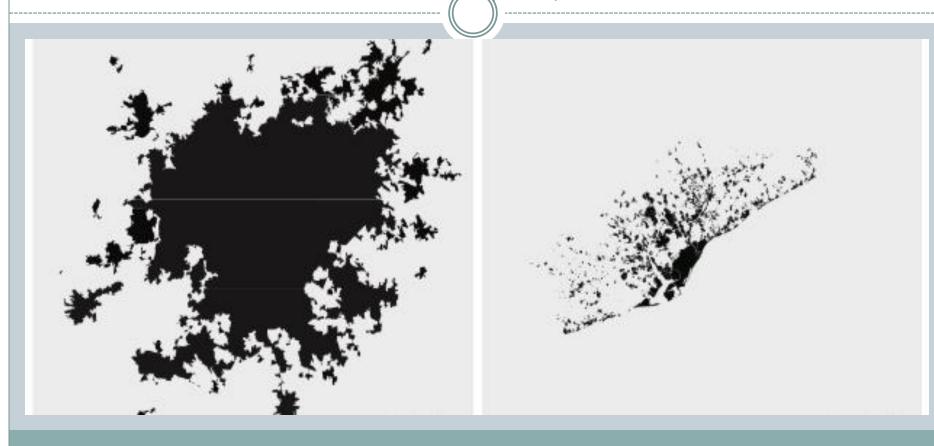
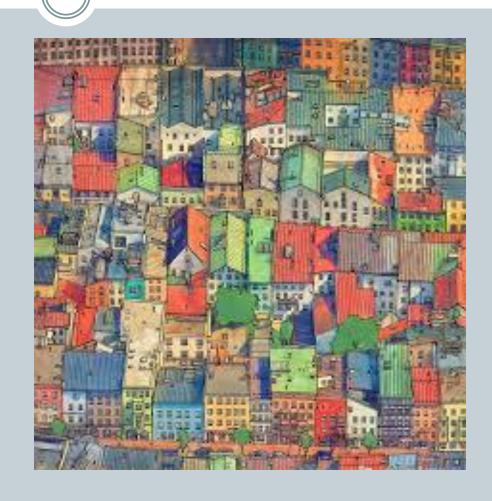
Can A City Be Sustainable?

STATE OF THE WORLD
GARY GARDNER
WORLDWATCH INSTITUTE
JANUARY 19-20, 2016



Today's Agenda

- An Urban World
- The Historic Perspective: What Does it Teach Us?
- The City: A System of Systems
- Toward a Vision of a Sustainable City



An Urban World

- The World: 54 percent urban today
- Urban Population has grown 5-fold:
 - o From 0.7 billion in 1950
 - o To 3.9 billion in 2014
- In 2050, the urban share of global population is expected to be 60 percent

Urban Share of Population, by Region



Megacities

- Greater than 10 million population
- Rapid growth in megacities

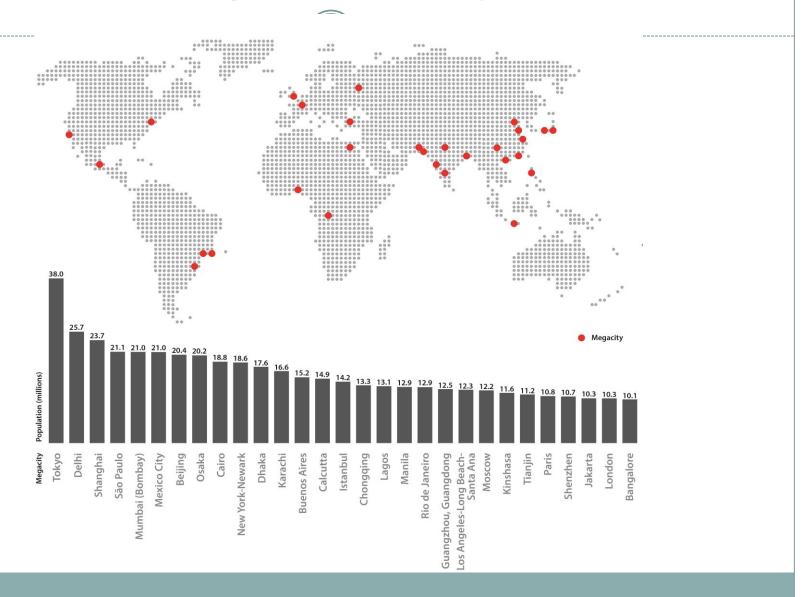
o 1950: 2 megacities

o 2016: 29

0 2030:41

- But ...
 - Almost half of urbanites live in cities of less than 500,000 persons

Megacities Today



Many Cities are Decreasing in Density

	Projected Increase by 2030		
	Built-up Area (%)	Population (%)	
Developing country cities	200	100	
Industrial country cities	150	20	

Cities as Economic Engines

- 80 percent of the global gross domestic product (GDP) is produced in cities
- 60 percent is produced in the 600 most productive cities, where one-fifth of the world's population now lives
- Urban economic activity accounts for
 - o up to 55 percent of gross national product (GNP) in low-income countries,
 - o 73 percent in middle-income countries, and
 - 85 percent in high-income countries.
- Cities generate a disproportionate amount of revenue for governments.

