Urban infrastructure, part 1

Prof.dr.ir. M.P.C. Weijnen

Professor, Faculty of TPM, TU Delft

Urbanization

- Good or bad news for the environment?
- What role can infrastructures play in creating eco-cities?

The essence of a city

Complex adaptive system


Pearl River Delta

Bigger cities do more with less

The bigger cities get, the more productive and efficient they tend to become.

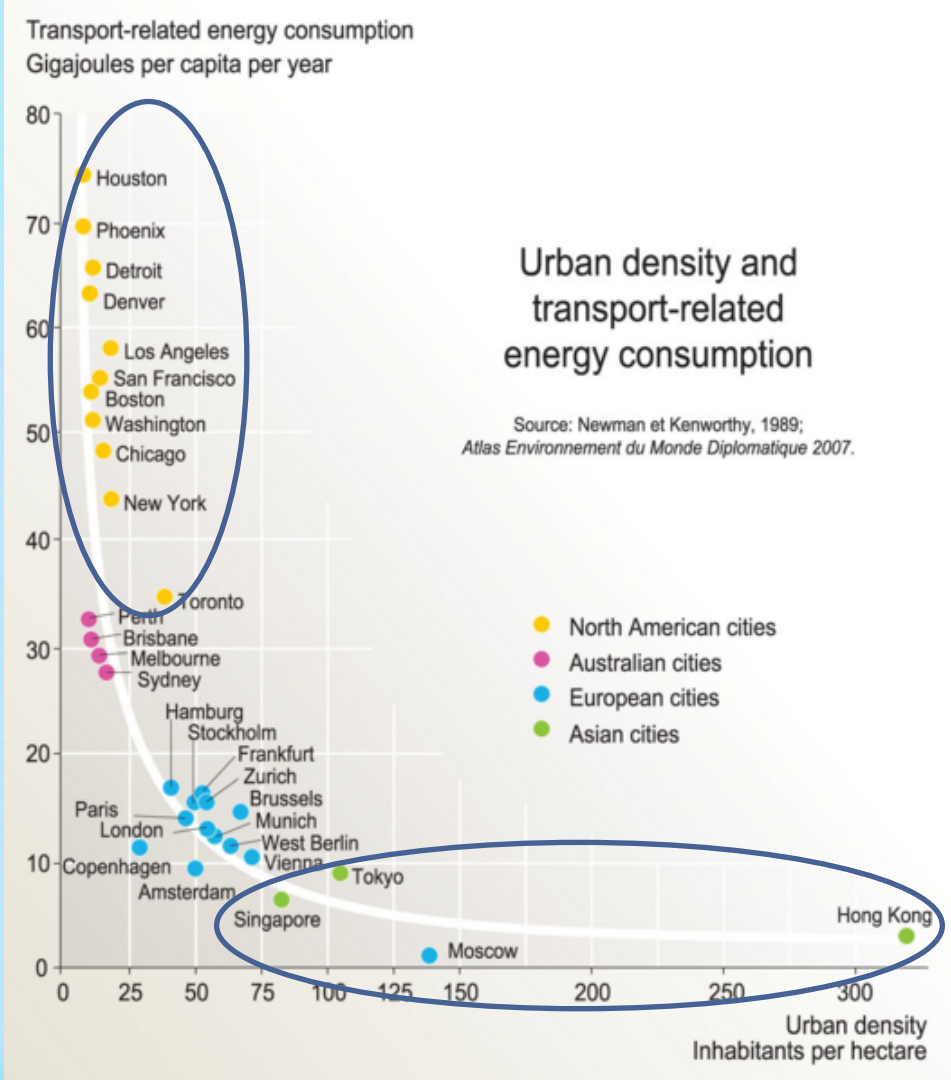
(Source: Luis M.A. Bettencourt and Geoffrey B. West, Scientific American, August 17, 2011).

Bigger cities do more with less

- A city of 8 million typically needs 15% less of the same infrastructure than do two cities of 4 million each.

