



Sustainable urban water management in developing region

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Development and environment

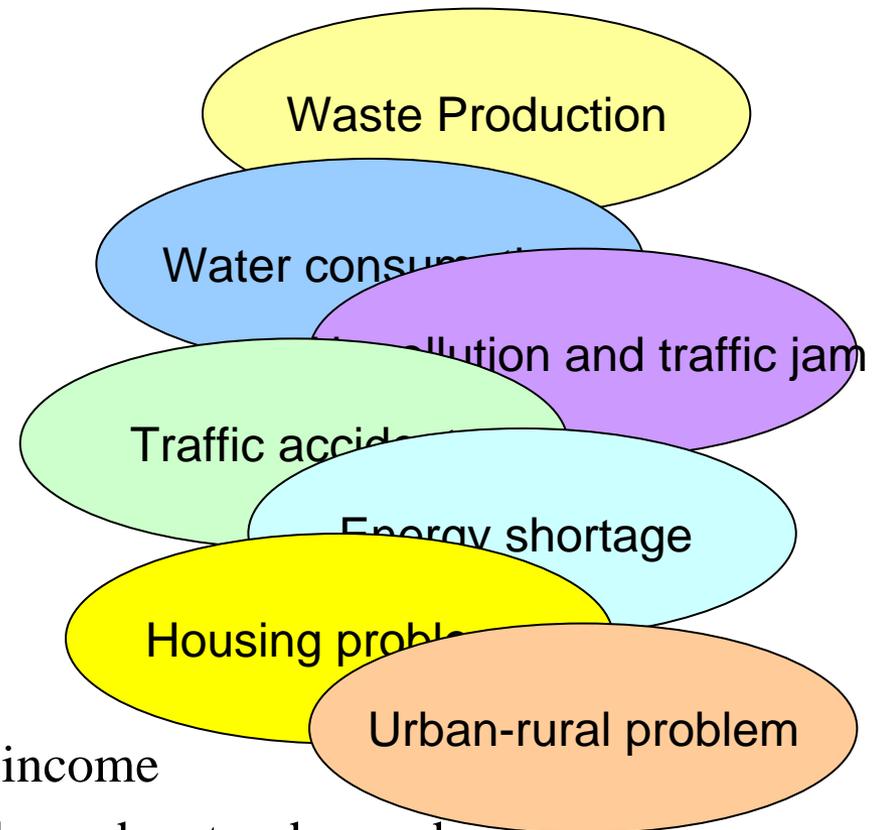
■ Economical development

– Income increase

- High energy consumption
- High material consumption
- Lifestyle change
- Diet change
- Etc

– Urbanization

- High-rise buildings
- Heavy traffic and highway
- Dense population
- Good job market and higher income
- Large energy, material, goods, and water demand



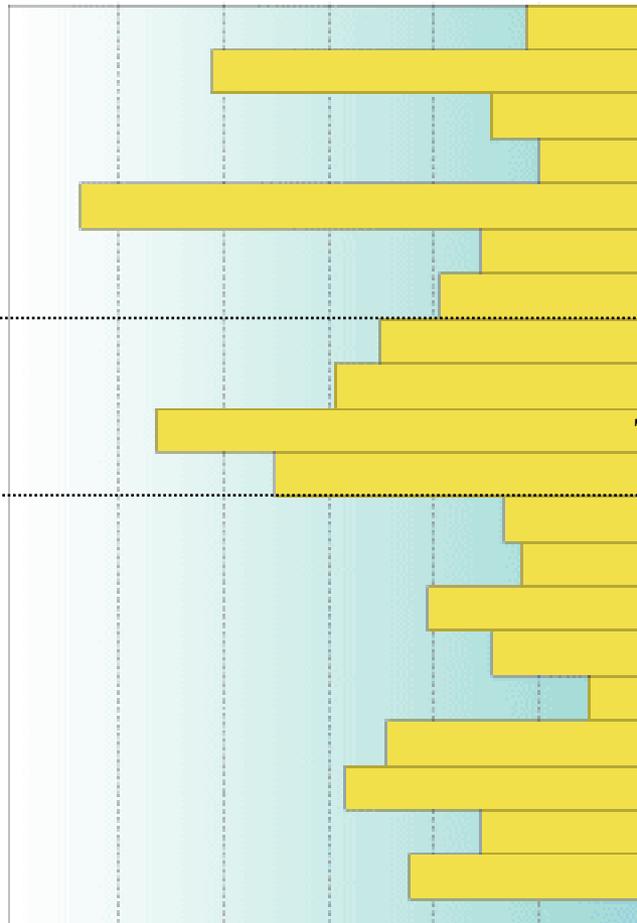
Urban water problems in developing regions