Urban Consumption and Waste

- Cities account for
 - o 60−80 percent of energy consumption
 - o more than 75 percent of natural resource consumption, and
 - o 75 percent of the world's carbon emissions
- 1.3 billion tons of Municipal Solid Waste (MSW) is generated globally each year
- MSW is the third largest source of human-caused methane emissions

Consumption in Cities

- Consumption in the lowest- and highestconsuming megacities differs by a factor of
 - o 28 in energy per capita
 - o 23 in water per capita
 - 19 in waste production per capita
 - 35 in total steel consumption,
 - 6 in total cement consumption.



The Poor in Cities

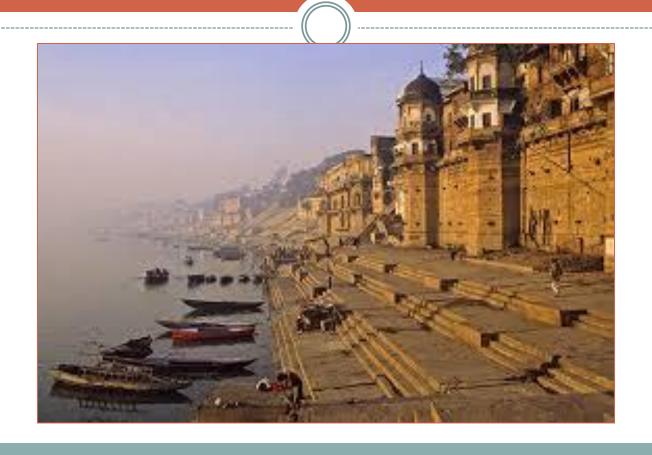
- 1 in 7 urban dwellers live in poverty
- Slum residents:
 - o 863 million in 2012
 - o 650 million in 1990
- But the share living in slums fell, from 46 percent to 33 percent.
- 10 percent of urban population of developing countries lacks access to electricity
- 18 percent uses wood, dung, or charcoal for cooking



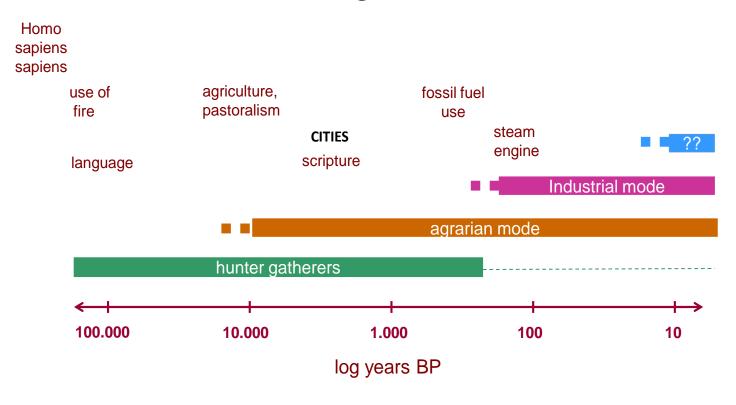
Summary

- We are now an urban species
- Big cities are growing fast, but most urbanites are in small cities
- Many cities are becoming less dense—a real challenge for sustainability
- Cities are economic engines
- Cities are centers of consumption, another challenge for sustainability
- Inequality and poverty remain key problems—yet another challenge for sustainability

Cities in the Arc of Human History

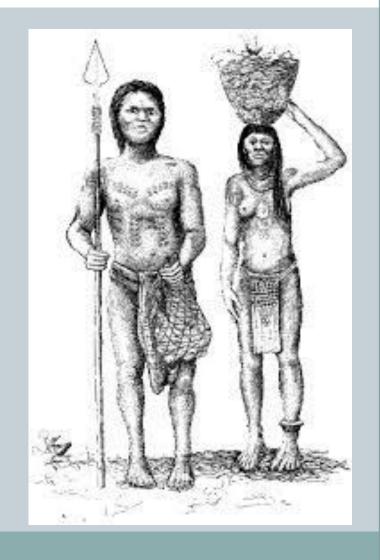


Sociometabolic regimes in human history



Materials Appetite of Hunter-Gatherers

Dimension	Hunter- Gatherers
Energy use per person (gigajoules per person per year)	10-20
Materials use per person (tons per person per year)	0.5-1
Population Density (people per km2)	0.025 - 0.115
Agricultural Population (percent)	
Biomass share of energy use (percent)	More than 99



