UNIVERSITY OF COPENHAGEN

City and water in local balance
– Experience from Beijing and Copenhagen

Li Liu, Postdoc. Landscape architect, PhD
Marina Bergen Jensen, Professor
IGN-Section for Landscape Architecture and Planning
University of Copenhagen
liu@ign.ku.dk; mbj@ign.ku.dk

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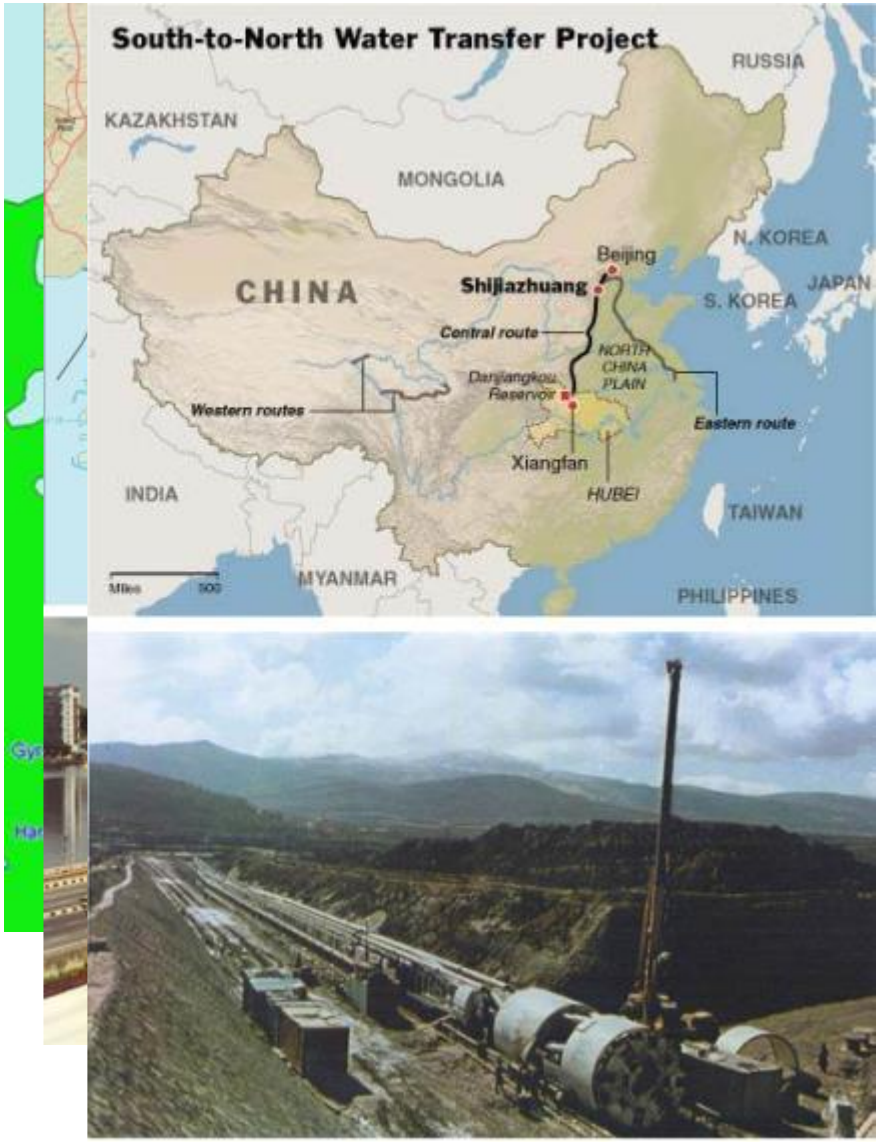
Urbanization – water stress



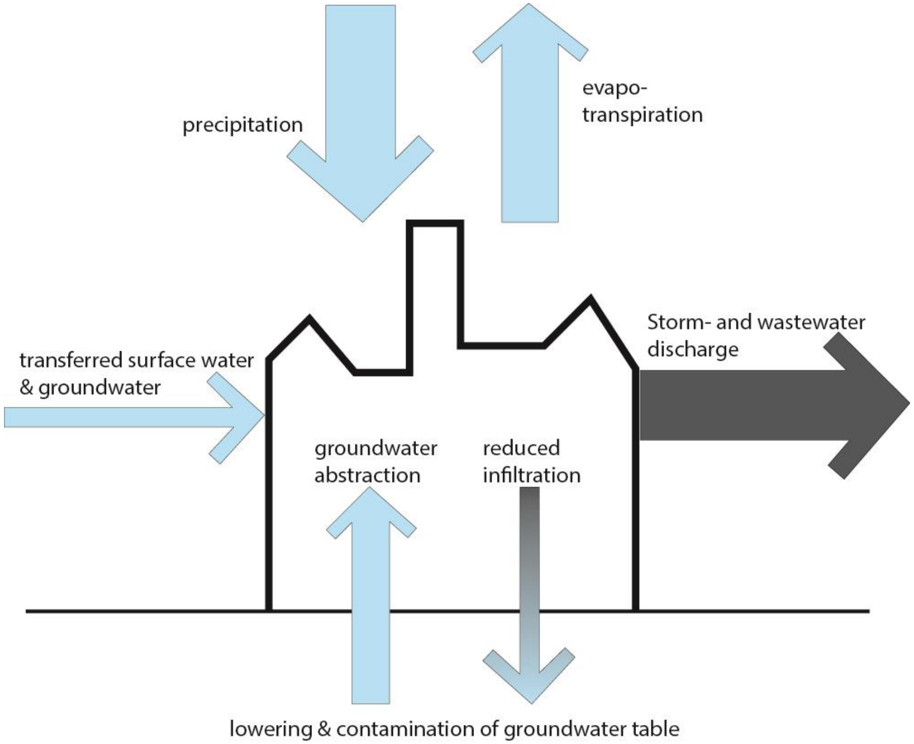
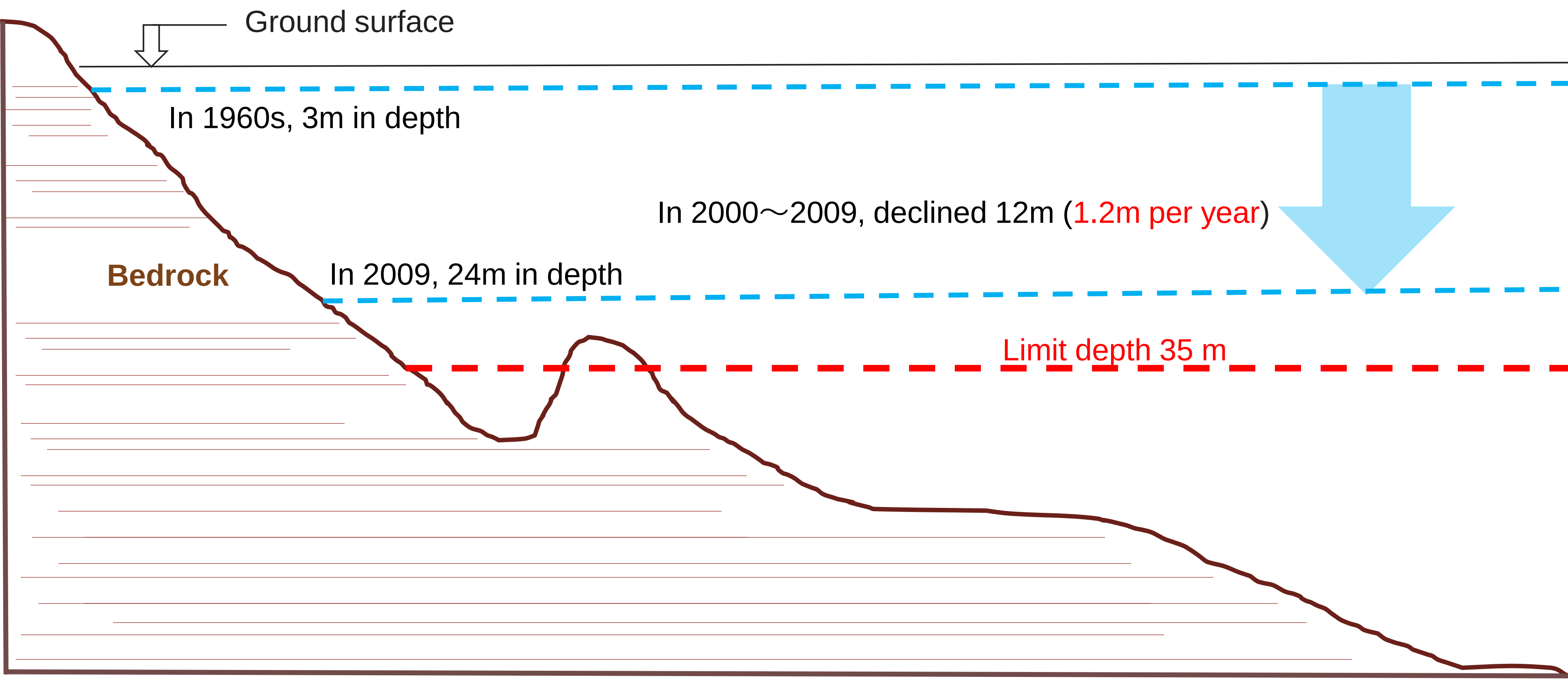