- **Rapid development of urban area**
 - Increase commercial water use
- **Increase of population**
 - Increase domestic water use
- **Change of lifestyle**
 - Increase domestic water use per capita (300 liter/p)
- **Inadequate wastewater treatment**
 - Deterioration of water environment
- **Small amount of water recharge to groundwater**
 - Urban inundation and groundwater table decrease
- **Overuse of groundwater**
 - Groundwater table decrease and ground subsidence
- **Stealing water and illegal use of water**

Annual rainfall and water availability

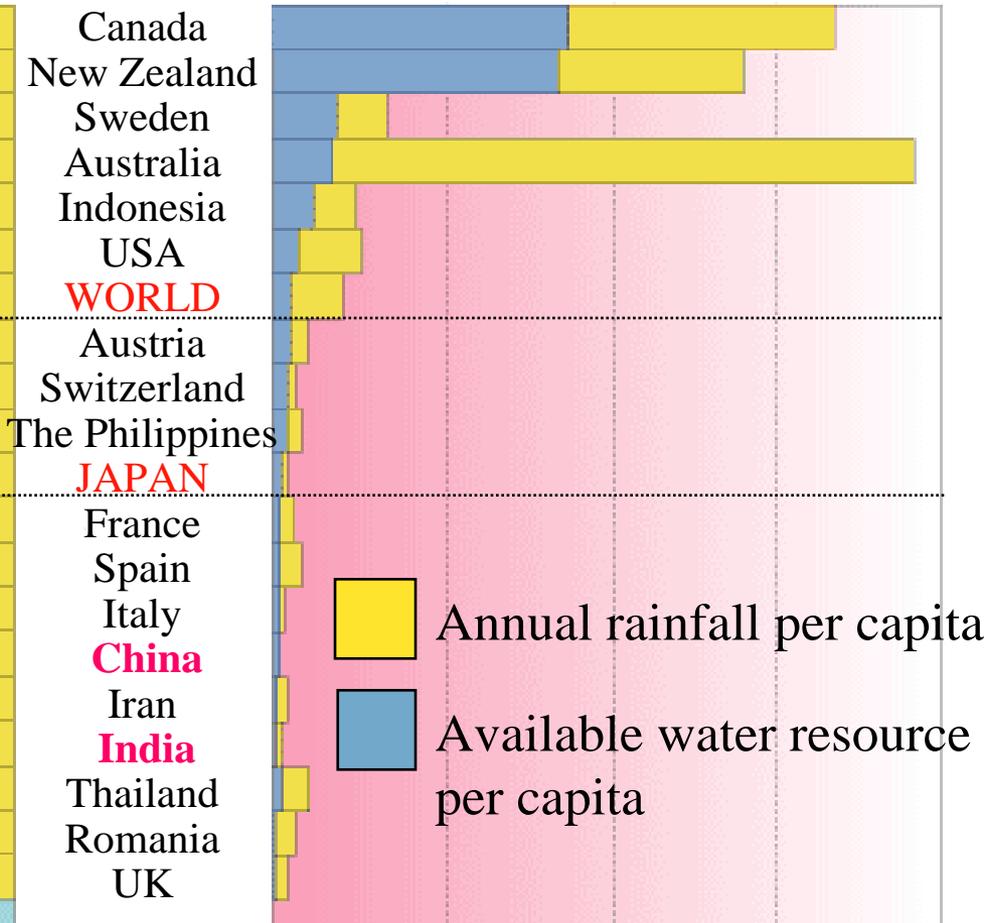
Annual rainfall (mm year⁻¹)

