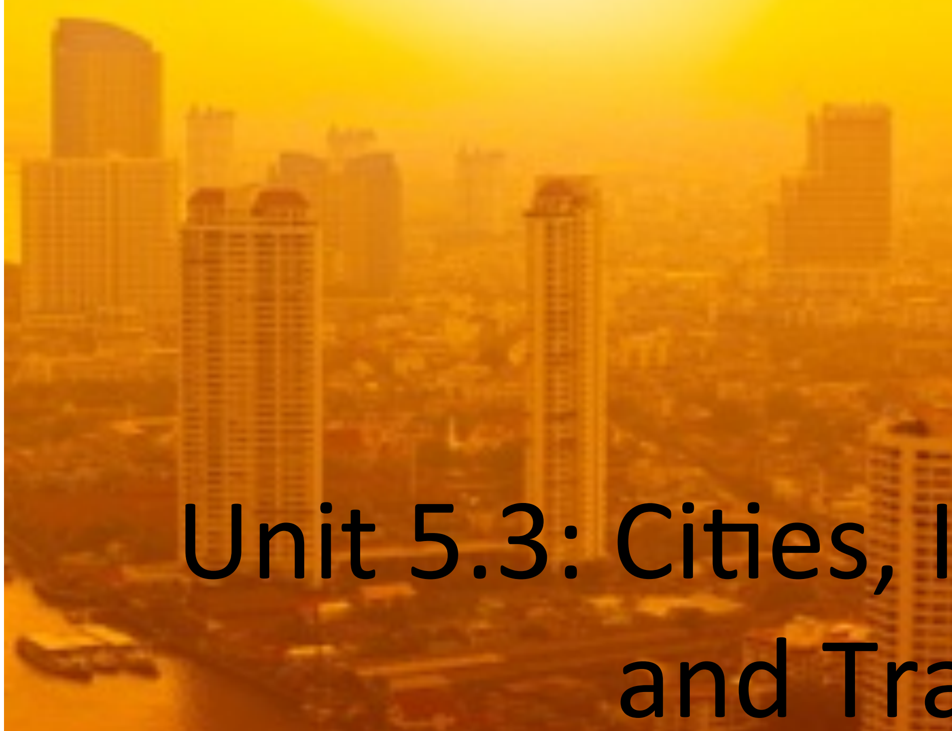
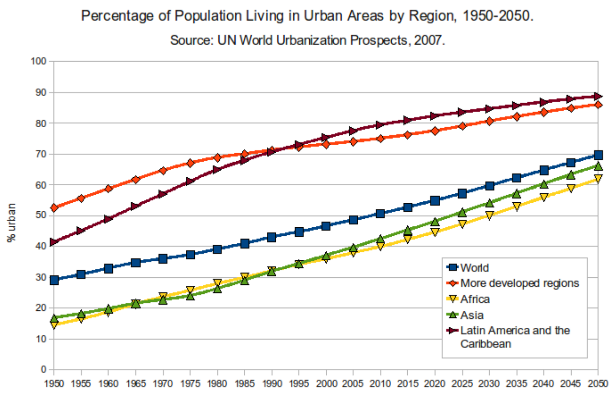
Unit 5.3: Cities, Infrastructure and Transit



