

EV20001: ENVIRONMENTAL SCIENCE



Lecture #3

Human Population & Urbanization

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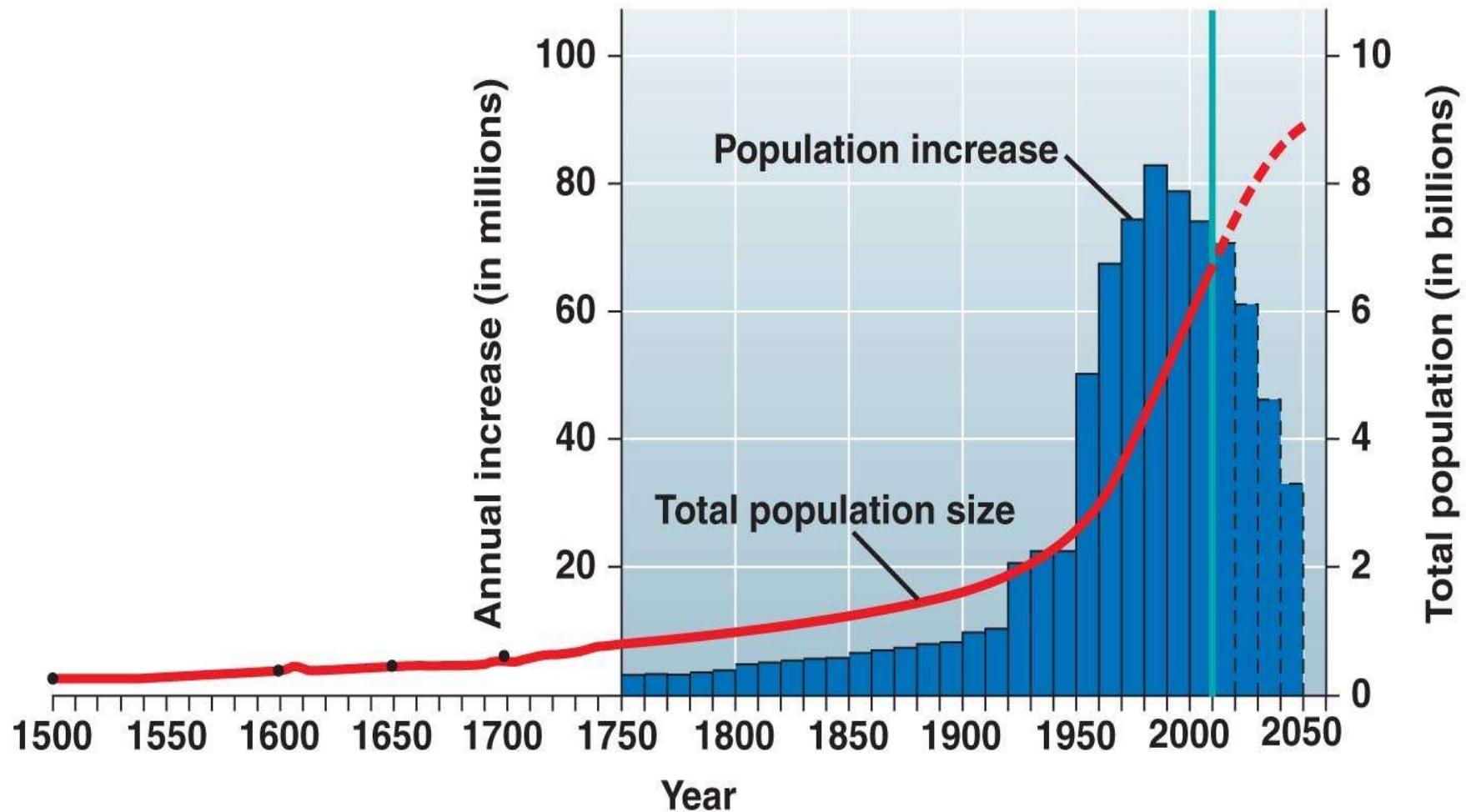
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Are There Too Many of Us?



- Currently, there are about **7.8 billion** of us. Each year, we add about **83 million** more people to the world's population. If such growth continues, the number of people on Earth is projected to increase to **8.5 billion** by **2030**.



Population Growth Affect Ecosystem Services



Natural Capital Degradation

Altering Nature to Meet Our Needs

Reduction of biodiversity



Increasing use of the earth's net primary productivity



Increasing genetic resistance of pest species and disease-causing bacteria



Elimination of many natural predators



Introduction of potentially harmful species into communities

Using some renewable resources faster than they can be replenished

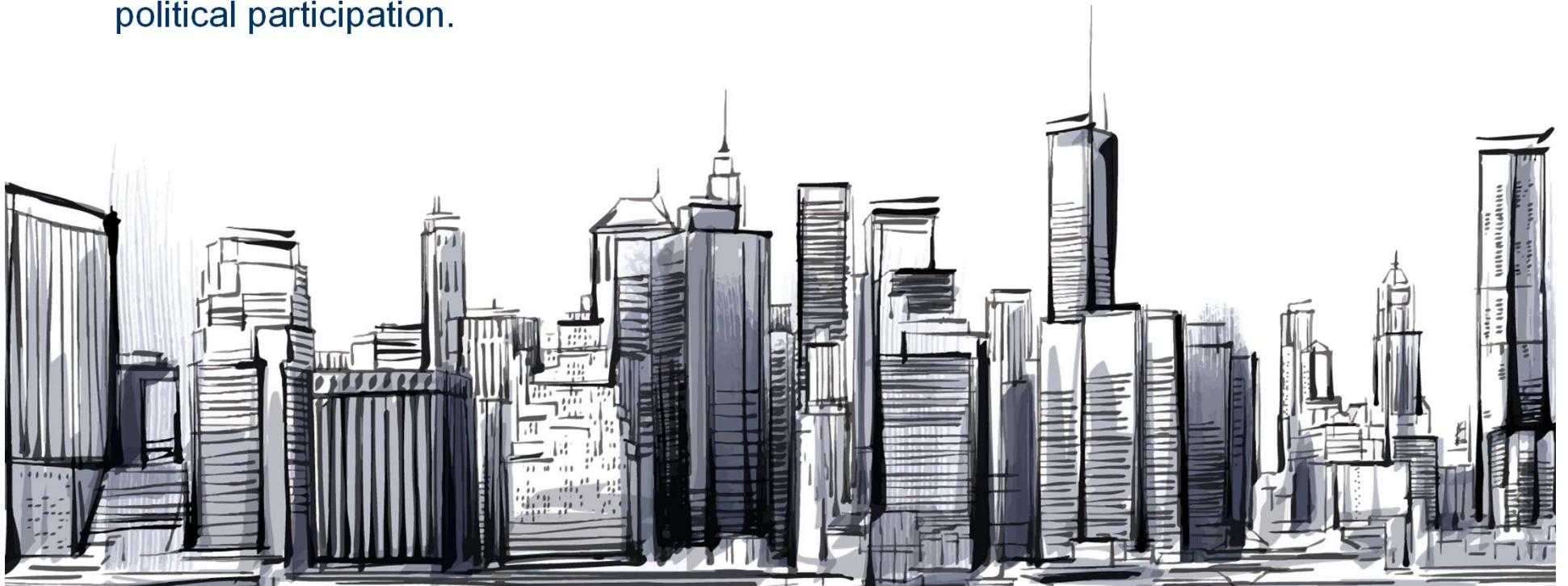
Interfering with the earth's chemical cycling and energy flow processes