Figure 1 – Unbalanced urban water cycle

(Liu & Jensen, 2014)

Groundwater level - Beijing



(Based on Meng, Q.Y., 2014)

Flooding (water logging)

City & water in local balance (CWLB)

Close the urban water cycle locally – reduce the impact on the environment

Resilience – pluvial flooding avoided by controlled retention

Pure water – quality of water discharged comparable to that of the incoming water

Strong green infrastructure – linked with urban water management, providing multiple ecosystem services

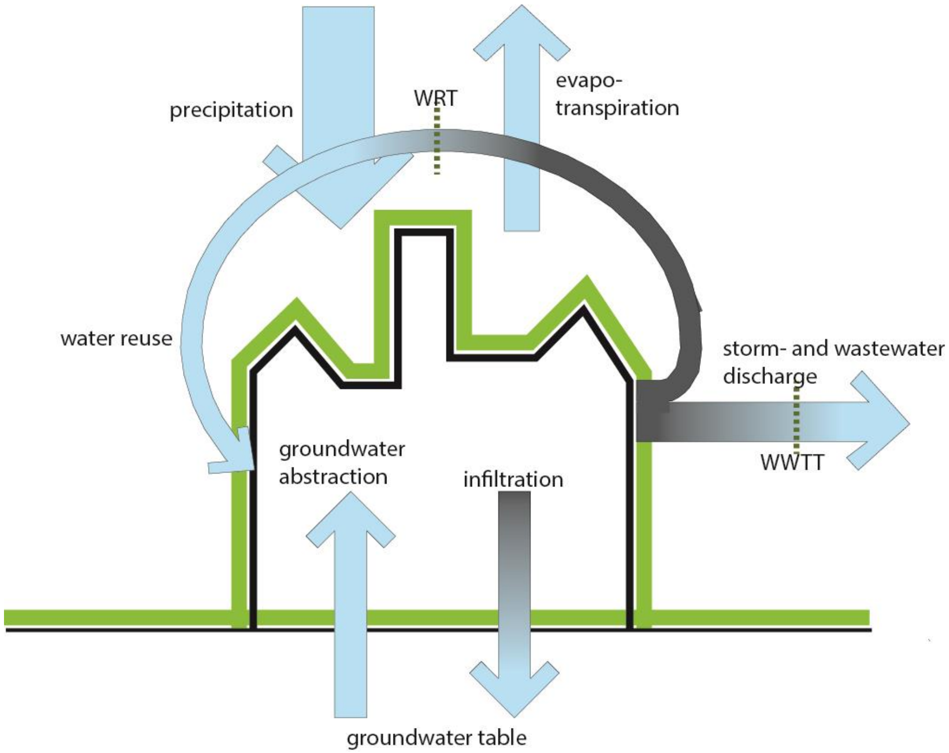


Figure 2 – City and water in local balance

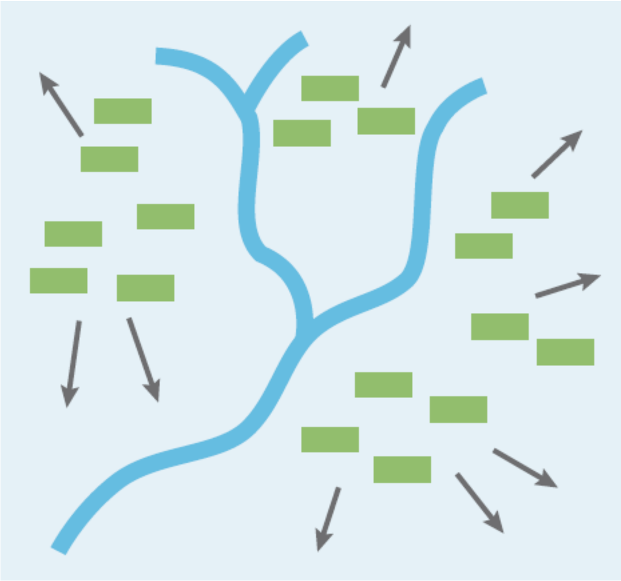
(Liu & Jensen, 2014)

Conventional approach: Make the sewers larger

Sewerbased adaptation
(hard & grey infrastructure)