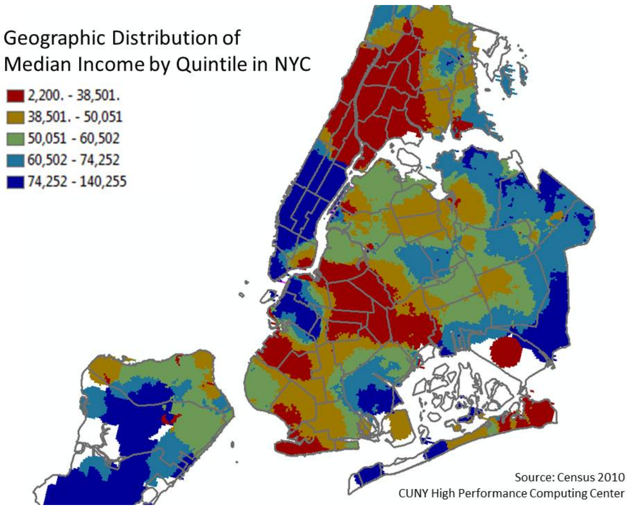
Urbanization

- Globally, there has been a trend towards urbanization
- More than 50% of the world's population now lives in cities larger than (population)
- This migration to the cities has mixed impacts on vulnerability, sustainability and infrastructure
- When a disaster strikes a city, more people in the city imply a higher vulnerability
- Arguably wealthy, Western suburban lifestyle the most environmentally costly
- More people in a city place more demands on the infrastructure and services of the city



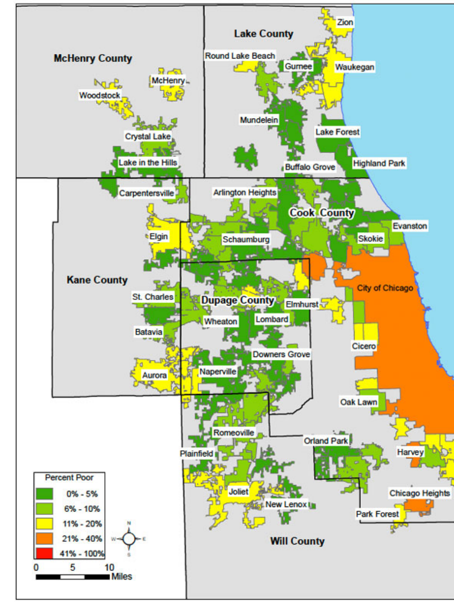
Socioeconomic and demographic trends and vulnerabilities

- Many cities are highly segregated by class
- This is often true of very wealthy and very large cities that are major hubs of industry
- Gentrification and segregation can compound existing vulnerabilities to the adverse consequences of climate change



Rich v. poor world city comparisons

- in both global North and global South contexts, many of the wealthiest people and highest income jobs can be found in major cities
- In both Global North and Global South contexts, there is often larger income disparity in cities than in suburbia or the countryside
- In both Global North and Global South contexts, there is often intense segregation by socioeconomic class (sometimes the segregation is as overt as having actual gated communities)
- in many cities in the Global North, much of the wealthy population lives in suburbs outside the city center, whereas in many cities in the Global South, the peri-urban areas are often quite poor and the wealthiest populations often live in the city center
- In both global North and global South contexts, many people who move to the city do so in search of a more prosperous life



Chicago, IL

Caracas, Venezuela

Urban vulnerability in the developing world

- Greater vulnerability than in developed world
- History of hegemonic influence
- Role of capital in skewing resilience outcomes
- Interweaving of agricultural and urban vulnerabilities

Niamey context continued

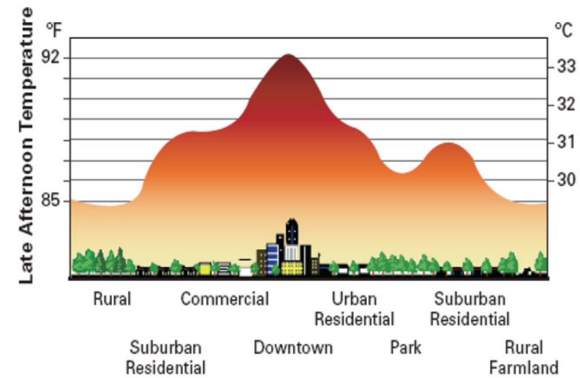
- Vulnerable infrastructure (only one bridge in Niamey, Niger – although second under construction)
- Competing investment and development interests (China, US, others)
- Role of expert knowledge versus local knowledge