Relying mostly on polluting and climate-changing fossil fuels



Urbanization

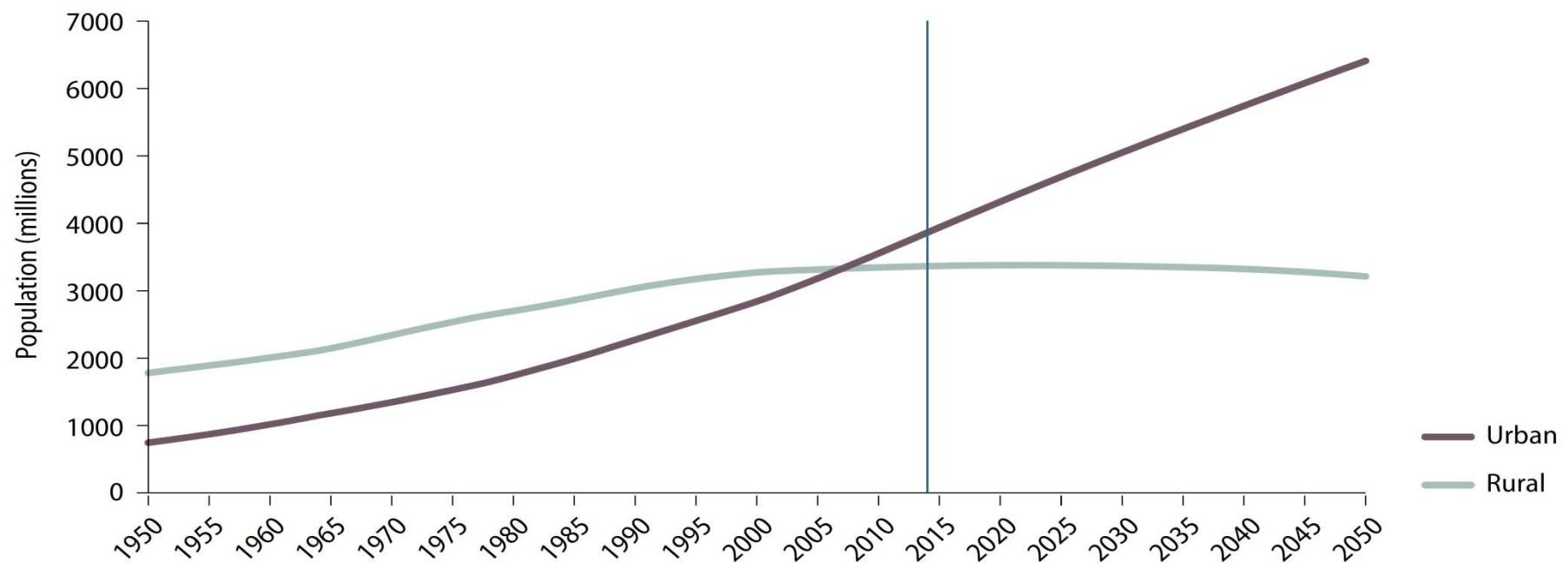
- As the world is undergoing the largest wave of population growth in history, **urbanization** – the process of transition from a rural to a more urban society – is **inevitable**.
- More than half of the world's population now lives in cities.
- Urban living is often associated with **higher levels of literacy and education**, **better health**, **greater access to social services**, and **enhanced opportunities** for cultural and political participation.



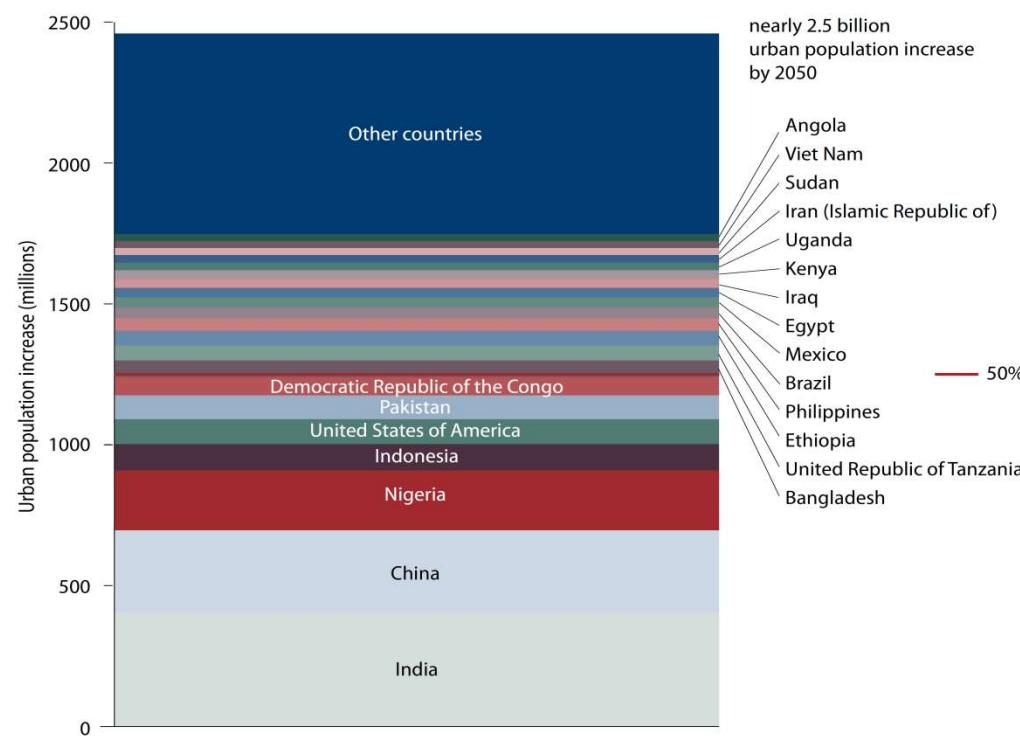
Trends in Urbanization



- Globally, more people live in urban areas than in rural areas, with 55% of the world's population residing in urban areas in 2018.
- In 2007, for the first time in history, the global urban population exceeded the global rural population, and the world population has remained predominantly urban thereafter.
- Growth in the urban population is driven by overall population increase and by the upward shift in the percentage living in urban areas.



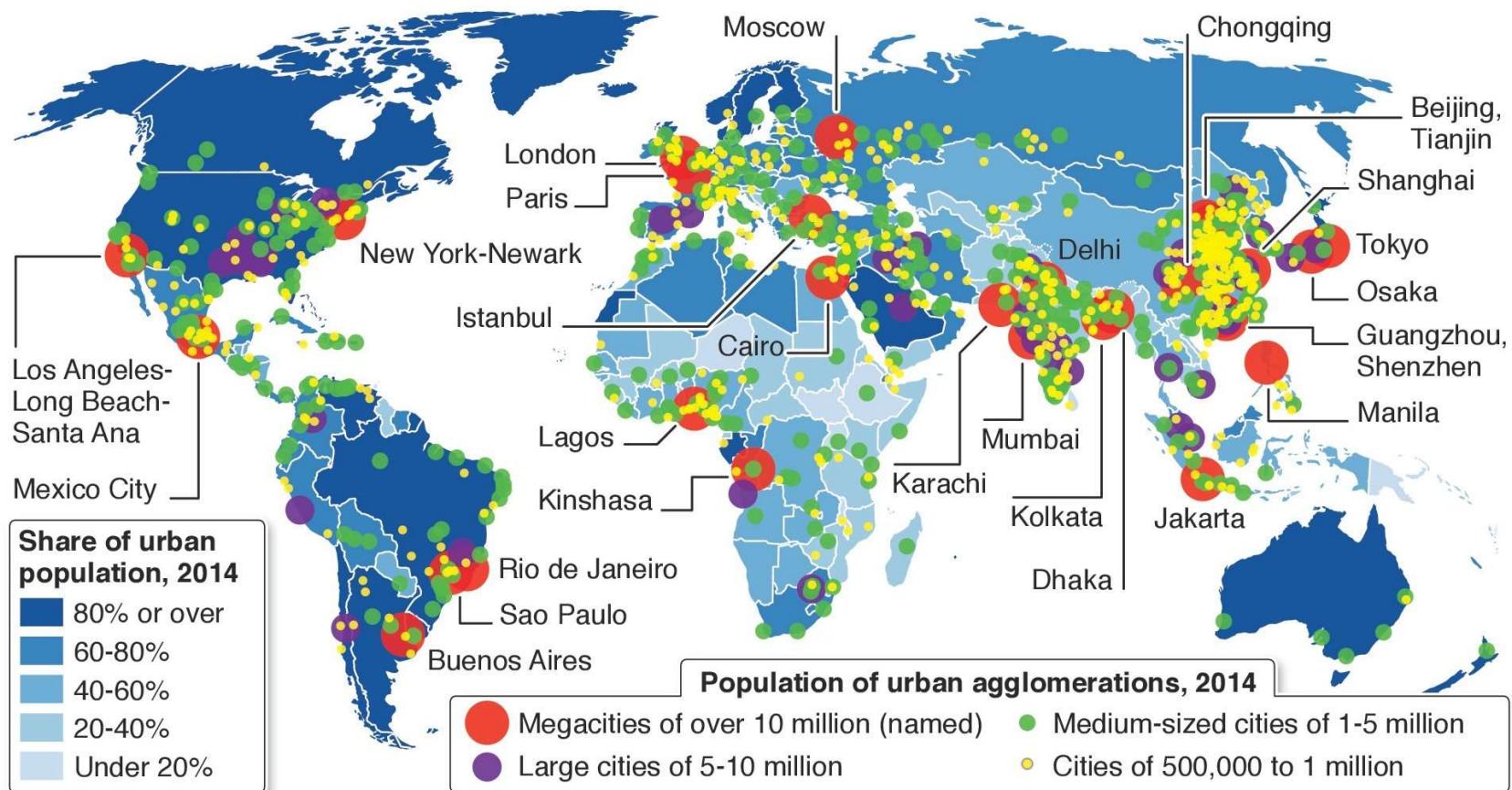
- Just a few countries are home to half of the world's urban population. China has the largest urban population (758 million), followed by India (410 million).
- Future increases in the world's urban population are also expected to be highly concentrated in just a few countries. India, China and Nigeria – together are expected to account for 35% of the growth in the world's urban population between 2018 and 2050. India is projected to add 416 million urban dwellers, China 255 million and Nigeria 189 million.