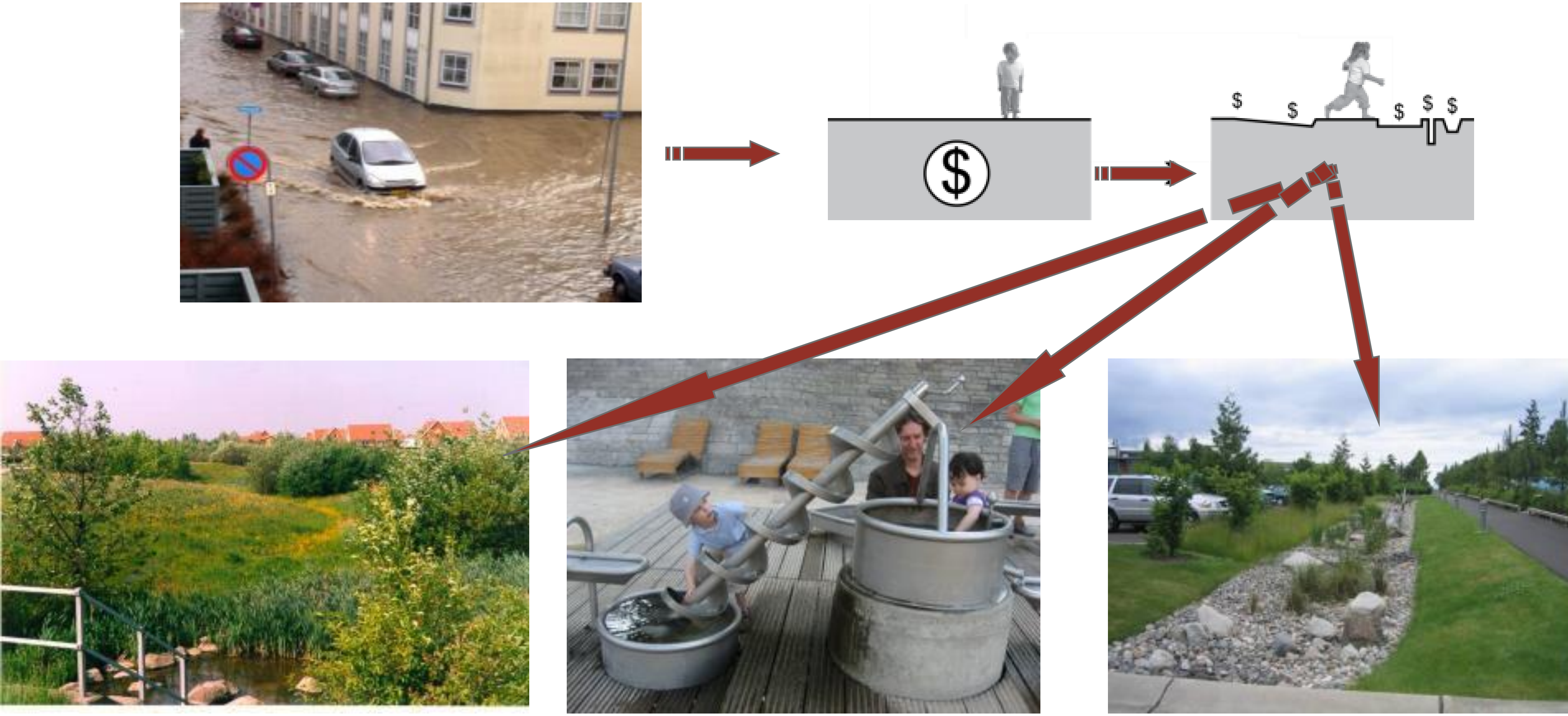
New approach: Remove stormwater from sewers

Landscape based adaptation
(soft & green infrastructure)



(Jensen, 2014)

Synergy – how to make more of the investment



(Jensen, 2014)

Method and cases

The distance to CWLB =

<u>Transferred water from beyond city limit + over exploitation of groundwater within city limit</u>

Total water supply

Cases:	**Beijing (2009)**	**Copenhagen (2003)**
Area (km^2)	16,410	89.6
Population (persons)	19,720,000	501,664
Population density (persons/km^2)	1202	5599

Major water flows

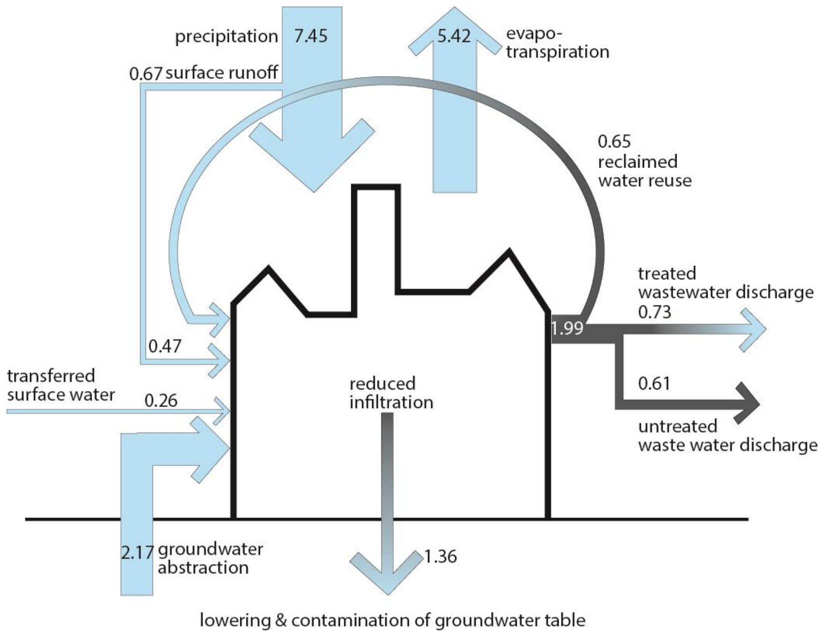


Figure 4 –Beijing 2009. Unit: 10^9 m^3 (adapted from Liu et al., 2014)

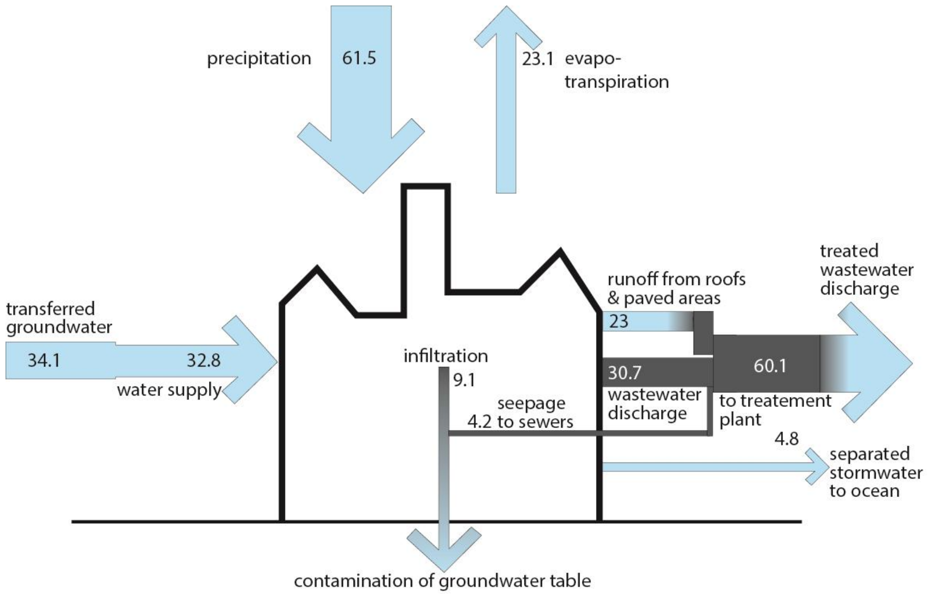


Figure 5 –Copenhagen 2003. Unit: 10^6 m^3 (adapted from Binning et al., 2006)