Materials Appetite of Agrarian Society

Dimension	Hunter- Gatherers	Agrarian Society	
Energy use per person (gigajoules per person per year)	10-20	40-70	
Materials use per person (tons per person per year)	0.5-1	3-6	
Population Density (people per km2)	0.025 - 0.115	Up to 40	
Agricultural Population (percent)		More than 80	
Biomass share of energy use (percent)	More than 99	More than 95	

Materials Appetite of Industrial Society

Dimension	Hunter- Gatherers	Agrarian Society	Industrial Society
Energy use per person (gigajoules per person per year)	10-20	40-70	150-400
Materials use per person (tons per person per year)	0.5-1	3-6	15-25
Population Density (people per km2)	0.025 - 0.115	Up to 40	Up to 400
Agricultural Population (percent)		More than 80	Less than 10
Biomass share of energy use (percent)	More than 99	More than 95	10-30

Maximum City Size By Regime

Mode of Subsistence	Maximum City Population
Pre-Agrarian State	10,000
Agrarian State	100,000
Agrarian Empire	1,000,000
Industrial Societies	25,000,000 or more?



Population, Affluence, Technology Over History

Period	Increase in Environment al Impact	Of Which
1AD to 1500AD	5-fold	Population and Affluence were roughly equally responsible
1500AD to present	10-fold	Affluence is responsible for about 3 times more impact than population growth. Technology increased impact by a factor of 1.5

The City: A System of Systems













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Land Use and Transportation

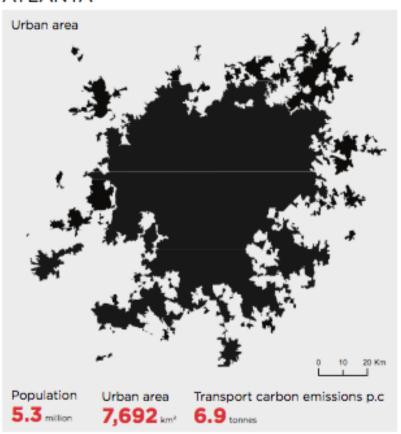
- Huge shaper of the look, feel, and sustainability of a city
- Density matters
- Sprawl a problem
- Car-centric planning is a major problem



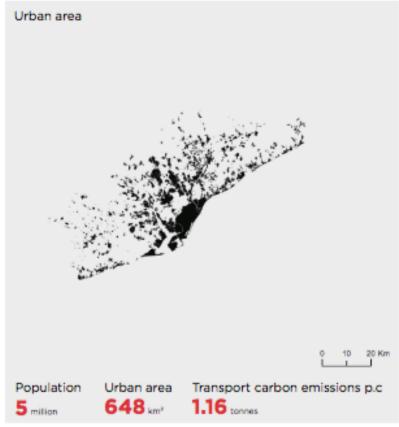
Land Use: Smart and Not-so-Smart



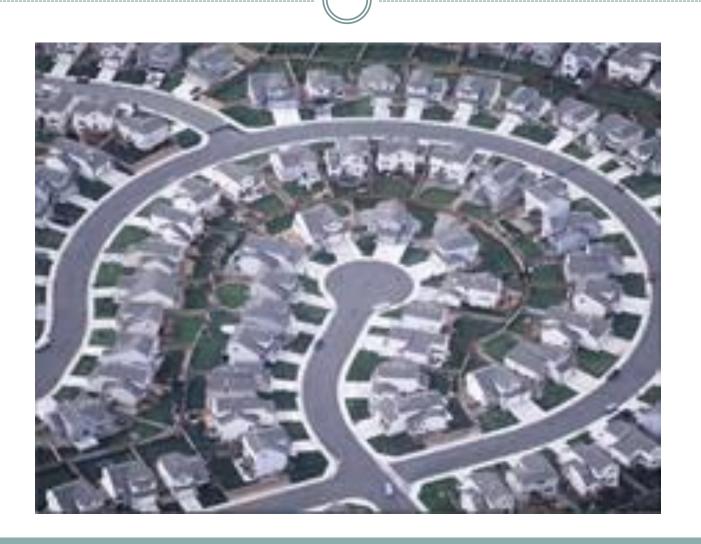
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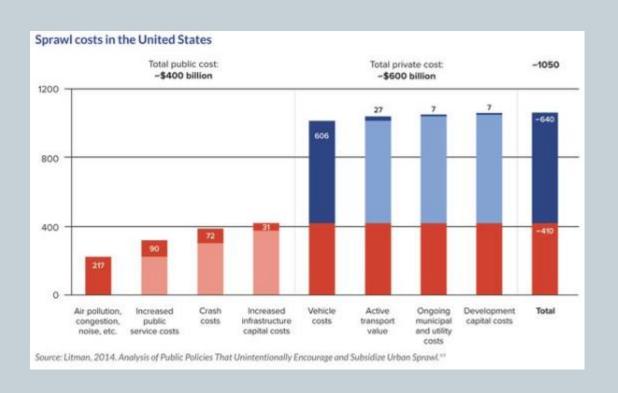
BARCELONA