How might population growth and the continued migration of people from rural to urban areas affect India's agricultural future?

- Tokyo is the world's largest city with an agglomeration of 37 million inhabitants, followed by Delhi with 29 million, Shanghai with 26 million, and Mexico City and São Paulo, each with around 22 million inhabitants.
- Today, Cairo, Mumbai, Beijing and Dhaka all have close to 20 million inhabitants.





Why are the majority of megacities in developing countries?

Benefits of Urbanization



- Urban areas are global economic platforms for **production, innovation and trade**, and offer significant **opportunities** for both **formal and informal employment**.
- Urbanization has helped millions escape poverty through increased productivity and employment opportunities; improved quality of life *via* better education and health; large-scale public investment and access to improved infrastructure and services.



Challenges of Urbanization



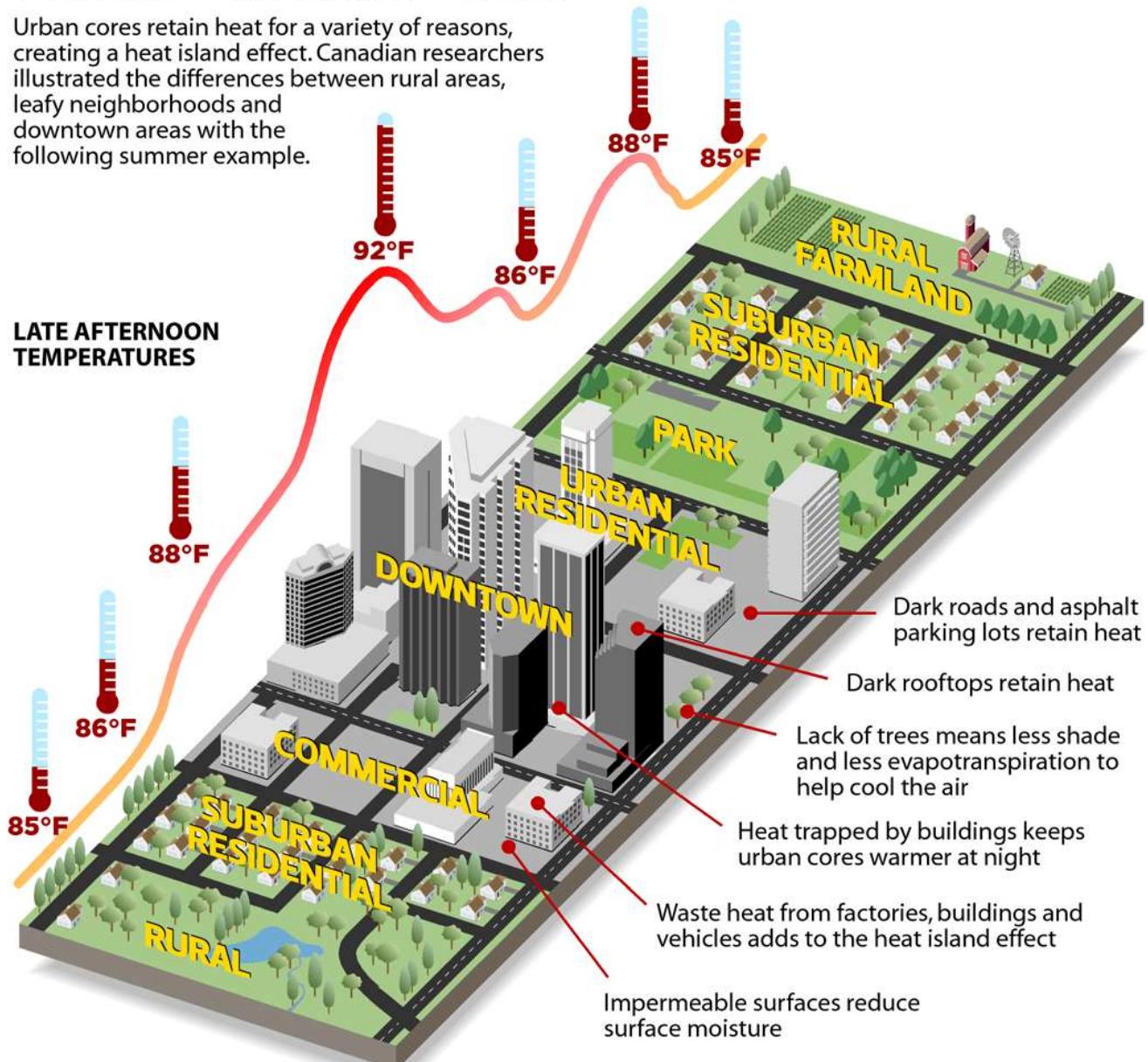
- Urbanization does not necessarily result in a more equitable distribution of wealth and wellbeing. Today, urban areas are more unequal than rural areas: 75% of the world's cities have higher levels of **income inequalities** than two decades ago.
- Inadequately managed urban expansion leads to **rapid sprawl**, pollution, and environmental degradation, together with **unsustainable production** and **consumption patterns**.





Urban Heat Island Effect

Urban cores retain heat for a variety of reasons, creating a heat island effect. Canadian researchers illustrated the differences between rural areas, leafy neighborhoods and downtown areas with the following summer example.



Cities Can Grow Outward or Upward



▪ Compact cities

- Limited land area with high population density, thus growing vertically
- Most people get around by walking, biking, or using mass transit
- Example: Hong Kong, Singapore, Tokyo

▪ Dispersed cities

- Ample land area available for outward expansion
- Residents mostly depend on motor vehicles for transportation
- Example: Cities in Australia, Canada, China, India and the United States



Transport and Urban Environment



- Road transport contributes significantly to **urban air pollution** in many countries.
- A common feature across road networks in many urban regions in the developing world is the presence of critical **congestion** areas. Traffic congestion worsens the emissions of both local and global pollutants.
- Besides, each year, **automobile accidents** kill approximately 1.2 million people and injure another 15 million people, globally. They also kill about 50 million wild animals and family pets every year. **Car accidents have killed more Americans than have all the wars in the country's history!**



Transport and Urban Environment



- Some cities promote **alternatives** to motor vehicles, each with its own advantages and disadvantages.