- Limited available local natural water resource, most precipitation lost by evapotranspiration
- Groundwater abstraction exceeds infiltration
- Some water reuse
- Severe discharge of untreated wastewater

- Significant amount of stormwater running to sewers, heavy load for wastewater treatment plant
- All water transferred from outside city
- Insignificant water reuse

CWLB – the related factors

The related factors

•Availability of local natural water resources (precipitation and river water)

•Water reuse ability

•Population density

•Water use efficiency (average water consumption per capita)

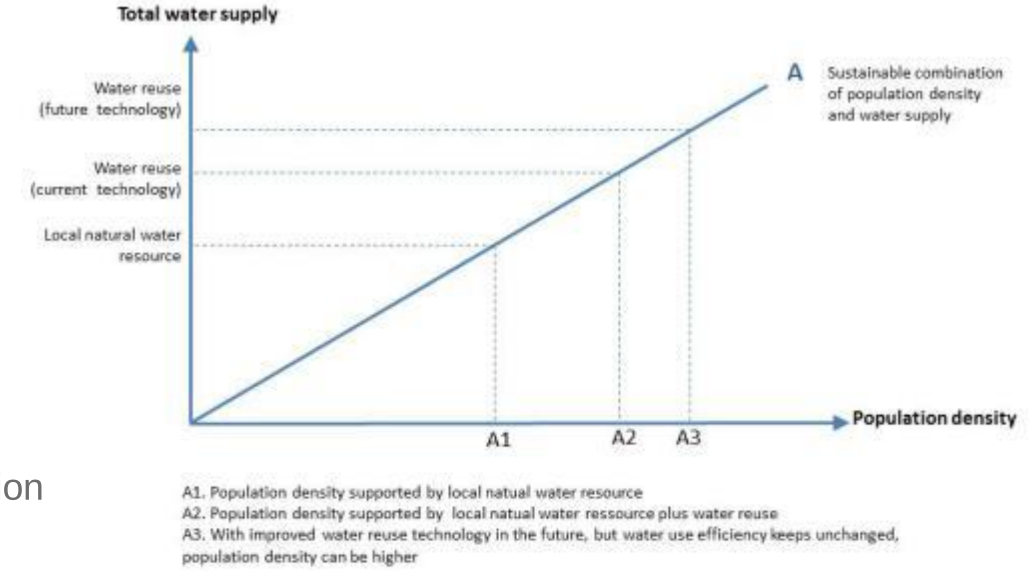


Figure 3 – Sustainable population density depends on water resources and reuse skills

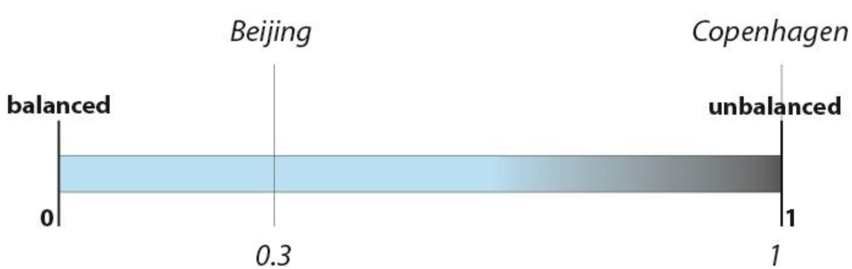
Maximum population density & the distance to CWLB

Table 1 - Maximum population density that natural water resources can support

	Beijing2009	Copenhagen2003	Beijing Scenario
Available local natural water resources*	2.03 (billion)	41.9 (million)	2.03 (billion)
Water consumption (m^3/person/year)	180	65.4	100**
Support population (million)	11.3	0.641	20.3
City area (km^2)	16410	89.6	16410
Support population density (persons/km^2)	**687**	**7150**	**1237**
Actual population density (persons/km^2)	1202	5599	

* Assumption: Available local water resource is formed by precipitation in case area deducting evapotranspiration.
** Average water consumption in European countries in the 1990s.

The distance to city & water in local balance



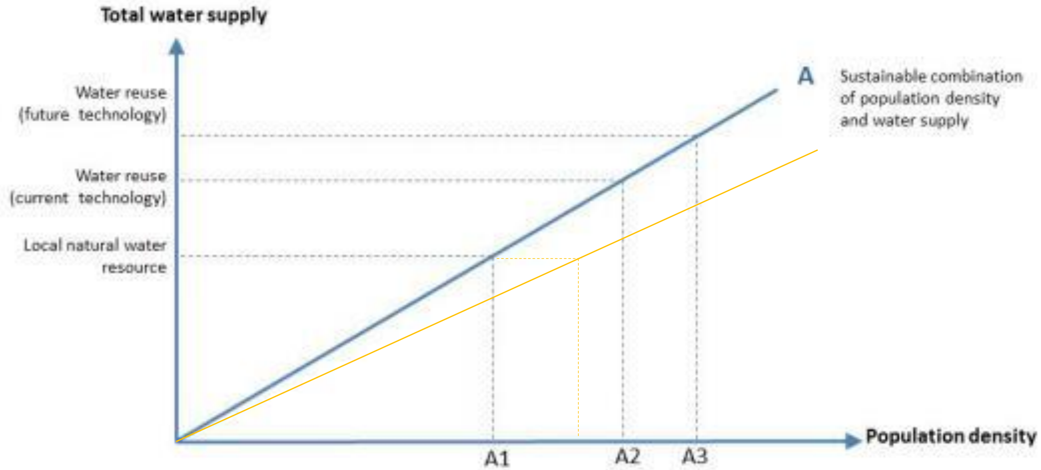
The distance to CWLB =

Transferred water from beyond city limit + over exploitation of groundwater within city limit
Total water supply