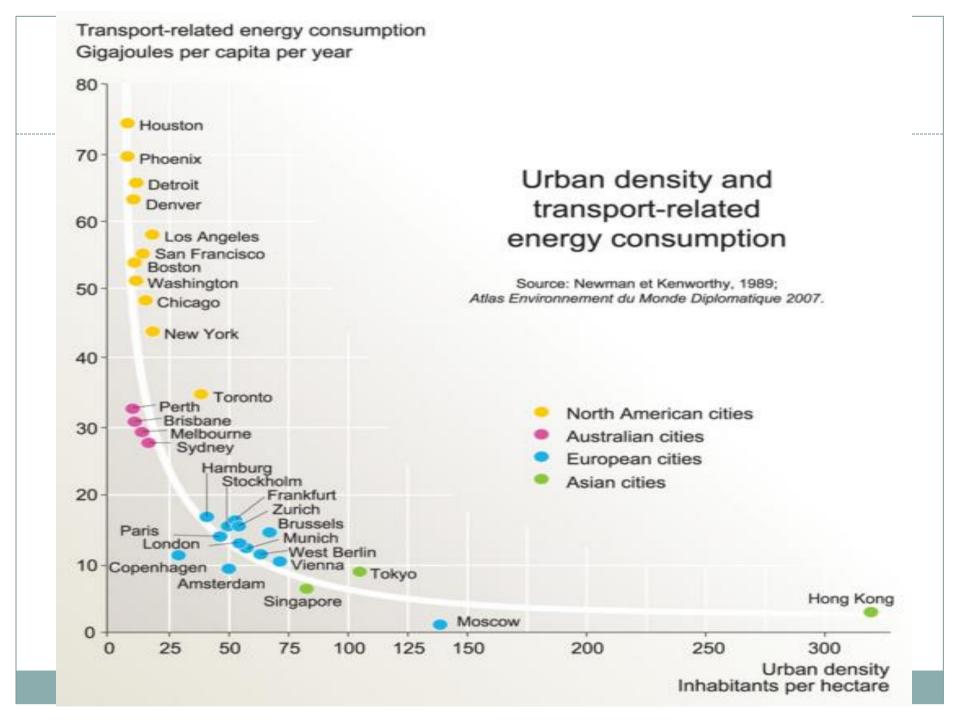


"Loops and Lollipops"



Sprawl: \$1 trillion per year in U.S.





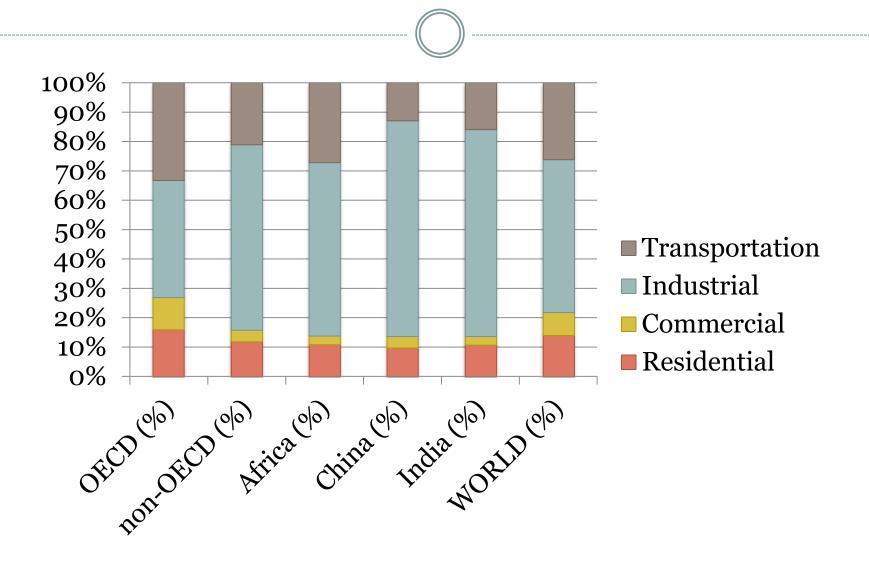
Material Use Patterns in Urban Development

Dimension	Examples	Increase with doubling of population (%)
Infrastructure	sewer lines, power lines, roads	85
Human Needs	employment, water consumption, electricity consumption, and housing	100
Socioeconomic measures	information, innovation, and wealth, but also serious crime and disease	115