Trade-Offs

Bicycles

Advantages

Are quiet and non-polluting

Take few resources to make

Burn no fossil fuels

Require little parking space



Disadvantages

Provide little protection in an accident

Provide no protection from bad weather

Are impractical for long trips

Secure bike parking not yet widespread

Trade-Offs

Mass Transit Rail

Advantages

Uses less energy and produces less air pollution than cars do

Use less land than roads and parking lots use

Causes fewer injuries and deaths than cars



Disadvantages

Expensive to build and maintain

Cost-effective only along a densely populated corridor

Commits riders to transportation schedules

Trade-Offs

Buses

Advantages

Reduce car use and air pollution

Can be rerouted as needed

Cheaper than heavy-rail system



Disadvantages

Can lose money because they require affordable fares

Can get caught in traffic and add to noise and pollution

Commit riders to transportation schedules

Trade-Offs

Rapid Rail

Advantages

Much more energy efficient per rider than cars and planes are

Less air pollution than cars and planes

Can reduce need for air travel, cars, roads, and parking areas



Disadvantages

Costly to run and maintain

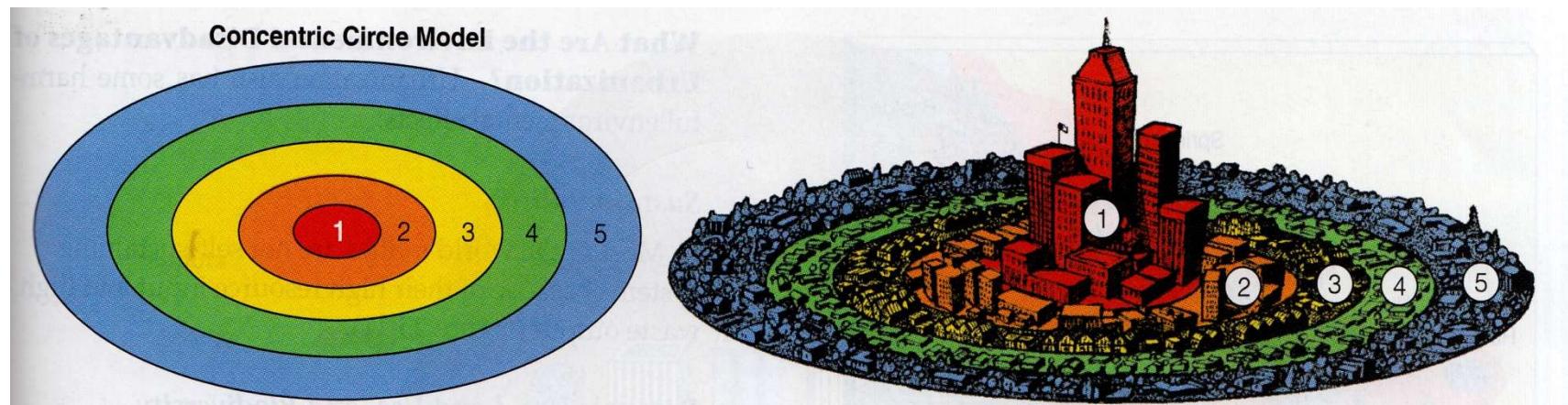
Causes noise and vibration for nearby residents

Adds some risk of collision at car crossings

Spatial Patterns of Urbanization



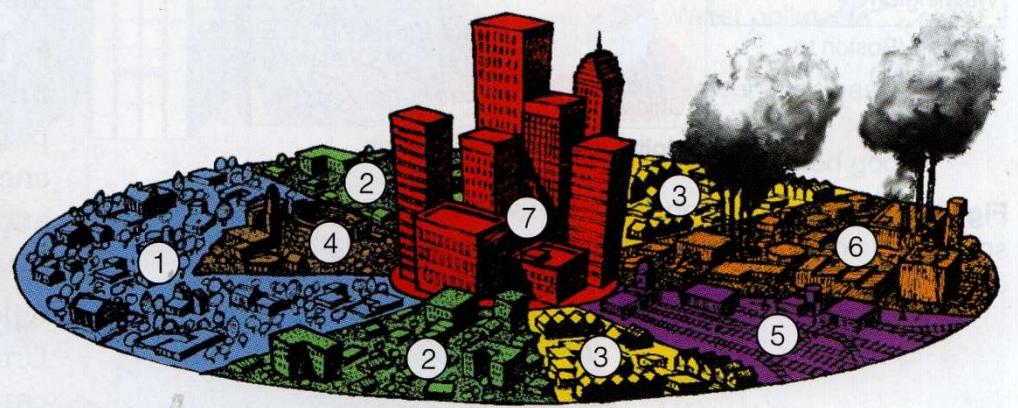
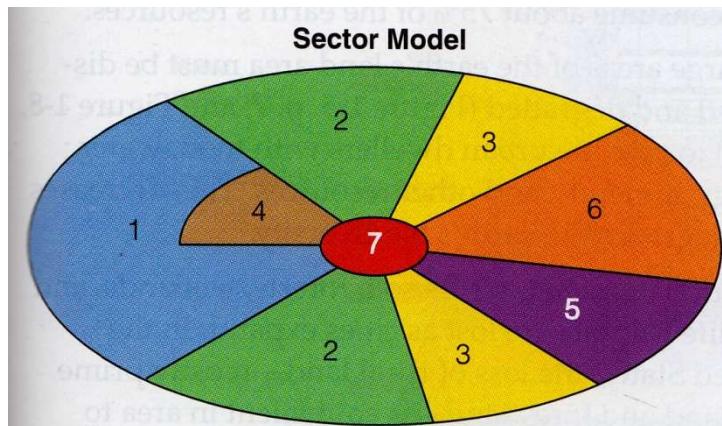
- A **concentric circle city**, such as Kolkata, develops outward from its central business district (CBD) in a series of rings as the area grows in population and size.
- Typically, industries and businesses in the CBD and poverty-stricken inner-city housing areas are ringed by housing zones that usually become more affluent toward the suburbs.



1. Central business district (CBD)
2. Deteriorating transition zone
3. Worker's home
4. Middle-class suburbs
5. Commuter's zone