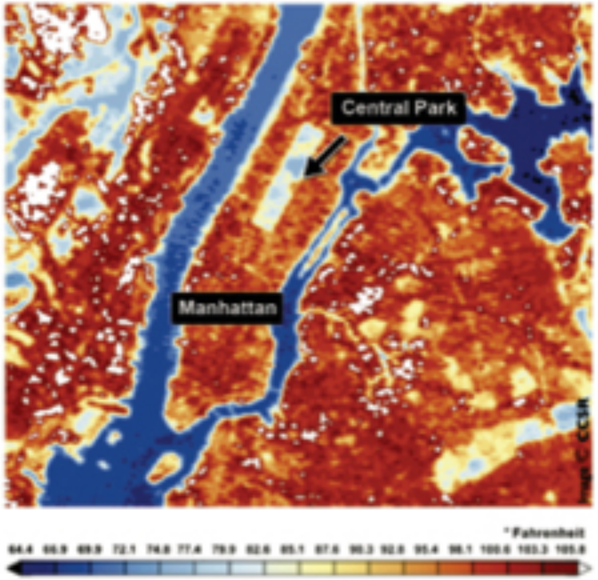
Globalization and cities: double exposures revisited

- Cost of living is often higher in cities (but variable by neighborhood)
- In spaces within cities where marginalization is underway from the effects of globalization, new vulnerabilities to environmental hazards are often evident
- Within city management agencies, there can be differential priorities in managing various aspects of disasters depending on socioeconomics, class and perceived “importance” of neighborhood

Urban heat island effect

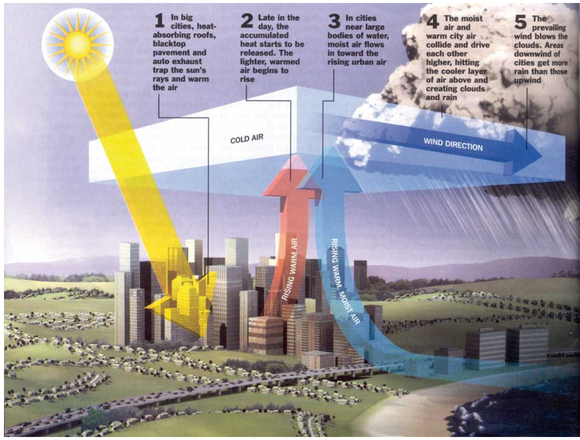
- In part because of the lower albedo of paved surfaces and in part because of the intensive, concentrated energy use in cities, observed temperatures in cities tend to be a few degrees hotter than in the surrounding suburbs and or rural areas
- This can be particularly problematic in the summer





Urban precipitation effect

- In the same vein as the urban heat island effect, the pollution emitted in cities tend to act as condensation nuclei locally, thereby slightly enhancing precipitation over many cities
- Additionally, the elevated temperatures from the UHI can drive more convective precipitation over cities
- However, there are countering effects (cold air settling in Mexico City)
- Storm dynamics and track still explain much of the spatial variability of rainfall
- Precipitation effects (and pollution effects) also persist downwind of major cities
- For a given amount of rain in a given time, flooding tends to be more severe and happen more quickly in cities because of the impervious nature of most pavement



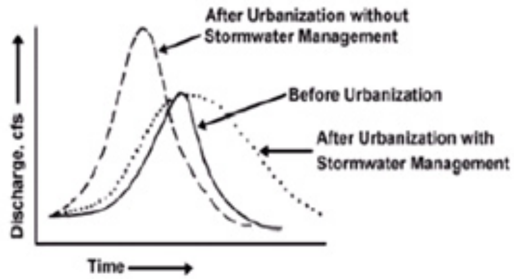
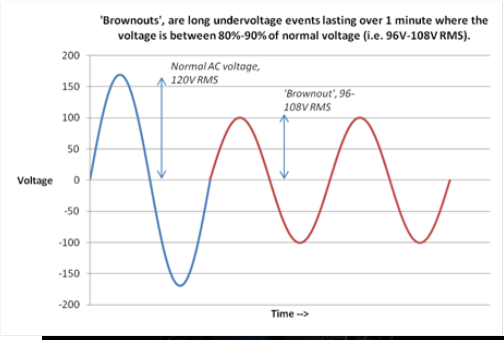