Cities Stimulate Energy Use

	GDP	Urban Share	Estimated
	per Capita	of Population	Urban
			Energy Use
			per Person
	U.S. \$	percent	gigajoules
North America	42,893	80	235
Pacific OECD	35,480	86	107
Western Europe	31,217	74	114
Latin America	4,973	77	40
North Af. & Middle East	4,384	60	72
Former Soviet Union	3,566	64	112
China & Centrally Planned Asia	1,738	42	52
Sub-Saharan Africa	907	33	34
South Asia	703	29	23
WORLD		47	

Energy Use by Urban Sector



Domestic Material Consumption per Person

	1980	2009	Change
	tons pe	r person	percent
Africa	5.0	4.8	- 4.5
Asia	4.9	9.2	87.2
Europe	16.3	13.0	-19.8
Latin America	10.6	13.1	23.4
North America	24.8	20.1	-18.9
Oceania	34.6	35.6	- 2.9
WORLD	7.9	9.9	25.4

Varying Levels of Consumption

- But global averages obscure:
 - o per capita consumption is 60 times higher in the highestconsuming country than in the lowest-consuming one
 - o Taipei: 30 kilos of copper per person
 - consumption growing at 26 percent per year,
 - o Vienna:180 kilos per person,
 - Growing at 2 percent per year.

Waste per person, by Region

Region	Waste generation per person (kilos / person / day)
South Asia	0.45
Africa	0.65
East Asia and Pacific	0.95
Europe and Central Asia	1.1
Latin America and Caribbean	1.1
Middle East and North Africa	1.1
OECD	2.2

More Waste to Come

- World Bank: waste levels will increase 69 percent by 2025 over 2012 levels.
- Peak in global waste:
 - o under BAU conditions, not before 2100.
 - o with more aggressive policies, around 2075.
- Wild card: how waste generation unfolds in sub-Saharan Africa, where population growth rates are high

Insufficient Recycling

- 2011 UNEP study of 60 metals
 - o only 18 had a recycling rate greater than 50 percent.
- Recovery rates from MSW streams:
 - Eastern and southeastern Europe, less than 30 percent
 - United States, about a third
 - Austria, Belgium, Germany, 50 percent
- Lack of legal, institutional, and market infrastructure keeps recycling rates low



Increasingly Complex Food Systems

- In Argentina, Brazil, Chile, South Korea and Taiwan, supermarkets' share of food sales have grown:
 - o from 10–20 percent in 1990
 - o to 50–60 percent in the early 2000s.
- Food travel to supermarkets can be long:
 - 70 percent of Chilean grapes are produced for export to Europe, the United States, and China



Vision of a Sustainable City



Principles of a Sustainable City

- 1. Reduced and Cleaner Consumption of Materials and Energy
- 2. A Prominent Place for Nature
- 3. Compact and Connected Patterns of Development
- 4. Creative Placemaking
- 5. Centers of Well-being
- 6. People-Centered Development
- 7. Participatory Governance

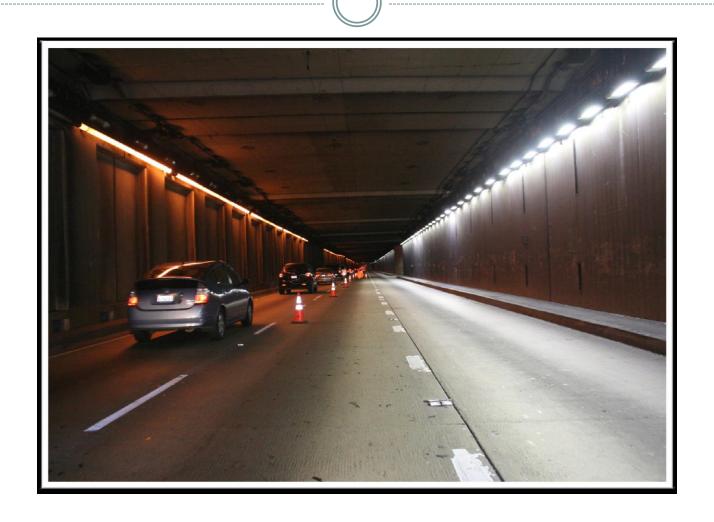
Principle 1: Reduced and Cleaner Consumption of Materials and Energy

- Scientists: the needed increase in resource productivity are huge in wealthy countries—on the order of 80 percent. How?
 - Circular economy, with essentially 100 percent zero waste to landfills
 - Absolute reductions in the use of materials and energy is an essential materials policy metric
 - Commitment to major reductions—on the order of 4- to 10fold—in materials use
 - Emphasis on enhanced wellbeing, which may involve a reduction in consumption levels
 - Consumption is increasingly public, often in civic places, and consisting of services