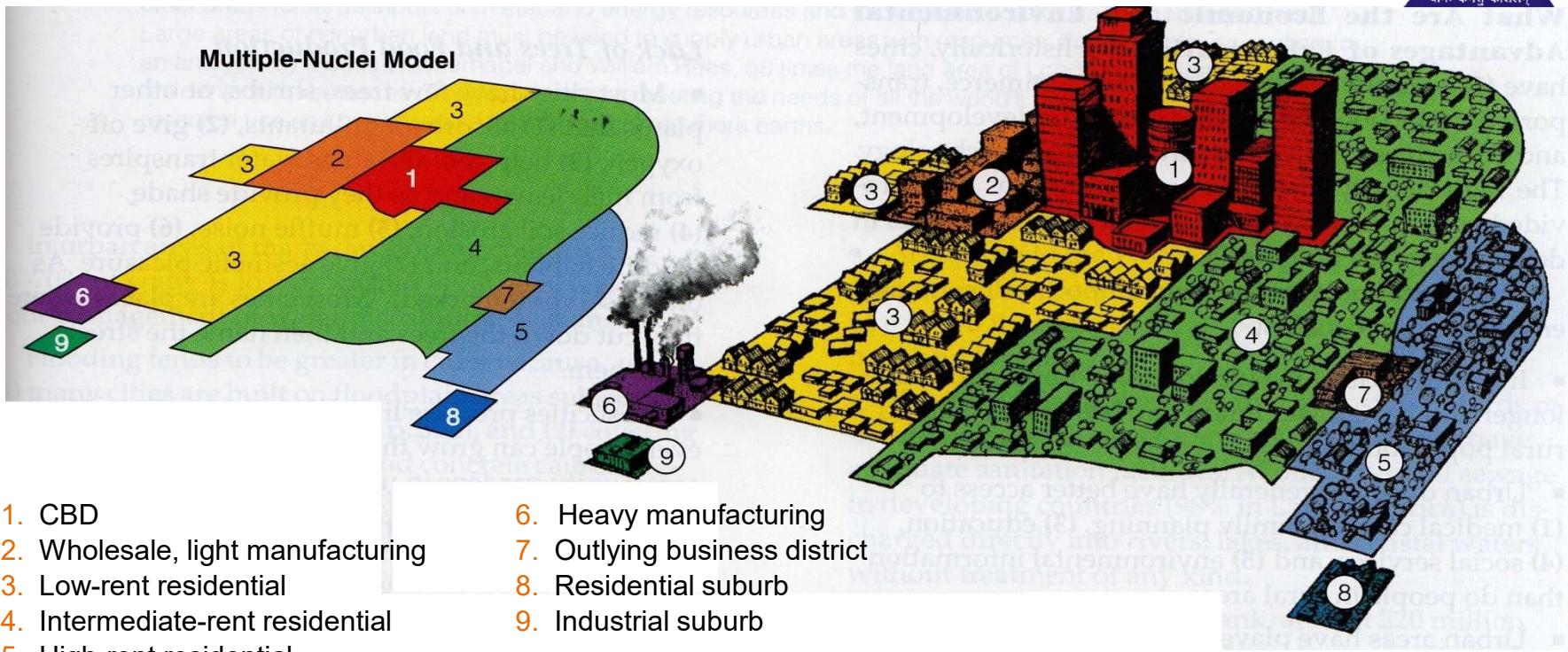
- A **sector city** grows in pie-shaped wedges or strips when commercial, industrial, and housing districts push outward from the CBD along major transportation routes. An example is the large urban area extending from Mumbai to Navi Mumbai.



- | | |
|----------------------------------|-------------------|
| 1. High-rent residential | 5. Transportation |
| 2. Intermediate-rent residential | 6. Industrial |
| 3. Low-rent residential | 7. CBD |
| 4. Education and recreation | |



- A **multiple-nuclei city** develops around a number of independent centres, or satellite cities, rather than a single centre. Singapore comes fairly close to this pattern.



Urban Sprawl



- Rapid expansion of the geographic extent of cities, often characterized by low-density residential housing, single-use zoning, and increased reliance on private automobile for transportation.
- The end result is the spreading of a city and its suburbs over more and more rural land.
- Urban sprawl is a complex phenomenon, which goes beyond average population density.



Causes of Urban Sprawl



- Urban sprawl is driven by **demographic, economic, geographic, social and technological** factors.
- As number of people in a city grows beyond capacity, the local communities continues to spread farther and farther from the core of the cities.
- Increased affluence, attractive land and housing prices, and the desire for larger homes with more amenities (such as yards, swimming pools, storage space, lower noise levels, better air quality, and privacy) play significant roles at the level of the individual.
- Most importantly, sprawl is also **policy-driven**. Maximum density restrictions, specific zoning regulations, tax systems that are misaligned with the social cost of low-density development, the underpricing of car use externalities and the massive investment in road infrastructure contribute to this phenomenon.



Consequences of urban sprawl



Natural Capital Degradation

Urban Sprawl



Land and Biodiversity

- Loss of cropland
- Loss of forests and grasslands
- Loss of wetlands
- Loss and fragmentation of wildlife habitats



Water

- Increased use of surface water and groundwater
- Increased runoff and flooding
- Increased surface water and groundwater pollution
- Decreased natural sewage treatment



Energy, Air, and Climate

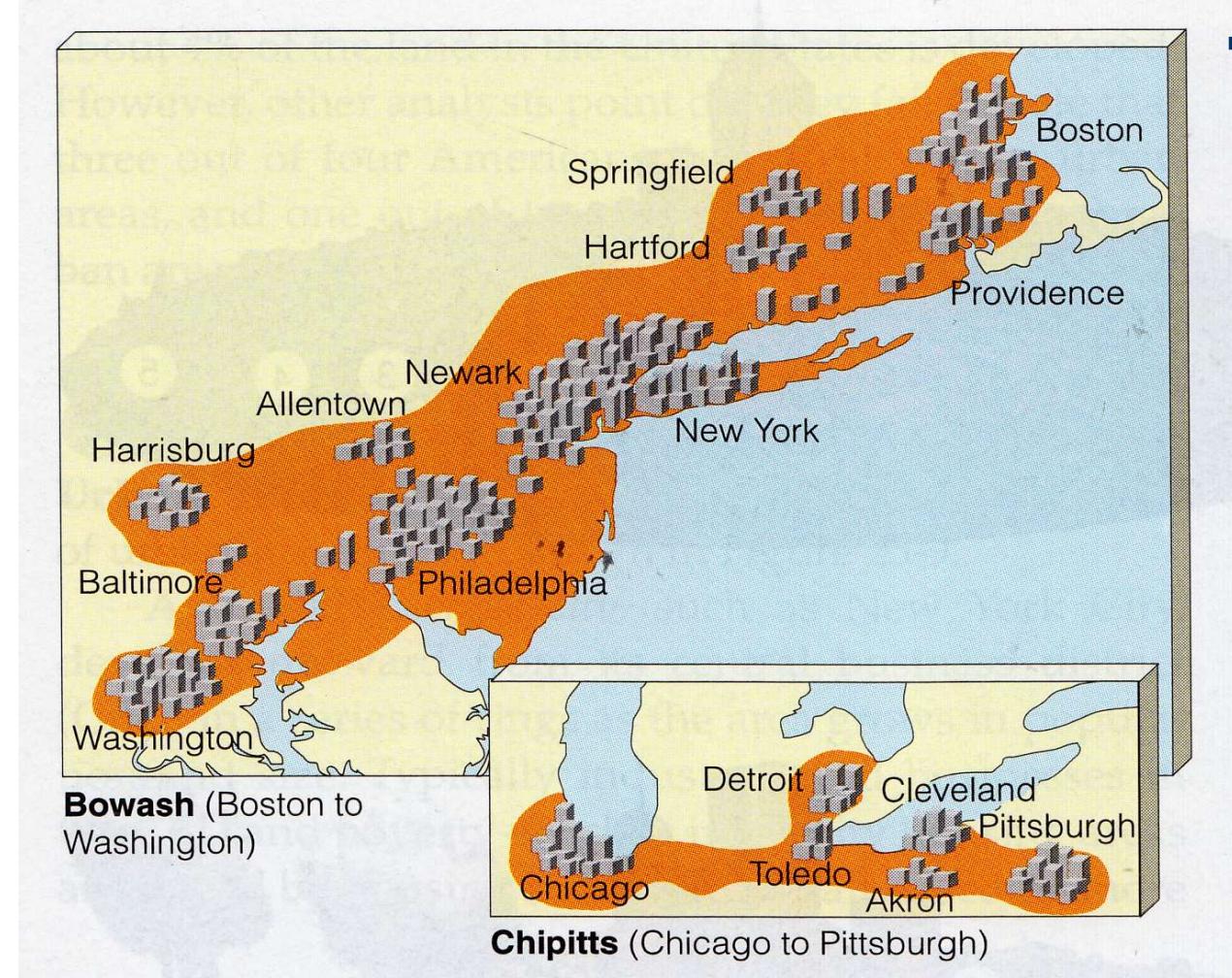
- Increased energy use and waste
- Increased air pollution
- Increased greenhouse gas emissions
- Can enhance climate change



Economic Effects

- Decline of downtown business districts
- Increased unemployment in central city
- Loss of tax base in central city

- As they grow and sprawl outward, separate urban areas may merge to form a **megapolis**. For example, the remaining open space between Boston, Massachusetts, and Washington D.C., is rapidly urbanizing and coalescing.