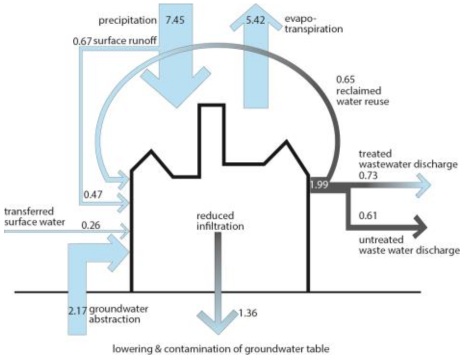
Figure 6 – The distance to CWLB, Beijing & Copenhagen

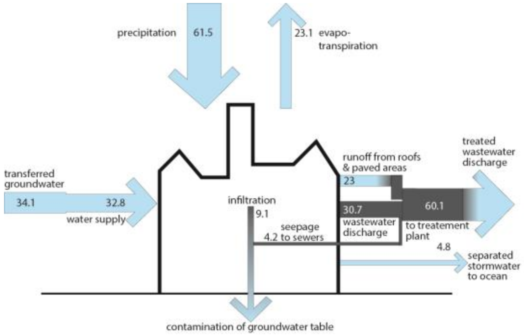
Discussion

- The size of a city
- People's behavior, technology and energy issue
- Data and scales of the two cities in comparison
- City form issues



A1. Population density supported by local natual water resource
A2. Population density supported by local natual water ressource plus water reuse
A3. With improved water reuse technology in the future, but water use efficiency keeps unchanged, population density can be higher





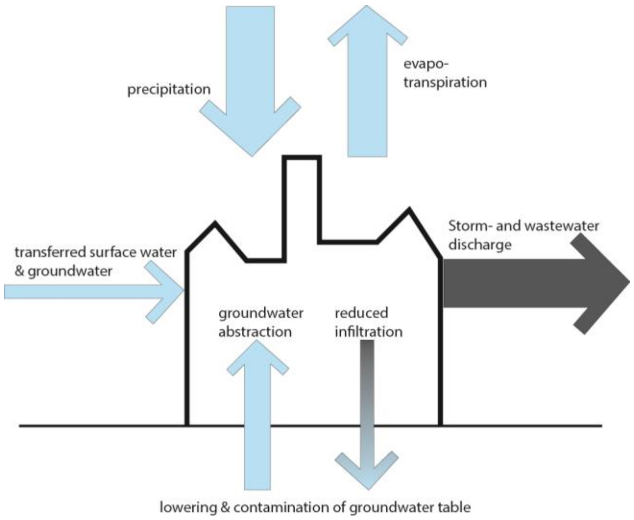
Prospect

To what extend green infrastructure can contribute to city and water in balance?

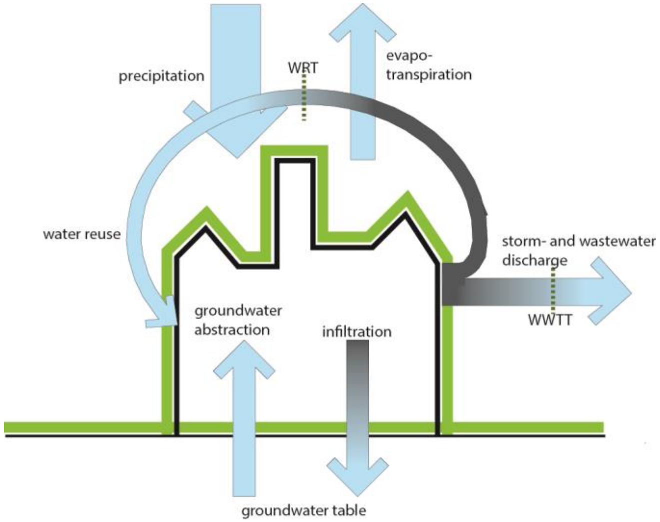
How can we as urban planners and landscape architects facilitate the transformation of a city from unbalanced urban water cycle to city and water in local balance?

- Close the urban water cycle locally
- Resilience
- Pure water
- Strong green infrastructure