Renewable Electricity Targets

City	Target Share for Renewable Electricity (%)	Target Year
Aspen, U.S.	100	2015
San Francisco, U.S.; Malmö,	100	2020
Sweden		
San Jose, U.S.	100	2022
Munich and Ulm, Germany	100	2025
Wellington, New Zealand	78-90	2020
Austin, U.S.	35	2020
Amsterdam, Netherlands	25	2025
Tokyo	20	2024
Cape Town, South Africa	15	2020

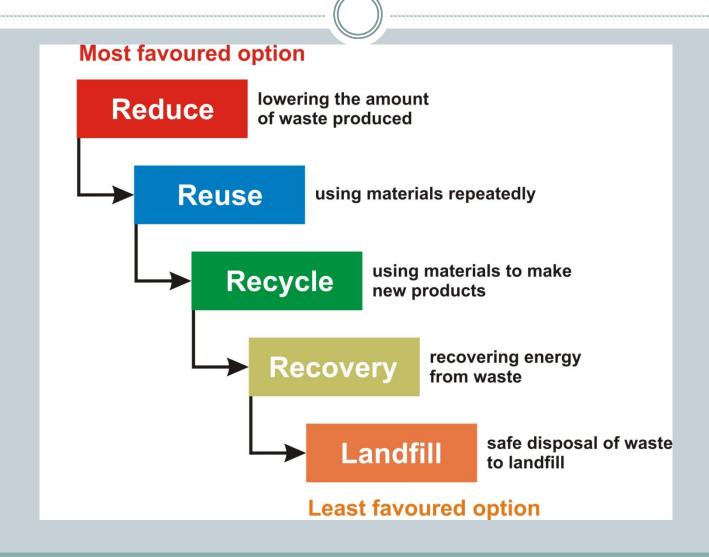
LED Street Lighting, Los Angeles



Dezhou, China's Solar Emphasis

- Million Roof Project
 - o new residential buildings must have solar water heating
- Solar thermal or PV technology in 95 percent of new buildings
- Strong local economic base
 - o over 120 solar energy firms and 30,000 jobs.

Materials Use Hierarchy



Environmental Benefits of Recycling

Material	Share of Scrap in Global Supply (%)	Energy Savings, relative to virgin production (%)
Aluminum	25	95
Copper	> 40	85
Plastic	n.a.	80
Steel	44	74
Paper	n.a.	65
Lead	45	65
Zinc	30	60

Waste Policies Matter

- New Yorker MSW: 1.49 tons per year
- Londoner MSW: 0.32 tons per year
- Why? UK has a landfill tax
- Reduced the share of waste landfilled
 - o 80 percent in 2001
 - o 49 percent in 2010.



Principle 2. A Prominent Place for Nature

- An ecologically vibrant city is one in which
 - nature is more integrated and less segregated
 - nature is a neighbor, not an artifact
 - ecological services are valued and protected
 - natural functions are given proper attention in city planning



Beatley's Indicators of Biophilic Infrastructure

- 100% of city population lives within 100 meters of a park or green space.
- Continuous green corridors from the city center to the periphery
- 10% of the urban area in a wild or semiwild state
- 40 percent forest cover (less in the core, more near the periphery)
- 1 Green feature (green roof, gardens, trees, etc.) per 1000 inhabitants (minimum of one per block)
- 1.6 km of trails for every 1000 personas
- 1 community garden for every 2,500 inhabitants

"Green Infrastructure"

 Using nature to manage water flow and other city functions













Principle 3. Compact and Connected Patterns of Development

- Connection is critical to urban life
 - In transportation
 - In cultural and political affairs
 - For innovative and efficient business operations
- Density is important for connection



Comparative Densities

City	Density (people per km2)
Atlanta	636
London	5,900
Tokyo, Singapore	9,000+
Shanghai, Seoul	20,000+
Hong Kong, Mumbai, Ho Chi Minh City	30,000+

Taming the Automobile in Milan

- "Ecopass" -- charge on the most polluting vehicles
- "Area C" -- congestion charge in city center
- Results:
 - Area C reduced traffic by 30 percent.
 - Public transit system, could finance upgrades to subway cars, trams, and buses
 - "BikeMi," the city's bike sharing system, expanded
 - 2005 -- 2013, share of private motorized transport fell from 44% to 37%.