- Two megapolises: *Bowash*, consisting of urban sprawl and coalescence between Boston and Washington, D.C., and *Chipitts*, extending from Chicago to Pittsburgh.

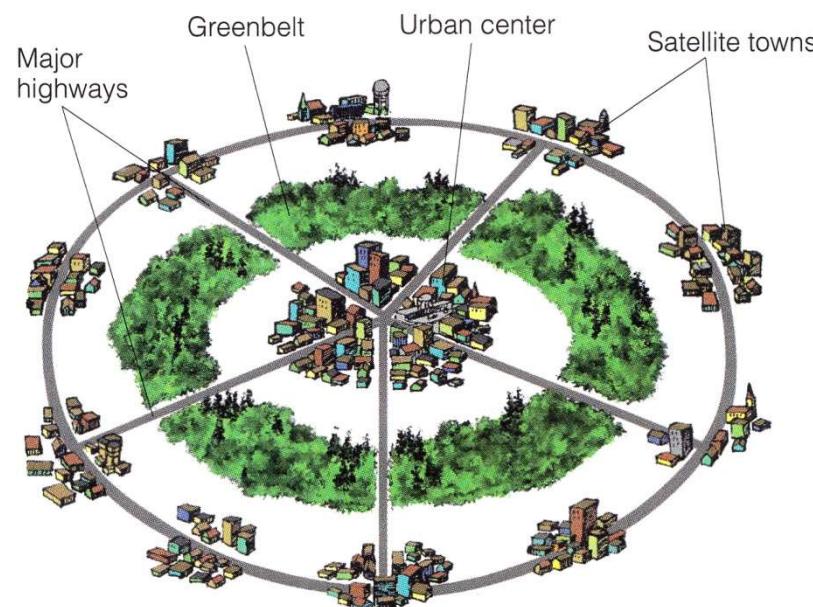


Can you think of anything good (from the viewpoint of sustainable development) that can come out of urban sprawl?



Regulating Urban Sprawl

- Some cities provide open space and control urban sprawl by surrounding a large city with a **greenbelt**: an open area used for recreation, sustainable forestry, and or other nondestructive uses.
- **Satellite towns** (smaller metropolitan areas which are located somewhat near to, but are mostly independent of larger metropolitan areas) can be built outside the belt.
- Highways or rail systems can be used to transport people around the periphery and into the central city.



Regulating urban sprawl



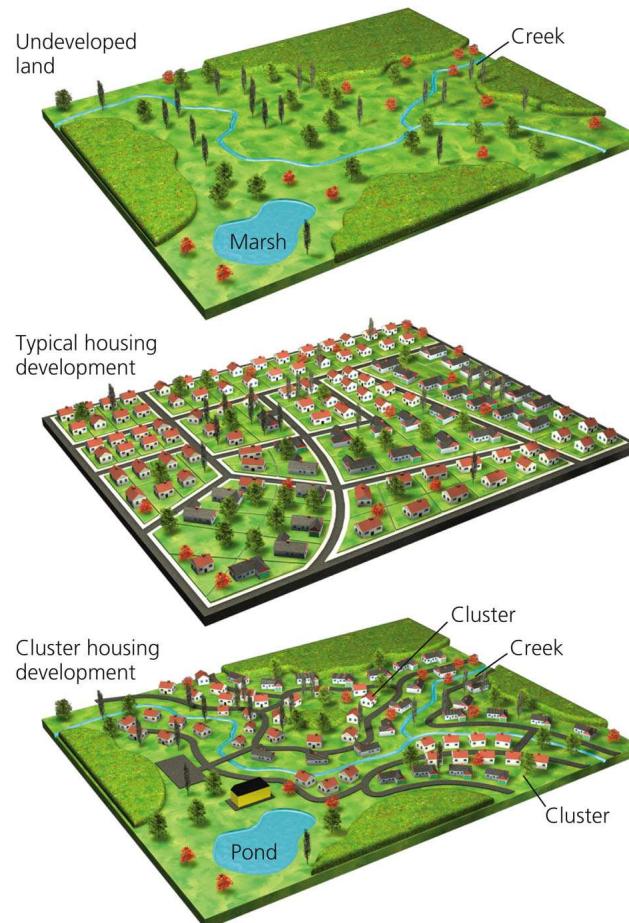
- Another increasingly popular approach to preserving open space outside a city is to set up an **urban growth boundary**: a line surrounding a city beyond which new development is not allowed.



- The sharp demarcation between the metropolitan area of Portland, Oregon (on the left), and the rural acreage that falls outside the city's urban growth boundary determines where, precisely, land can be developed — and where it cannot.

Regulating Urban Sprawl

- In recent years, builders have increasingly used a new pattern, known as **cluster development**, in which high-density housing units are concentrated on portion of a parcel, with the rest of the land (often 40–50%) used for commonly shared open space.