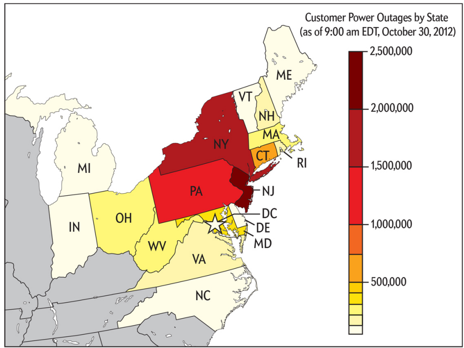
Figure 1.2 - Impact of Urbanization on Flood Peaks

Critical infrastructure; energy systems

- In many major cities, energy infrastructure is buried (as opposed to above ground transmission lines in suburbs)
- To the degree that energy infrastructure may also be below sea level, there is risk from flooding
- Overuse of energy (especially excessive AC demand on hot summer days) can cause brownouts and blackouts
- http://www.nyc-grid.com/map/

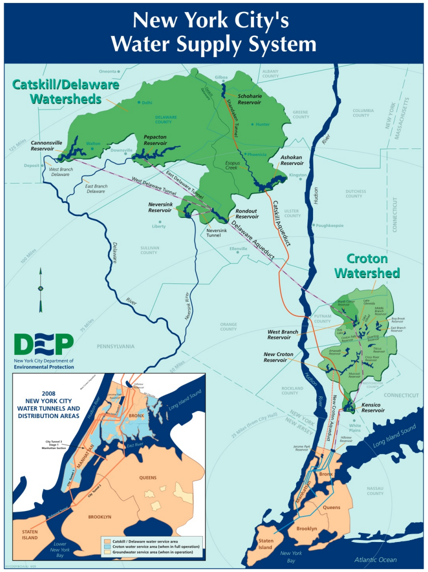


Black out in Buenos Aires following heat wave



Critical infrastructure; water systems

- Water provision varies greatly by city
- Climate impacts include variability to supply
- Allocation rules and infrastructure have a significant role to play in how water is used by the city relative to suburbs and rural communities
- Age and functionality of infrastructure matters – wider pipes can transport more water, but cost more to build
- Aging pipes can be leaky
- Single reservoir versus multiple reservoir cities; differentiated vulnerability

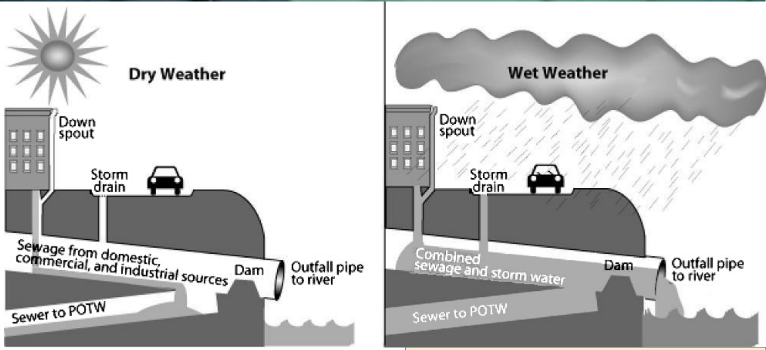


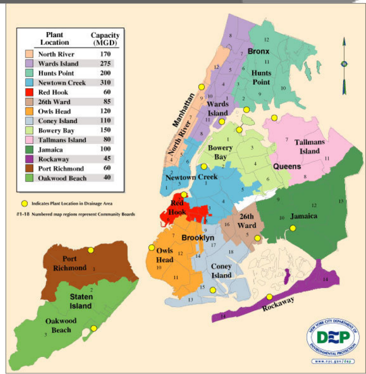
NYC water system

Angat Reservoir, Philippines

Critical infrastructure; sewage systems

- Many cities have stormwater and sewage water going into the same drains
- In excessive storms, stormwater and sewer water can combine to create combined sewer overflow (CSO) events
- Most wastewater treatment facilities are located near the coast or riverbanks so effluent can go into a water body after treatment
- During severe flooding, these facilities can be overwhelmed and compromised