Other Policies to Restrict Cars

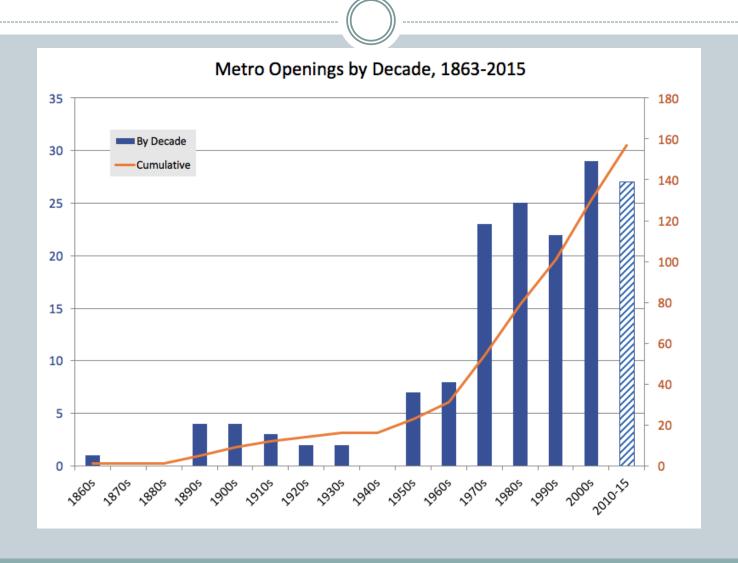
- Vehicle quotas through auctions or lottery systems (in Chinese cities such as Beijing)
- License plate restrictions (such as Mexico City's Hoy No Circula program and initiatives in other Latin American and Chinese cities)
- Low-emission zones (adopted in 226 European cities as of 2013)
- Parking restrictions (in Singapore as well as cities in Europe, Japan, and the United States)
- More than 100 big cities, many in Latin America and Europe, close some roads on weekends.

Car-Sharing Taking Off

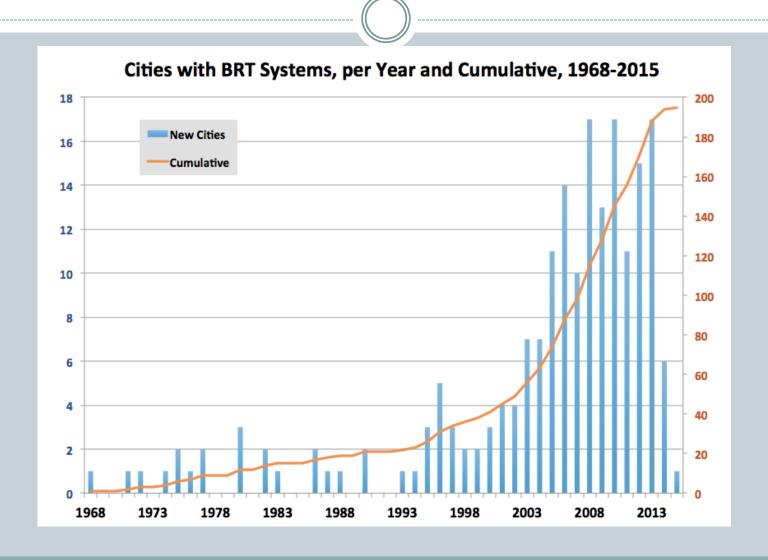
- More than 1,000 cities in over 30 countries.
- 1995—15,000 car sharers globally
- 2014—4.9 million
- 2020:Navigant Research projects 12 million car sharers.



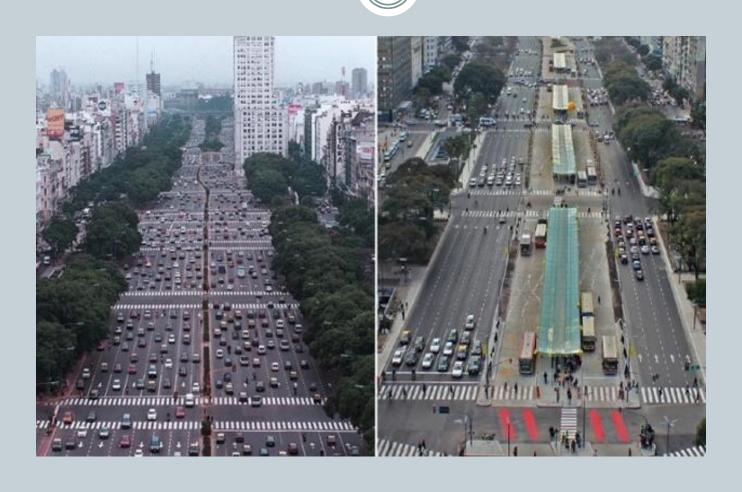
Greater Access to Public Transit



Growth in Bus Rapid Transit



Bus Rapid Transit



BRT by Region

Region	Number of cities	Passengers per day (million)
Latin America	63	20.04
Asia	40	8.74
Europe	56	1.98
North America	27	1.05
Oceania	6	0.43
Asia	3	0.26
WORLD	195	32.49

Walking and Biking

- Clean, healthful
- Modal share growing
 - Copenhagen: 1 of 3 trips made by bike
 - Munster: 2/3 of trips made by bike, walking, transit
- Bike sharing:
 - o 2000:6 cities and 4,000 bikes
 - o 2014: 712 cities, 806,000 bikes