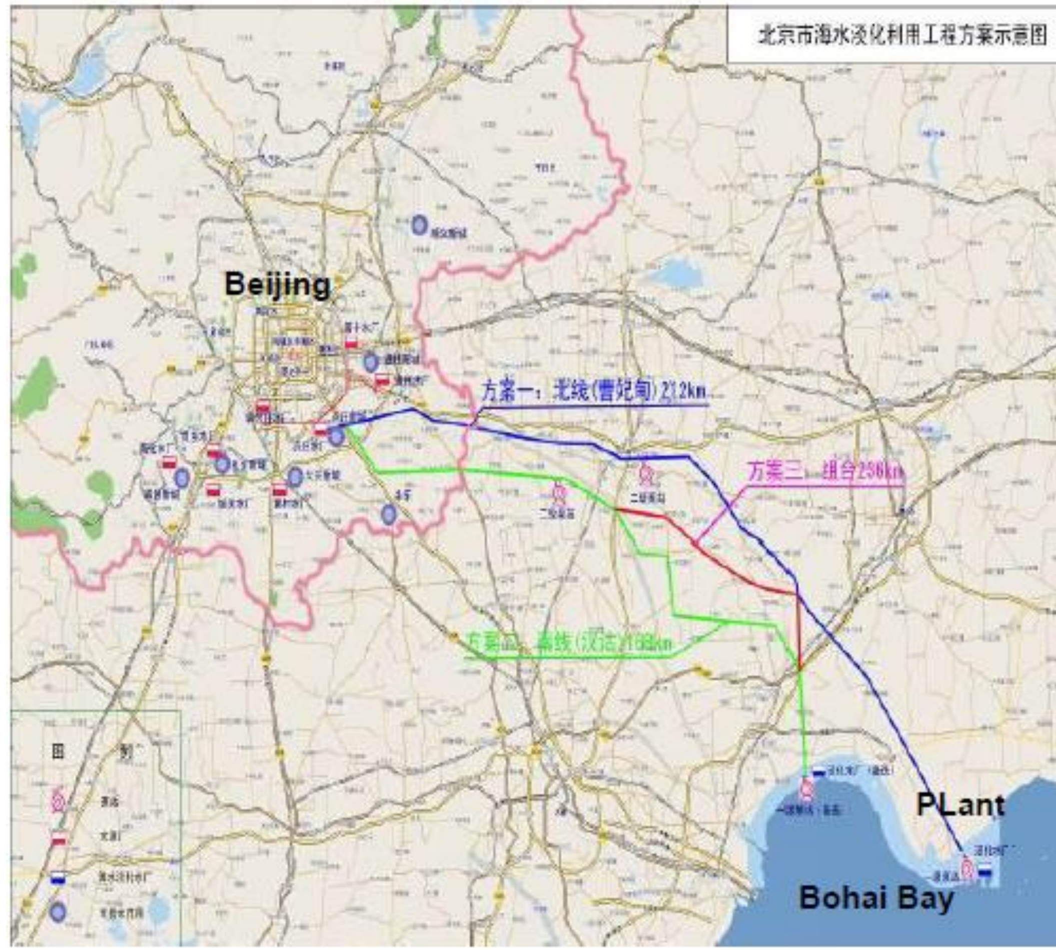
Unbalanced urban water cycle



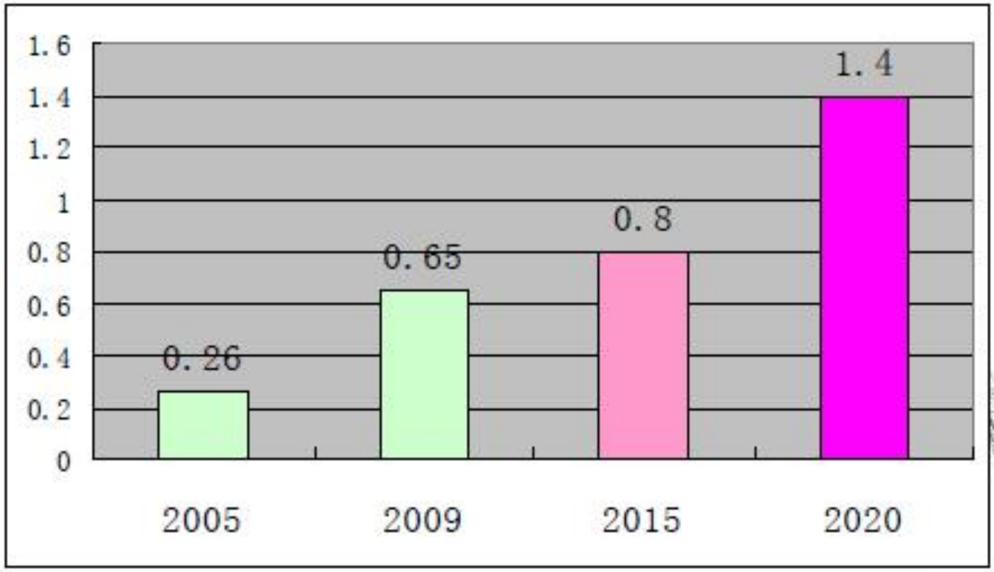
City and water in local balance



Distance water transfer & unconventional water resource

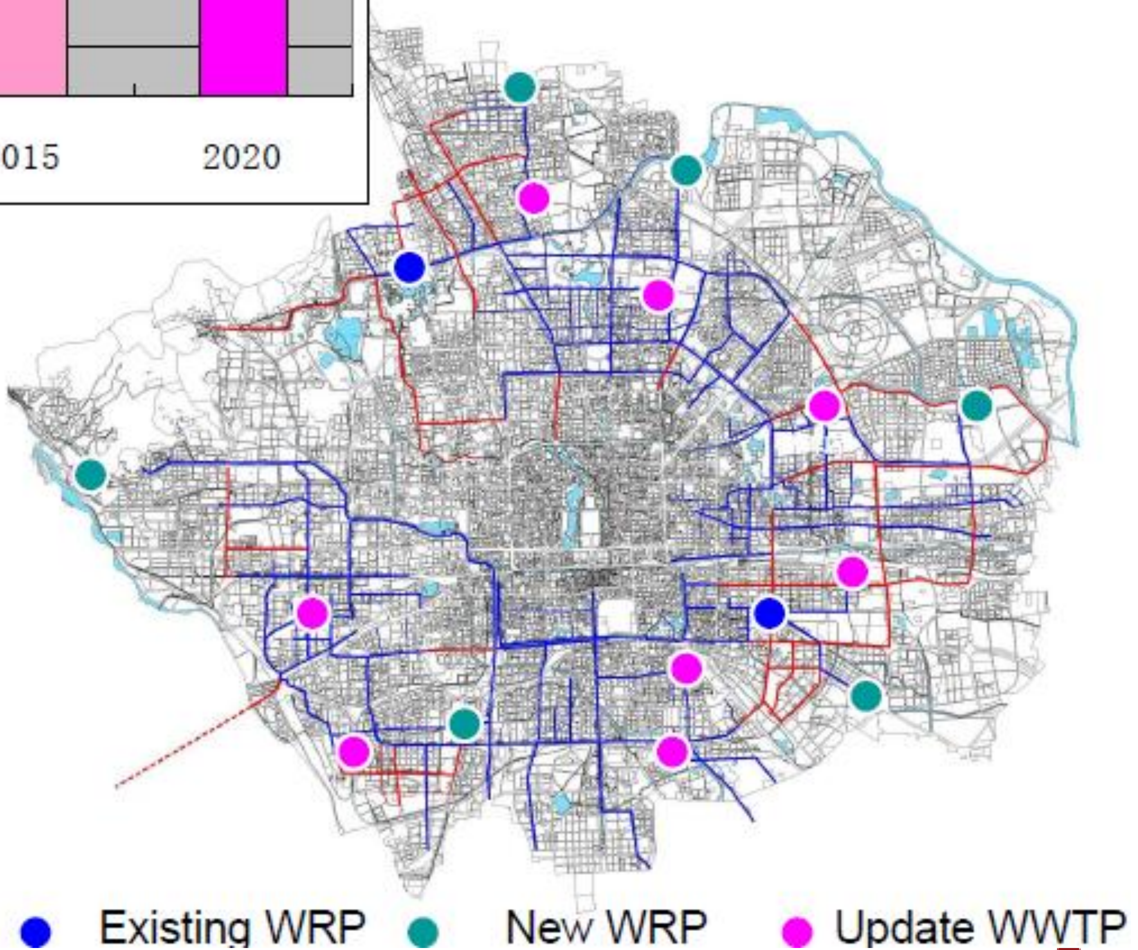


(Zhang, X.X., 2014)