Critical infrastructure; emergency response systems

- Emergency response bureaus, fire departments, etc. need accurate up-to-date forecast information for impending storms and the infrastructural and institutional capacity to mobilize quickly during a crisis
- Coordination and communication
- Need to coordinate with other city bureaus to repair damaged infrastructure
- http://www.nyc.gov/html/oem/html/hazards/hazards.shtml

Red Cross workers in the Philippines after Haiyan


Fire damage, Breezy Point, after Sandy

Critical infrastructure; hospital systems

- Life or death need for reliable source of energy and water
- Hospital populations vulnerable to infrastructural challenges that emerge from severe events and inundation
- Climate related disease can add enough of a morbidity burden to overwhelm an area's response capacity, even if hospital infrastructure is left intact

Scenes from evacuation of NYU Hospital during Sandy

Critical infrastructure; transportation systems (buses and cars)

- Clearly, all modes of transit contribute to carbon pollution from tailpipe emissions (or from the manufacture of the car when considering fully electric vehicles)
- Switching to compressed natural gas can help reduce tailpipe emissions
- Severe inundation can pose risks to cars and buses in low-lying areas
- Inundation risk can be partly addressed by permeable pavement (although this is somewhat costly)

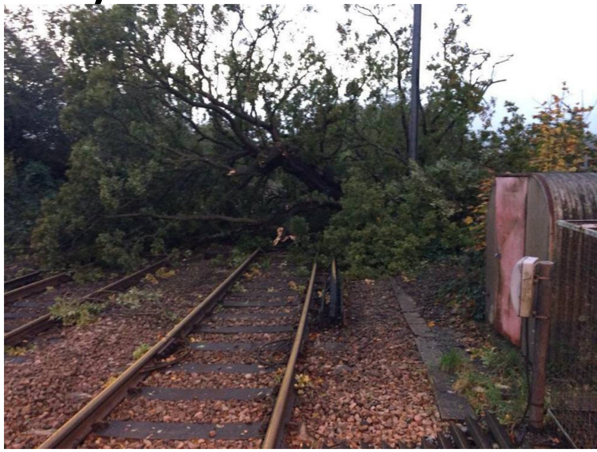
Courtesy of The National Renewable Energy Laboratory (NREL)

CNG bus

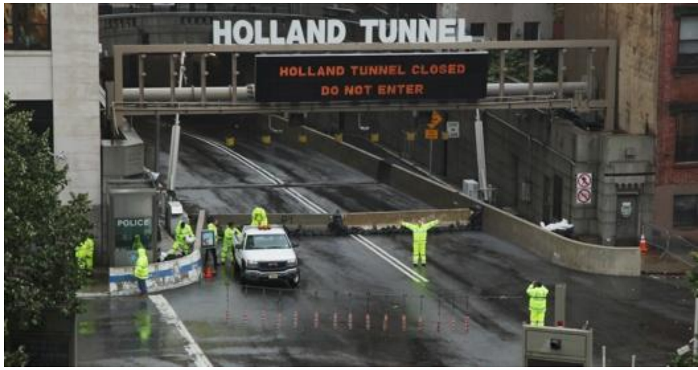
Porous vs. regular asphalt

Critical infrastructure; transportation systems (commuter trains and light rail)

- Above ground trains are often fairly resilient to many climate hazards
- severe winter weather can compromise electrical lines
- major flooding events can endanger tunnel entrances or threaten bridge structural integrity