Principle 4. Creative Placemaking

Placemaking

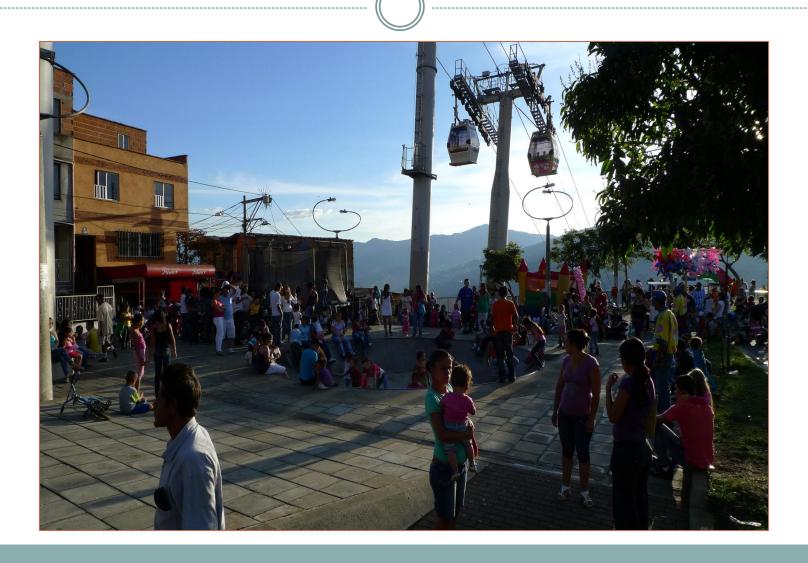
- Adds beauty and civic stimulus to a city
- Can be large or small
- Should be done all over a city
- Promotes civic pride
- Stimulates public consumption in place of private consumption



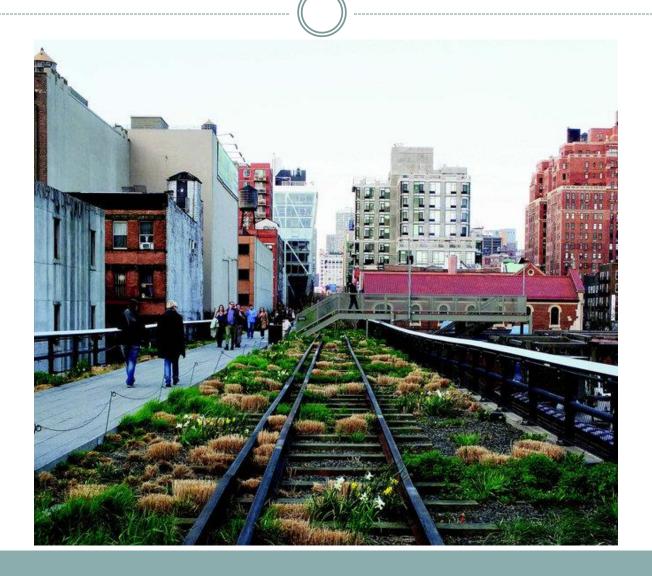




Metrocable, Medellin, Colombia



High Line, NYC



Sardana at La Seu Cathedral, Barcelona



Principle 5. Centers of Well-being

Health

- Accessibility to medical care
- Opportunities and stimulus for exercise in daily life

Income

- o "Decent Work Agenda (ILO)--creating jobs; guaranteeing rights at work; extending social protection; and promoting social dialogue
- Cities can set wage and benefit minimums for city contracts
- "Bolsa Verde" (Brazil)--\$150 each trimester to poor families for environmental conservation actions. Women account for 93 percent of program debit card holders.
- Self-Employed Women's Association—informal sector workers in India. Establishes minimum rates for piecework.

Principle 6. People-Centered Development

- Strategic plans based on citizen needs
- People's interests drive the planning process; economic interests build around people's interests
- Broad access to basic services, increasing equity across a city



Water Policy Based on Needs

Need Type	Relevance to Water	Affect on Water Policy
Existence meeting basic survival needs	water for domestic use; sanitation to prevent disease; stormwater drainage	Water largely supplied through conventional water management infrastructure
Relatedness facilitating interactions among people, and with nature	Parks, sports fields, open spaces, where people socialize and enjoy nature	Recycled stormwater and wastewater were used during droughts to augment water supply and keep parks green?
Growth promoting equity, justice, beauty	Greater control over water management to citizens, which often translates to diversity of offerings and decentralized management	Rainwater harvesting options can cut household water costs. Beautification created by exposing stormwater in garden-like drainage systems

Principle 7. Participatory Governance

- Power is distributed and devolved, with districts
 and neighborhoods having strong voices
- Decision-making processes are public, including posting of progress on mass communications media, including a website
- \overline{\text{Z}} Citizens of all kinds are encouraged and recruited to participate
- Meeting calendars of civic officials are made public

Thank You!