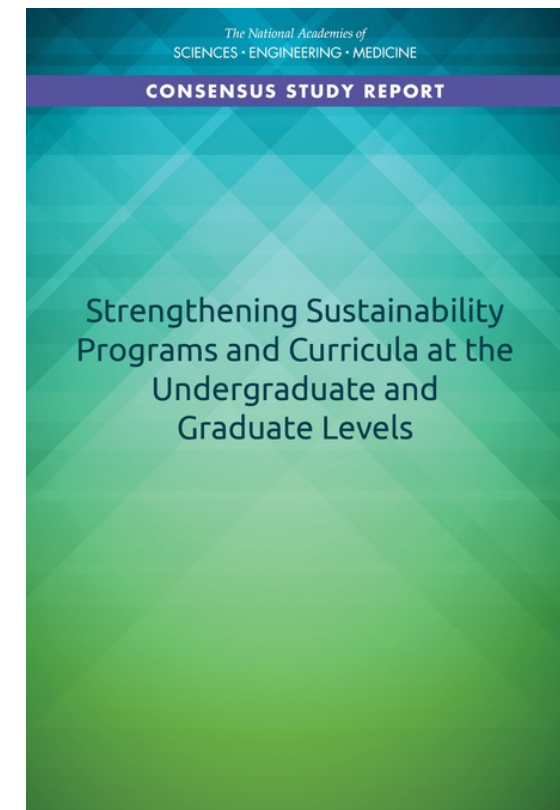
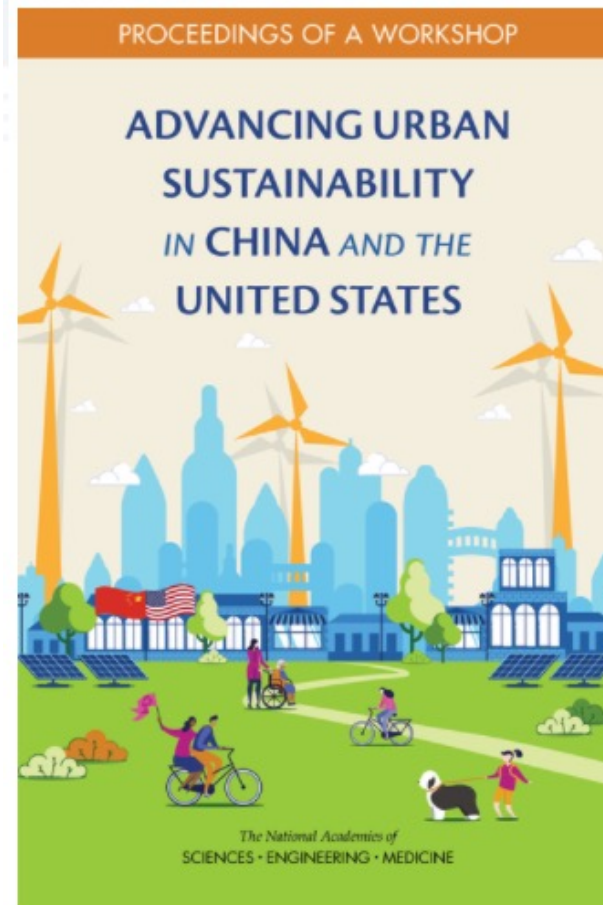
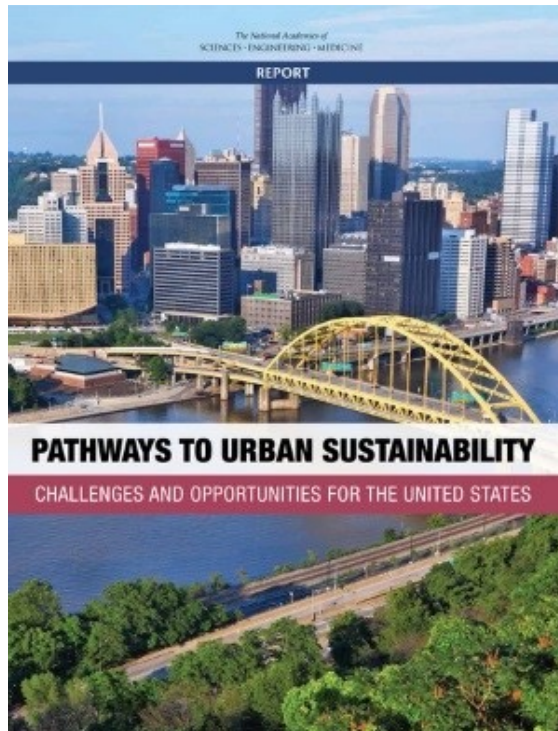
Urbanization in China: Challenges and Opportunities

- How China continues to urbanize, as it seeks to become “a moderately prosperous society” is of tremendous importance for how human society will transition towards sustainable development and adapt to climate change.
- How can Chinese urbanization decarbonize? How can social mixing and mobility be achieved in China’s large cities? Can the benefits of urbanization be experienced without China’s large cities getting larger? How can sustainable regional development be designed and facilitated? How can sustainable development be a driver of overall development/
- Importance of learning: China learning from the rest of the world, the rest of the world learning from China.

China: CO2 Emissions Total & Per Capita 1960 - 2018



Urban Sustainability: NAS and CAS



- In both the United States and China, significant urban challenges and changes to the urban landscape are occurring, largely due to rapid population growth in these areas. While in the United States, the urban proportion of the population has been over 80 percent for the last decade, it is projected to reach about 89 percent by 2050 and the numbers in cities is expected to continue to increase by about 100 million between 2010 and 2050. During this same period, China will experience even more dramatic and rapid urbanization: Its urban population will increase from about 50 percent to about 78 percent. By 2050, China will be the first country with 1 billion urban dwellers.
- This rapid expansion in cities in both the United States and China has and will continue to place pressure on environmental, economic, and social systems. Urban areas are facing growing challenges from climate change, water and energy shortages, pollution, and aging infrastructure. As the growth of Chinese and U.S. cities continues, it is critical to support research that will further understanding of the interconnections between the natural and built environments and how they impact human health in urban areas.

Questions? Comments? Suggestions? Criticisms?

Contact me!

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