Downed tree over rail line in W. Sussex, UK after major storm, Oct 2013



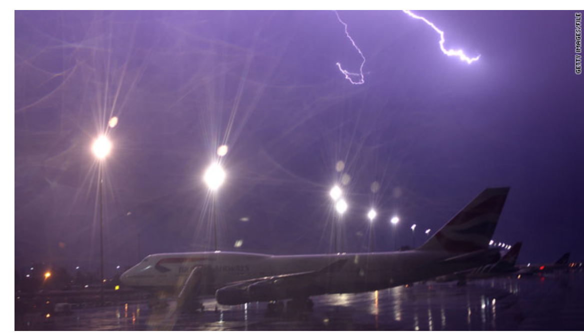
Holland Tunnel entrance after Sandy

Critical infrastructure; transportation systems (subway systems)

- Coastal storms and severe flooding events can be major challenges to the operational capabilities of subway systems
- Saltwater exposure especially can short out electrical equipment
- Many coastal cities have many subway stops and a lot of infrastructure near sea level
- Very true of NYC – very clear during Sandy
- Inflatable subway plugs?
- How far in advance of a storm to stop service?
- Move subway cars to higher ground
- What to do about people who have limited access to transportation in coastal or riverine evacuation zones?

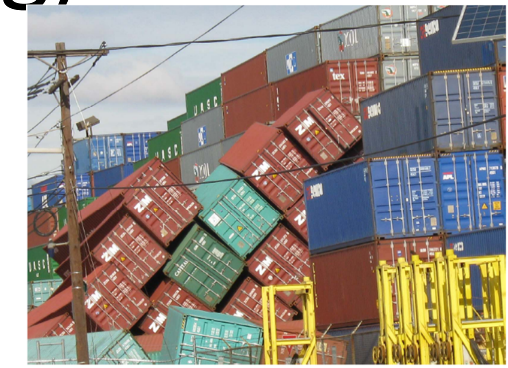
Critical infrastructure; transportation systems (airports)

- In many major cities, especially near coasts, airports are a major vulnerability to inundation risk
- often the flattest areas – most suitable for siting airports are near the coast and close to sea level
- In addition to inundation risks for coastal airports, the effect of climate change on weather poses a challenge for commercial flying across the board



Critical infrastructure; transportation systems (ports/shipping)

- Ports play a vital role in commerce and international trade
- Severe storms can damage coastal port infrastructure and can compromise shipping access
- Severe storms can also do damage to docked boats and boats trying to navigate relatively narrow harbors
- Ships may become grounded



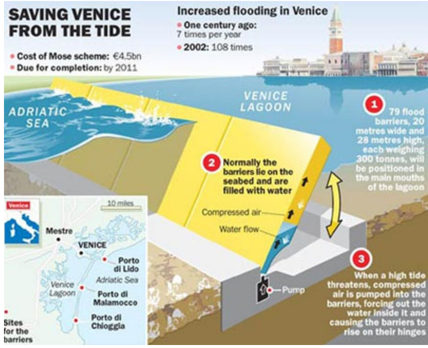
Port of Elizabeth after Sandy

Beached tanker, SE Australia

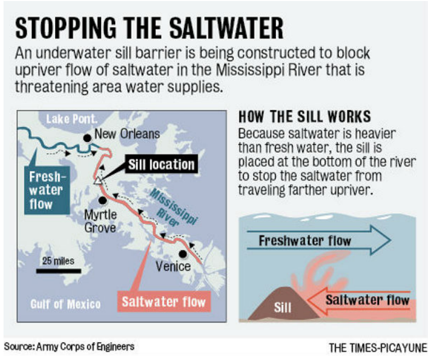
Sea level rise and cities – large scale engineering

- Fixed sea walls
- Movable flood barriers to protect critical infrastructure depending on conditions
- Moving some water supply infrastructure upstream or building sills to hedge against saline intrusion