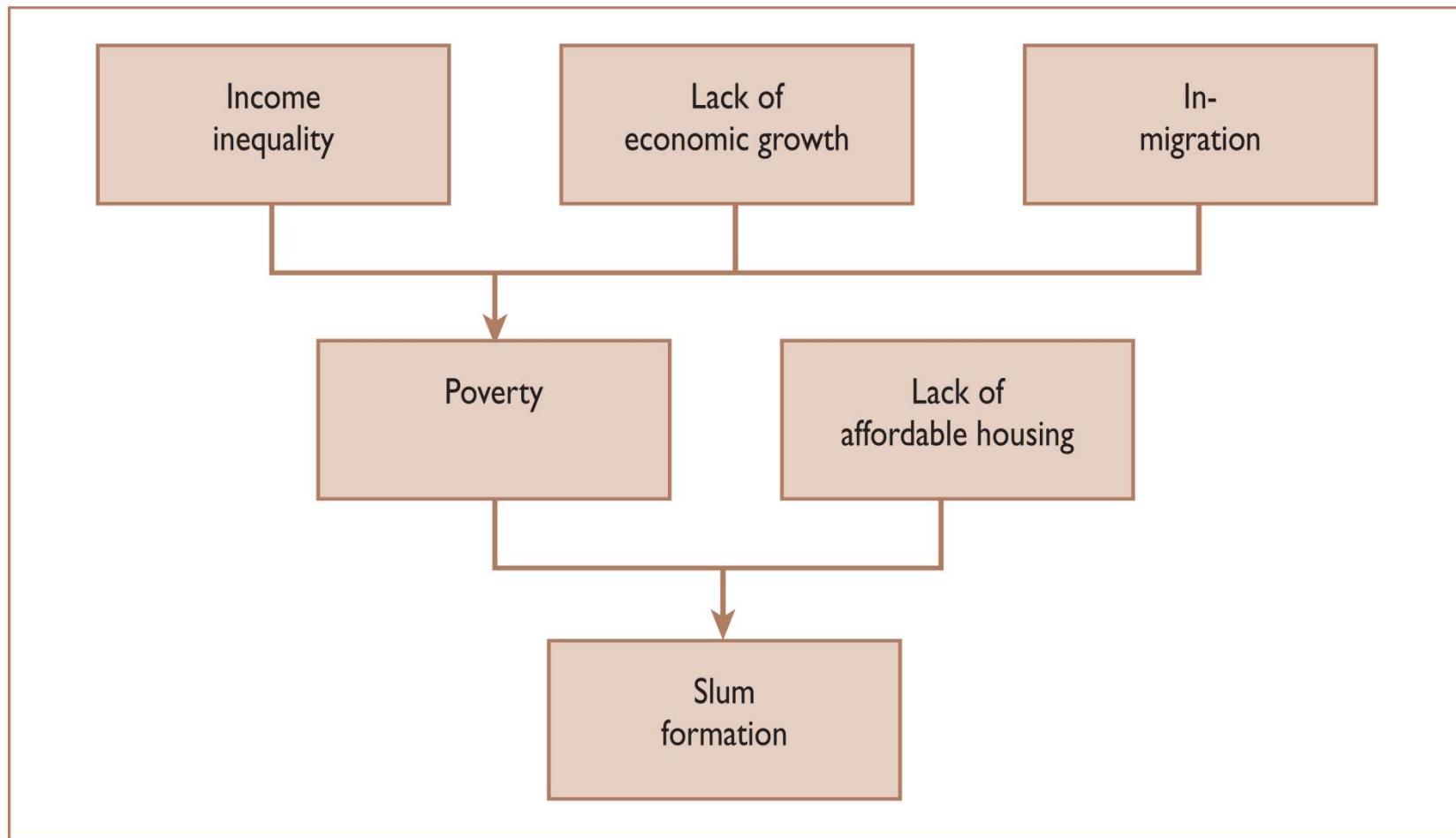
Urban Poverty



- With uncontrolled migration and rapid urban growth, the redistribution of wealth and opportunities across diverse individual abilities and cultural backgrounds that historically characterizes urban dynamics seems to have stalled in many regions of the world.
- At least 1 billion people live under crowded and unsanitary conditions.
- Some live in **slums** – areas dominated by tenements and rooming houses where several people might live in a single room.
- Others live in improvised **shanty towns** or **squatter camps** – housing developments often made up of corrugated metal, plywood, cardboard boxes and sheets of plastics.
- People in slums live under the most deplorable conditions, with little access to effective social and health care services, potable water, sanitation facilities and are therefore more vulnerable to epidemics and developmental challenges.



- The numbers of urban poor are, to a large extent, outside the control of city governments, and are swelled by a combination of **economic stagnation**, **increasing inequality**, **population growth** (especially growth through in-migration), and **inadequate and expensive accommodation**.



Sustainable urbanization: Eco-cities



- An eco-city is
 - an ecologically healthy human settlement modelled on the self-sustaining resilient structure and function of natural ecosystems and living organisms.
 - an entity that includes its inhabitants and their ecological impacts.
 - a subsystem of the ecosystems of which it is part — of its watershed, bioregion, and ultimately of the planet.
 - a subsystem of the regional, national and world economic system.
- The ultimate goal of eco-cities is to eliminate all carbon waste, to produce energy entirely through renewable sources, to incorporate the environment into the city, reduce poverty, organize cities to have higher population densities, and therefore higher efficiency, and improving health.

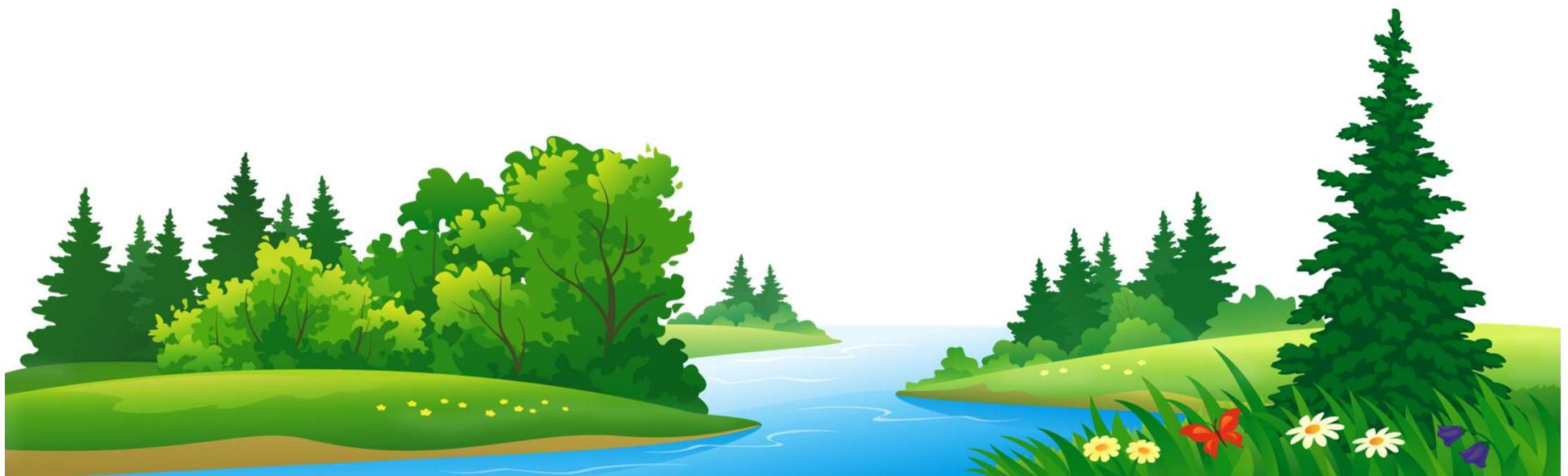


Sustainable urbanization: Eco-cities



■ Eco-cities

- centralize the population within a given area.
- use renewable energy as much as possible.
- use energy and matter efficiently.
- prevent pollution and reduce waste.
- recycle, reuse, and compost.
- protect and encourage biodiversity.
- promote urban gardens and farmers markets.



Case study: Vauban, Freiburg



- The Vauban district of Freiburg in southern Germany is the world's best example of sustainable urban living.
- Pedestrian and bicycle paths form a highly-connected, efficient, green transportation network with every home within walking distance of a tram stop. Trains appear every 7.5 minutes during rush hours with ticket costs subsidized to encourage use.
- Public energy and heat are generated by a highly efficient woodchip-powered combined heat and power generator connected to a district heating grid.
- Organic household waste is treated with an anaerobic digester. The city has an unique ecological sewage system in one pilot project: sucked by vacuum pipes, faeces are transported into this digester; generating biogas, which is used for cooking.
- Grey-water is cleaned in biofilm plants and returned to the water cycle.