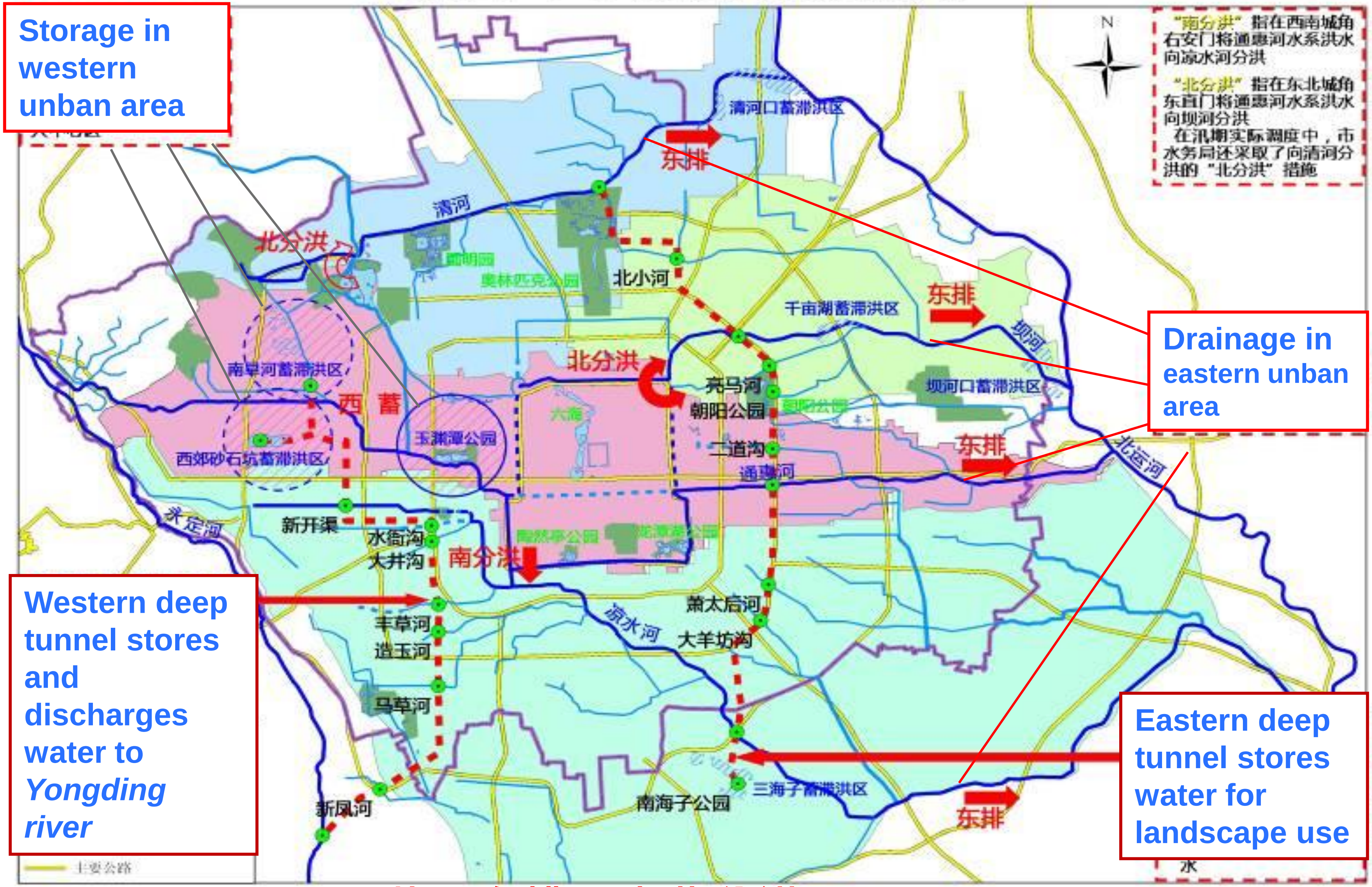
■ Increase Water Resource

- Preserve 2 existing Wastewater reclaimed plant
- Update 8 existing WWTP
- Set up 5 Wastewater reclaimed plant



(Zhang, X.X., 2014)

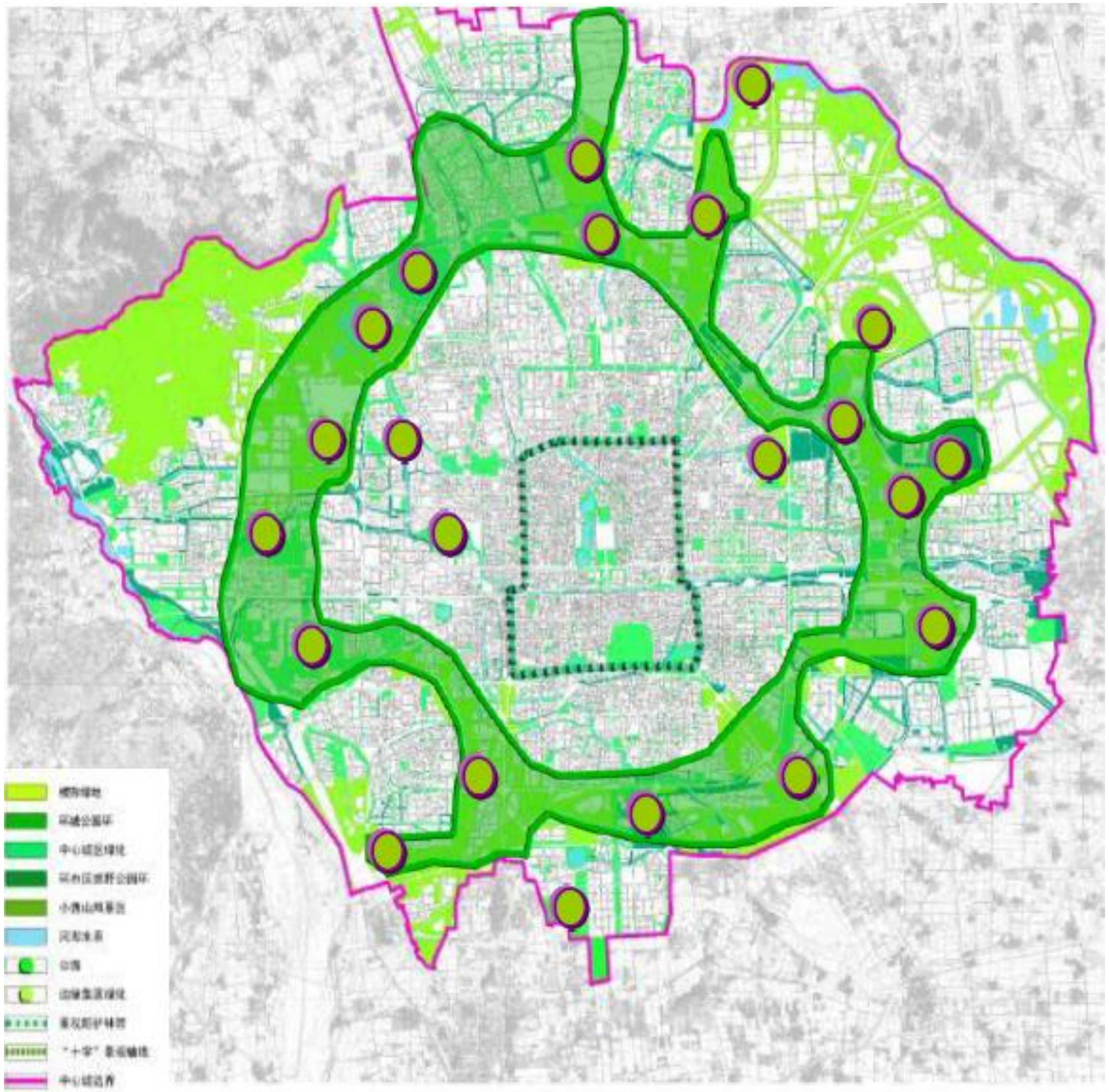
The Strategic layout of unban flood control and drainage