3,000 2,500 2,000 1,500 1,000 500 0

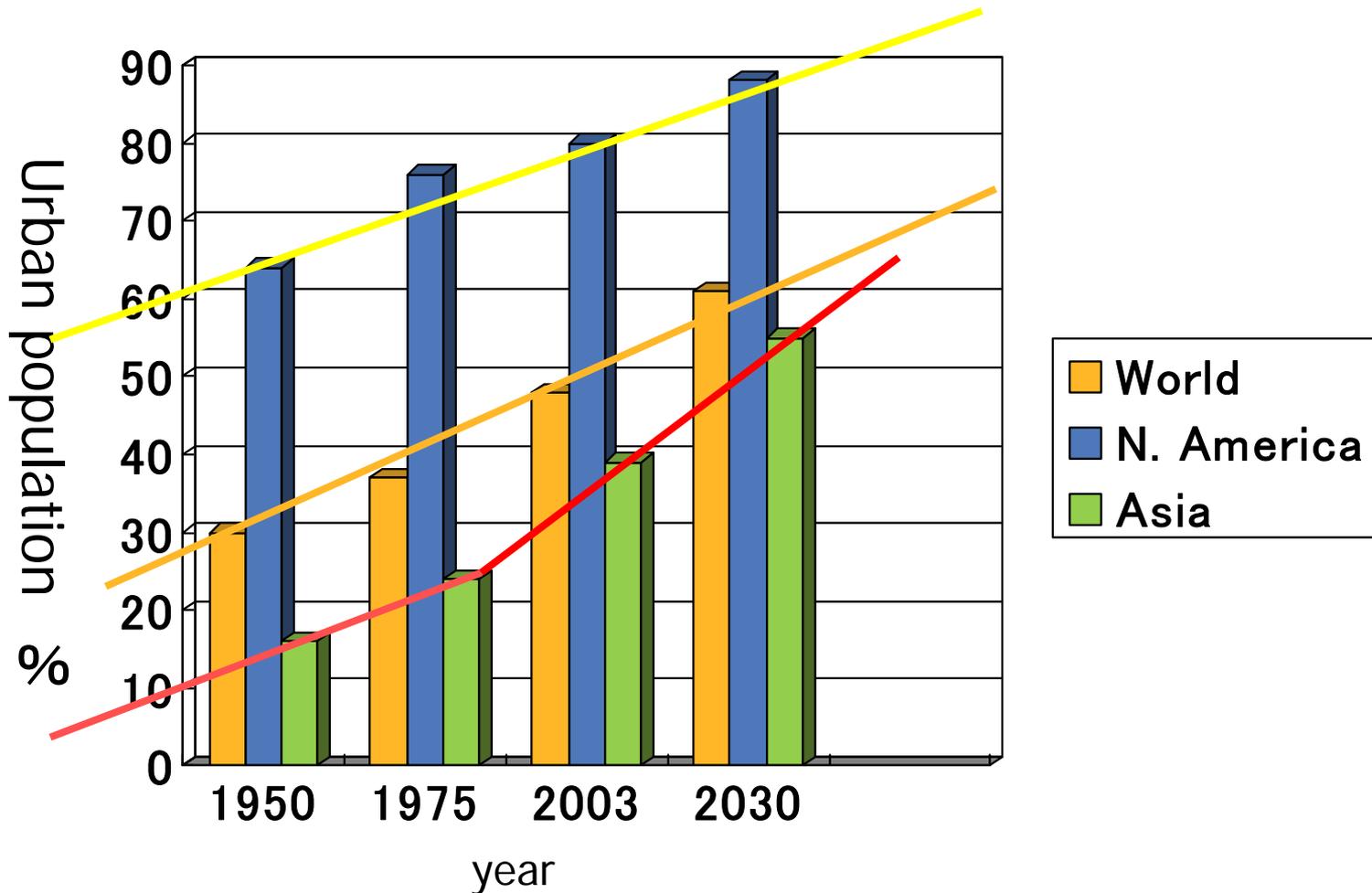


per capita (m³ year⁻¹ capita⁻¹)