- On average, the bigger the city, the more efficient its use of infrastructure, leading to important savings in materials, energy and emissions.

Research on cities as complex systems


Transport-related energy consumption
Gigajoules per capita per year
80
70
60
50
40
30
20
10
0
Houston
Phoenix
Detroit
Denver
Los Angeles
San Francisco
Boston
Washington
Chicago
New York
Toronto
Perth
Brisbane
Melbourne
Sydney
Hamburg
Stockholm
Frankfurt
Zurich
Brussels
Paris
London
Munich
West Berlin
Vienna
Copenhagen
Amsterdam
Tokyo
Singapore
Hong Kong
Moscow
0
25
50
75
100
125
150
200
250
300
Urban density
Inhabitants per hectare
Urban density and transport-related energy consumption
Source: Newman et Kenworthy, 1989;
Atlas Environnement du Monde Diplomatique 2007.
North American cities
Australian cities
European cities
Asian cities

Eco-cities

- Have a well-planned city layout and public transportation system
- Operate on a self-contained economy, resources needed are found locally
- Have completely carbon-neutral and renewable energy production
- Ensure resource conservation, creating a zero-waste system
- Restore environmentally damaged urban areas
- Ensure decent and affordable housing for all socio-economic and ethnic groups and improve job opportunities for disadvantaged groups
- Support local agriculture and produce
- Promote voluntary simplicity in lifestyle choices, decreasing material consumption, and increasing awareness of environmental and sustainability issues


Many of these criteria are not easily applicable to megacities

Megacities need to harvest their renewable energy resources outside the city

Megacities

- Provision of water and energy, and removal of waste and waste water can be accomplished with higher efficiency and with better quality of service than in rural areas.

Infrastructures do the trick

AEB Amsterdam

1 Tonne

Electricity
900 KWh

Heat
91 KWh

Iron
16 kg

Other metals
3 kg

Gypsum
4.5 kg

Construction material
209 kg

Waternet

Waste water

Clean water

Biogas

Heat

Electricity

District heating

- The denser the city, the more efficient heat distribution is.
- Using heat generated from waste, biogas, solar, and gas fired cogeneration units.
- Denmark: wind power peaks are used to generate heat in the district heating system. This allows the cogeneration plants to be shut down temporarily, thus reducing fossil fuel use.

Biogas

- Biogas harvested abundantly by farms
- To fuel co-generation plants
- Upgraded to green gas

Sonderborg, Denmark

- Objective: carbon neutral by 2029
  - Replacement of natural gas in district heating with geothermal, solar, biomass etc.
  - A new pipeline connecting all existing district heating networks.
  - Generating biogas from pig manure, organic waste and energy crops.
  - Generating power from biogas, wind and photovoltaic.
  - Installing photovoltaic cells and heat pumps in rural areas.

Energy saving

“The cheapest, most competitive, cleanest, and most secure form of energy for the European Union thus remains saved energy.” - Andris Piebalgs

Thank you for your attention!

Please post any questions you may have
on our discussion forum.