Sea Wall, Jaffa Israel



Schematic of Venice flood barrier



Urban planning and policy issues surrounding climate change

- Engineering approaches – in addition to large scale initiatives, small scale protection around specific vital infrastructure
- Policy/financial approaches – zoning regulations can encourage or discourage different levels of residential, commercial or industrial risk exposure
- Insurance rates also play a pivotal role in communicating risk cost to businesses and residents
- Trade off between short term economic benefits and longer term resilience from reduced exposure
- Sometimes there is a practical need to site critical infrastructure in vulnerable areas to serve populations that live in high hazard zones
- http://www.citiesandclimatechange.org
- http://www.usmayors.org/climateprotection/climatechange.asp
- http://www.c40.org
- http://uccrn.org/about-uccrn/

Infrastructure vulnerabilities and tradeoffs

- Short term versus long term costs of addressing aging infrastructure
- Political challenges at multiple scales
- Differentiated impacts to differentiated populations and geographies
- Forecast limitations – impact of severe impacts on energy, water, wastewater and health facilities not always predictable
- Difficult for even well intentioned politicians and bureau managers to avoid some asymmetry of outcome

Transit vulnerabilities and tradeoffs

- Need for transit infrastructure to serve vulnerable coastal populations/tradeoff with elevated management risks and challenges
- Need to maintain aging infrastructure vs. cost
- Need to adapt existing infrastructure to address emerging climate vulnerabilities vs. cost of doing so
- Time and money that goes into extensive repairs and retrofitting passed on to ridership in fare hikes and service disruptions

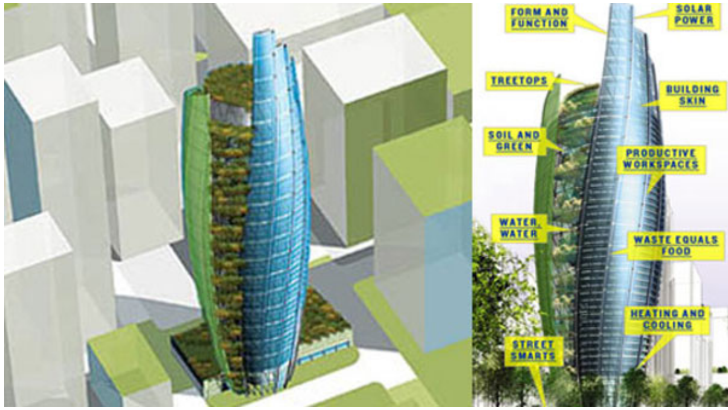
Urban mitigation and adaptation efforts

- Higher fuel economy standards
- Incentives to use public transportation (expansion of existing public transit infrastructure)
- Switching city bus systems to natural gas or biofuels
- Parks
- Trees – million trees campaign under Bloomberg as part of PlaNYC
- http://www.nyc.gov/html/planyc2030/html/home/home.shtml

Biodiesel bus in Sao Paolo, Brazil

Green urban infrastructure; green buildings

- Many different design aspects
- Orientation of windows to minimize heating and cooling costs
- Use of more eco-friendly design materials
- Use of low energy appliances
- Rainwater harvesting
- Use of vegetation (on roof or in building)
- Low flow toilets
- Energy conserving lighting systems
- Solar roof
- http://www.usgbc.org/leed
- http://www.worldgbc.org



Green urban infrastructure; green roofs and rooftop farms

- Vegetation sequesters carbon
- Reduces summer peak temperatures on high floors (can help to reduce urban heat island)
- Can help manage stormwater runoff better
- Can grow food for local consumption
- Need for soil layer to not be too thick
- http://www.greenroofs.org

Chicago city hall

5 Boro Green Roof Garden, Randall's Island, NYC

Green urban infrastructure; parks

- Trees sequester carbon
- Parks provide recreational space
- Beautifies a city
- Provide some relief from urban pollution
- Can help to reduce urban heat island
- Manage stormwater runoff
- If sited near major bodies of water, can serve as flood barrier
- http://www.cityparksalliance.org

Prospect Park, Brooklyn, NY

Maltepe Urban Park, Istanbul

Hot cities and Green Cities

- Videos
- https://www.youtube.com/playlist?list=PLC0EA73D7E7C57AE7
- https://www.youtube.com/watch?v=IjhMQM8eaVY