(Meng, Q.Y., 2014)

“西蓄、东排、南北分洪”

Plan for ”water smart use city”



Wetland

Storage ponds

filtration Pit

(Zhang, X.X., 2014)

Gravel Pit, Beijing – infiltration & retention basin

Copenhagen

- All drinking water are groundwater from surrounding regions
- Need simple treatment
- Groundwater table in some places decreased up to 10 m
- Only 2% water reuse (second water) in 2011, and planned to be 4% in2017
- Climate change brings further falling of groundwater table in the in-land regions

Climate Adaptation Plan 2011– 30% more precipitation

Methods:

1. Larger sewers, underground basins and pumping stations;

2. Manage rainwater locally instead of guiding it into the sewers;

3. Flooding takes place only where it does least damage – a “plan b”.

Copenhagen Cloudburst Plan 2012

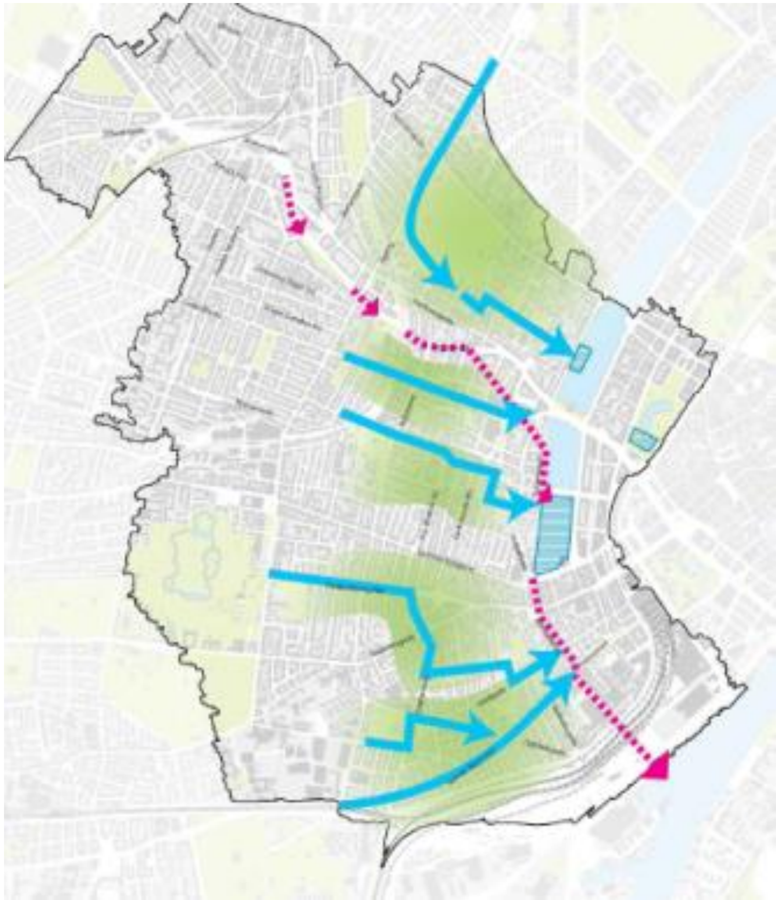
Methods:

1.Service level 10 years retain period; Retrofitting city to hold 10cm flood for 100 years rain.

2.Efficient storage capacity and water ways, e.g. open channels on streets, retention reservoirs in parks.

3.Inner city – large pipes underground draining water to ocean

4.For small rainfalls, keeping rainwater in the city for multifunctional uses



(Rambøll, 2014)

Implementation

- Cloudburst Implementation Plan - for the next 20 years.
- 300 projects in 7 catchment areas. Political decision - Spring 2015.
- Prioritize areas: with high flooding risk, with easy implementation, with ongoing construction & with synergetic effects.
- Stakeholders: The property owners, the utility companies & the city Administration, because 1/3 of the areas are in private common road areas. Budget to make partnership in 2015.

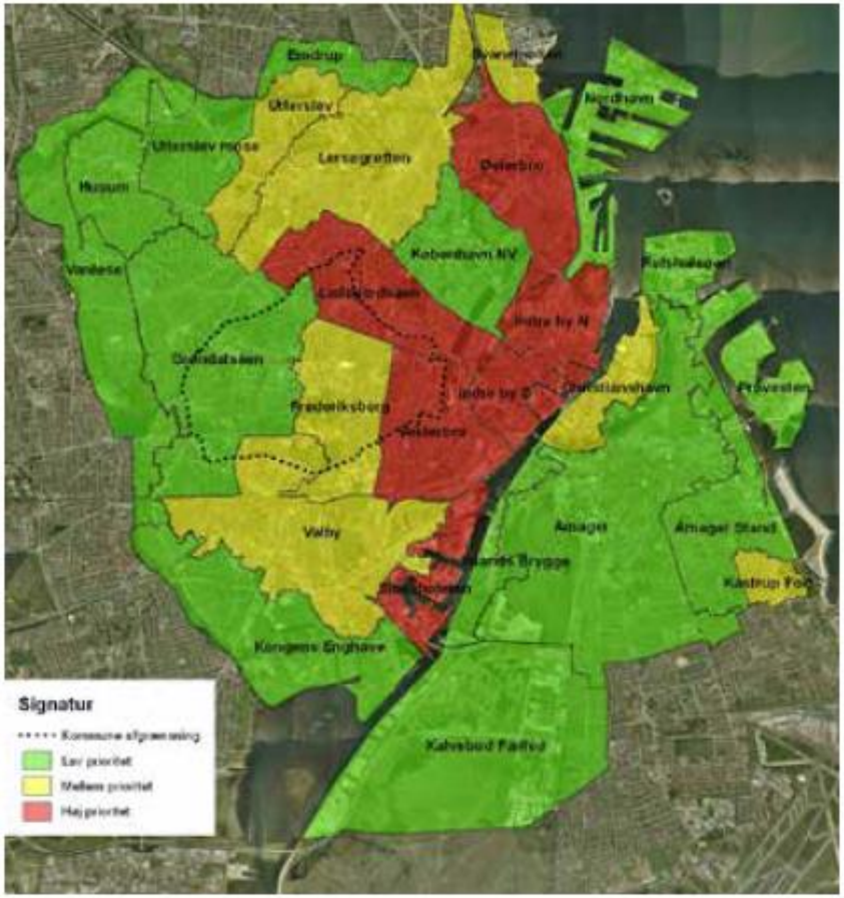


FIGURE 3 // PRIORITISING ADAPTIVE MEASURES
The map shows the priority of measures in the water catchment areas of Copenhagen – at three levels according to risk, implementation, and synergistic effect with urban planning and development projects.

SDC Sino-Danish Center

Thank you!

Contect:

Dr. Li Liu
Department for Geosciences and Natural Resource Management
University of Copenhagen

Email: liu@ign.ku.dk