Urban infrastructure, part 2

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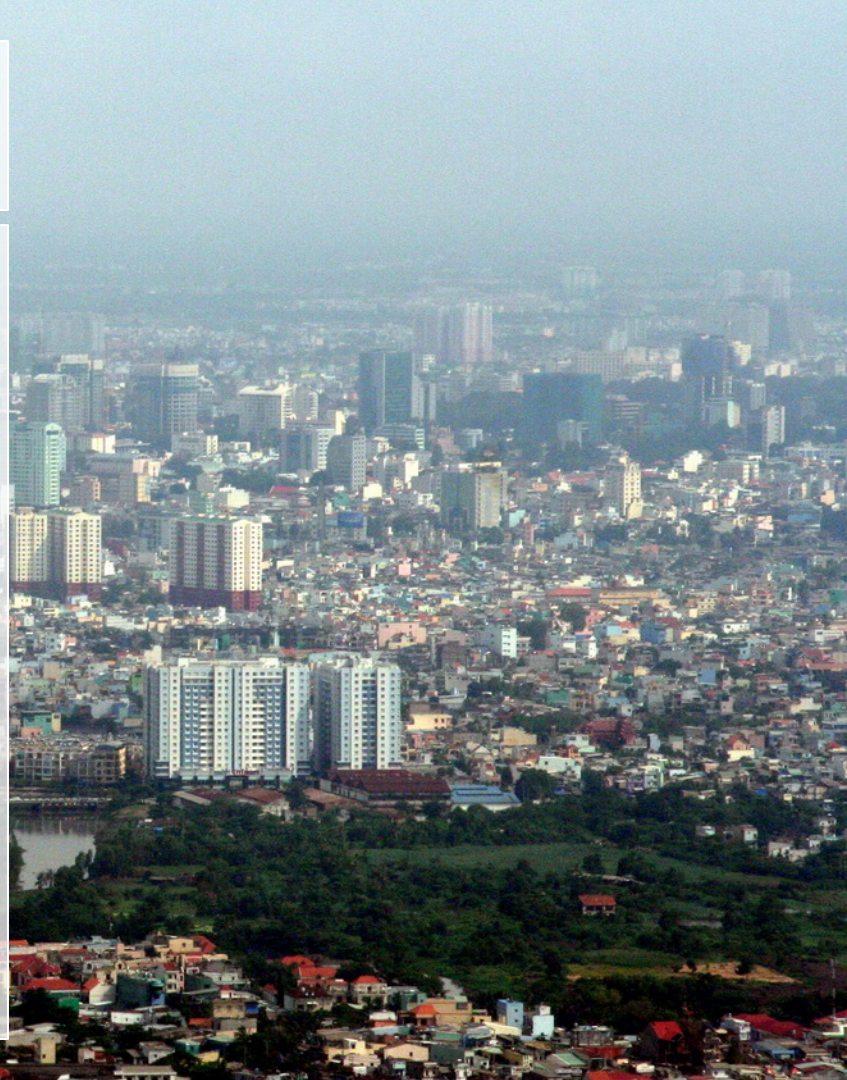
Megacities

- Can do a lot more towards:
  - Energy efficiency in transport
  - Quality of building
  - Supply of safe drinking water
  - Treatment of waste (water)
    - Public health
    - Local environment
    - Sources of secondary raw materials