Case study: Vauban, Freiburg



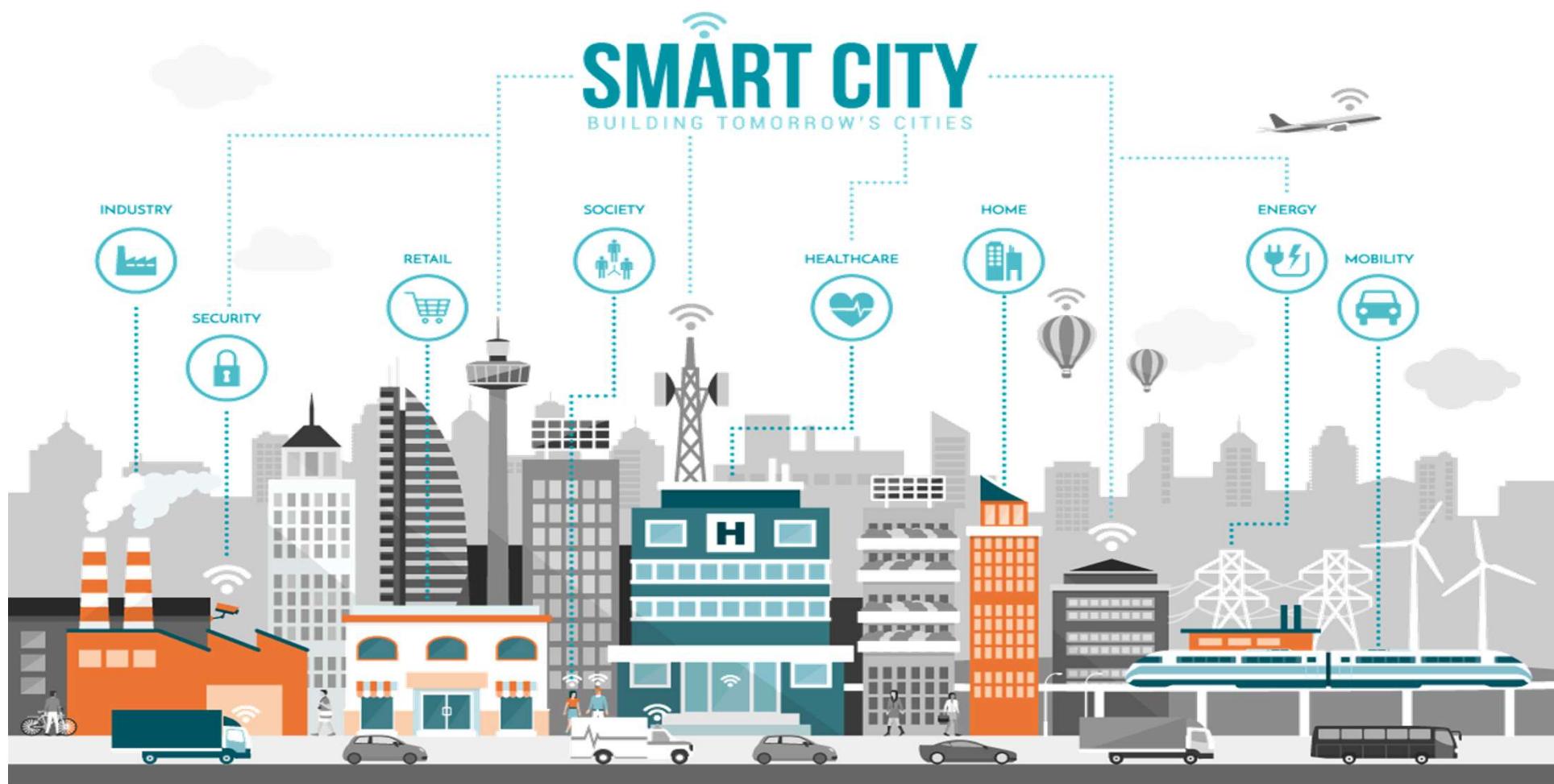
- The city contains over 600 hectares of parks and 160 playgrounds providing greenery, recreation, and biodiversity.
- 3,800 small privately owned garden allotments for the inhabitants to grow their own food lie on the outskirts of the city.
- Local food is also supplied by farm shops, a farmers' market, a local winery and distillery, beekeeping, butchers, bakers and plant nursery.
- Shops and offices are located on the ground floor of the apartment buildings, allowing residents easy access, on foot or bicycle, to their daily needs.
- Renewable energy production is encouraged with tax credits from the federal government and subsidies from the regional utility.



Sustainable urbanization: Smart cities



- A **smart city** is a municipality that uses information and communication technologies to increase operational efficiency, share information with the public and improve both the quality of government services and citizen welfare.



Sustainable urbanization: Smart cities



FROM GREEN TO SMART

CLEVER ROUND THE CLOCK

Apart from being energy-efficient, these intelligent structures centralise and automate all operations and management systems – including lighting, temperature, air quality and security – making surveillance and maintenance a breeze.

See how a smart building works by following Sam through a typical work day. You might wish for the future to come a little sooner.

WHY SMART BUILDINGS?

Capital efficient

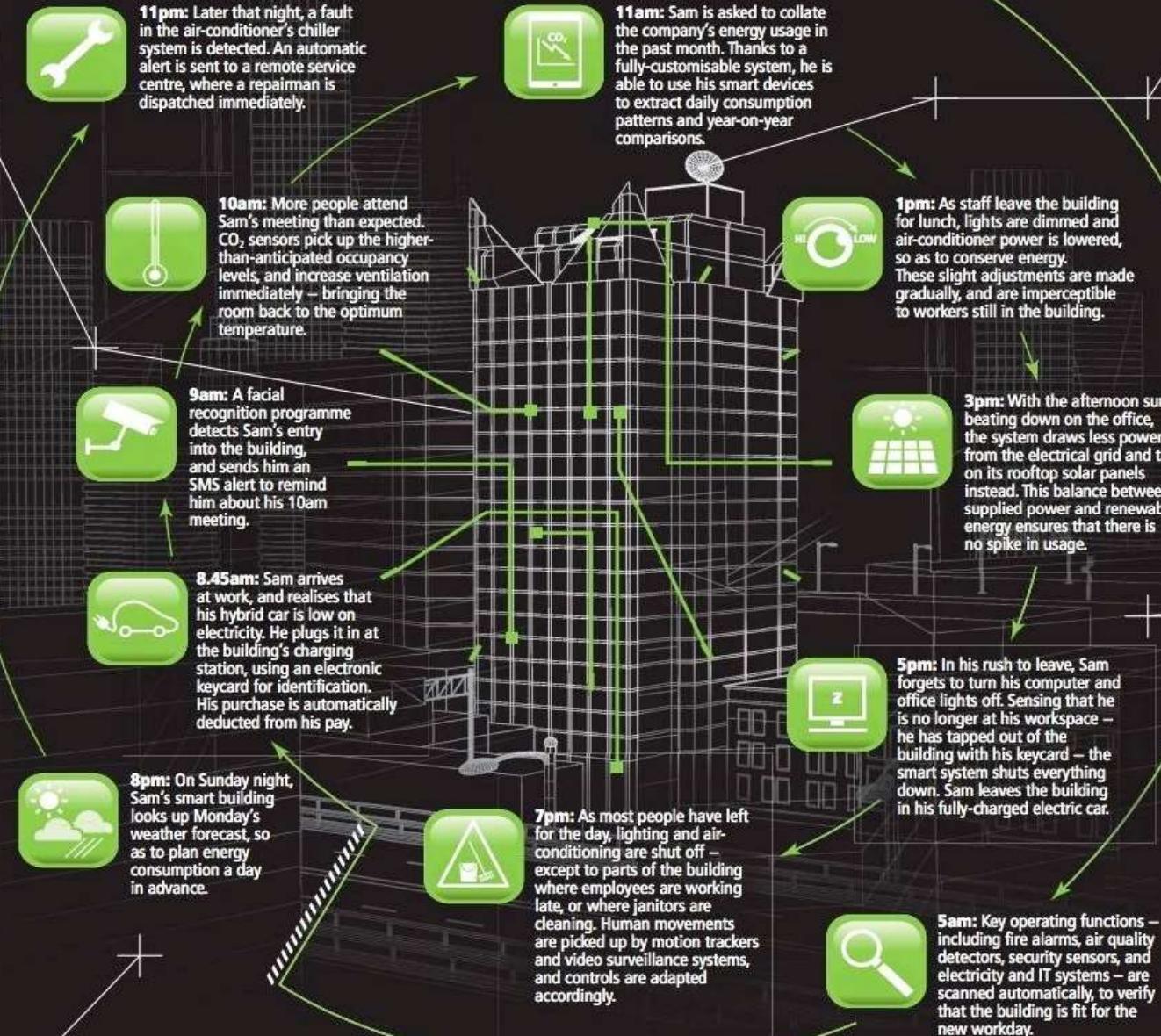
- 24% reduction in capital costs
- Return on investment (ROI) in 10 years

Cost-saving

- 20% lower energy bills
- 36% decrease in running costs

Sustainable

- 15% reduction in carbon emissions



Sustainable urbanization: Smart cities



TOP 10 SMARTEST CITIES IN 2019

1 Singapore,
Singapore

2 Zurich,
Switzerland

3 Oslo,
Norway

4 Geneva,
Switzerland

5 Copenhagen,
Denmark

6 Auckland,
New Zealand

7 Taipei,
Taiwan

8 Helsinki,
Finland

9 Bilbao,
Spain

10 Dusseldorf,
Germany





In 2015, India has pledged \$120 billion to make its cities ‘smart’ by 2022. Do you think India’s Smart Cities Mission will primarily serve the needs of the digerati (i.e., the elite of digitalization, social media, content marketing, computer industry and online communities) and neglect the real problems that urban residents face (such as poverty, lack of basic services, etc.)?