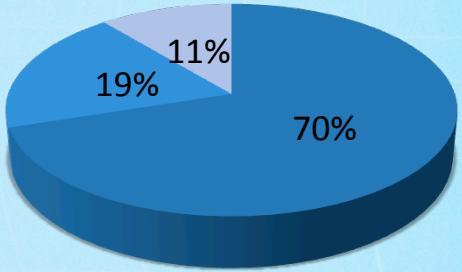
Fresh water use

1000 liter

11000 liter

10000 liter

The world's fresh water use

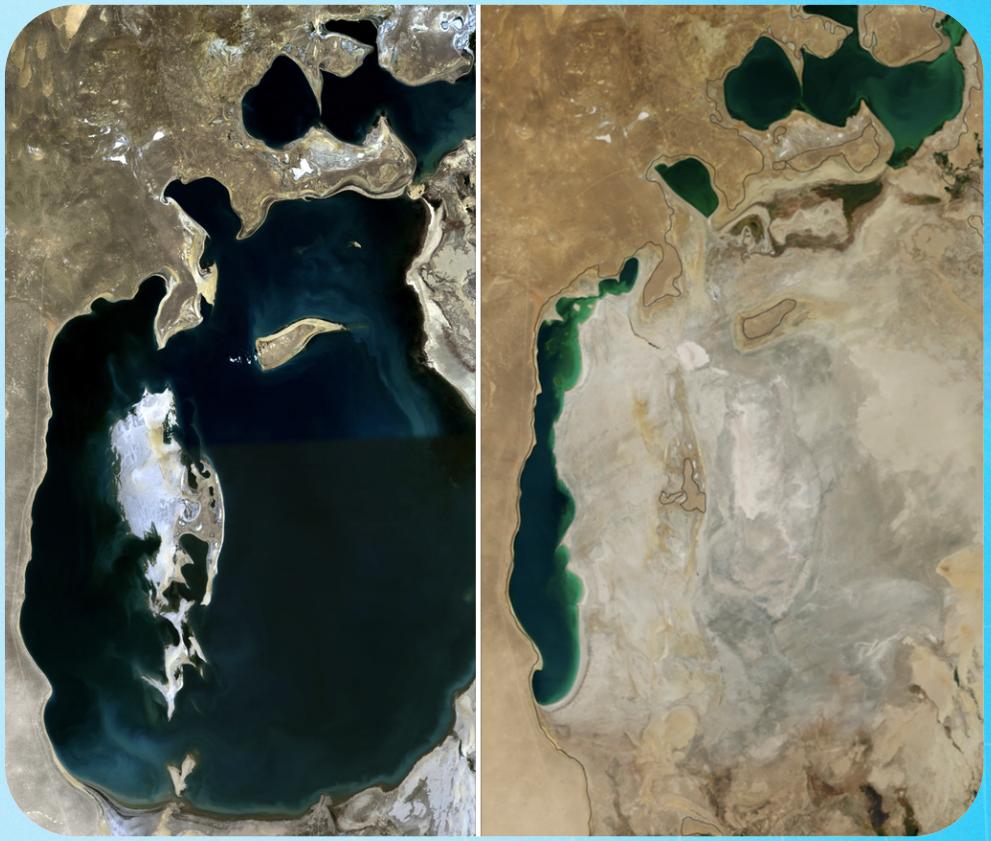


Agriculture

Industry

Domestic

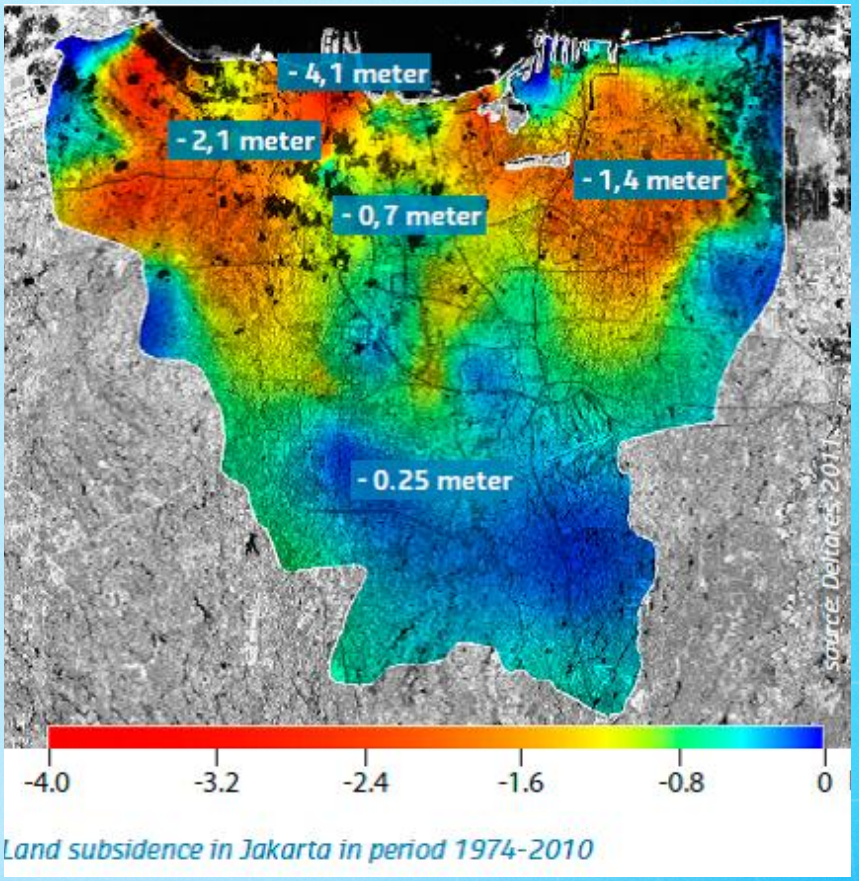
Aral Sea



1989

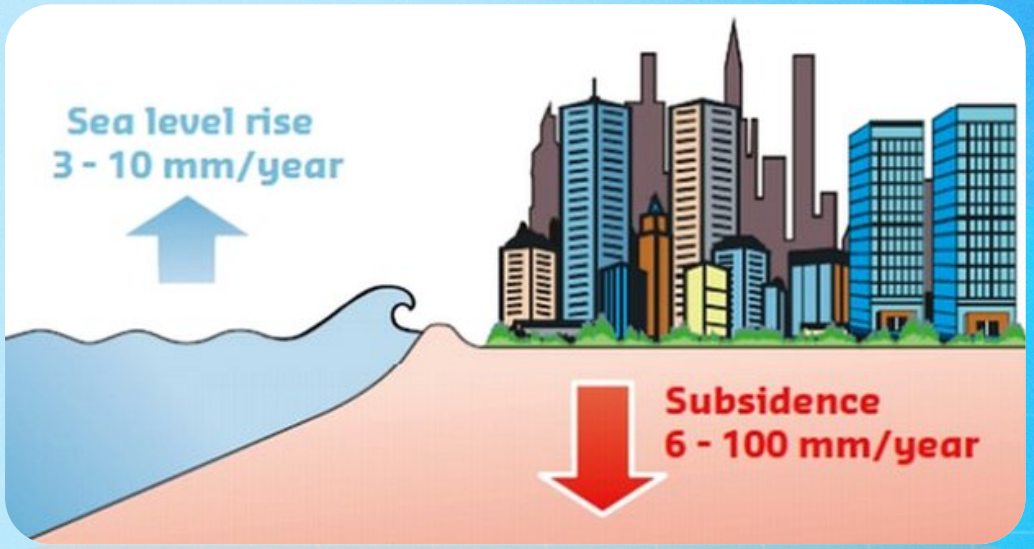
2014

Extraction of groundwater



Land subsidence in Jakarta in period 1974-2010

Land subsidence



Desalination

Azzizia desalination plant, Saudi Arabia

Water: a prime condition for life

City's water needs often conflict with the water needs of agriculture and local ecosystems.

Polluted surface water

Water retention

- Let water seep into the soil so that it will replenish groundwater
- Porous pavements
- Green parks and ponds
- Reduce salt water intrusion
- Ensuring eco-systems' fresh water supply

Challenge for cities

Meet the water demand with renewable internal freshwater resources.

- Raise people's awareness of freshwater scarcity
- Advocate frugal water use
- Costs should be covered by all users

Singapore


新生水 newWater
A PRODUCT OF PUB
Official Opening of Keppel Seghers Ulu Pandan NEWater
15 March 2007
newWater
A PRODUCT OF PUB
新生水 newWater
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Official Opening of Keppel Seghers Ulu Pandan NEWater
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newWater
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Hongkong

UN World Water Day 2014

- Focus on the water-energy nexus
- Energy depends on water

Global water use for energy

2010:

- Withdrawals 583 billion cubic metres (bcm), 15% of the world's total water withdrawals.
- Water consumption was 66 bcm.

2035:

- withdrawals increase by about 20%, but consumption rises by 85%!

Dependency on scarce materials

- Used in e.g. wind turbines, batteries, photovoltaic panels and fuel cells
- How to secure the future supply of these materials?
- No effective recycling systems!

The factor 8 question

‘Is it possible to imagine infrastructure systems that can meet the needs of twice today's population with half today's resources while providing twice the liveability?’

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