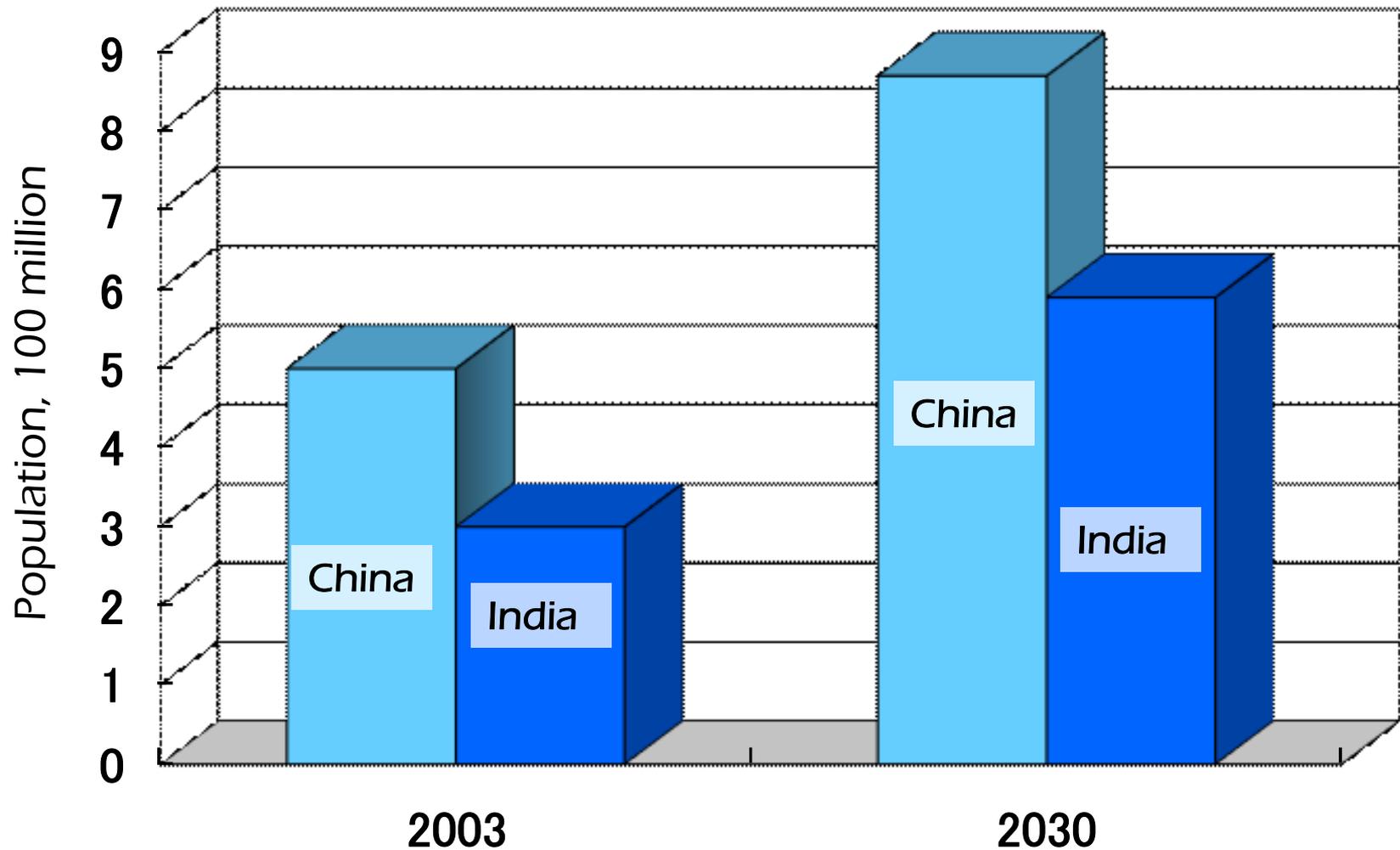
0 50,000 100,000 150,000 200,000



Increase of urban population



Urban population increase

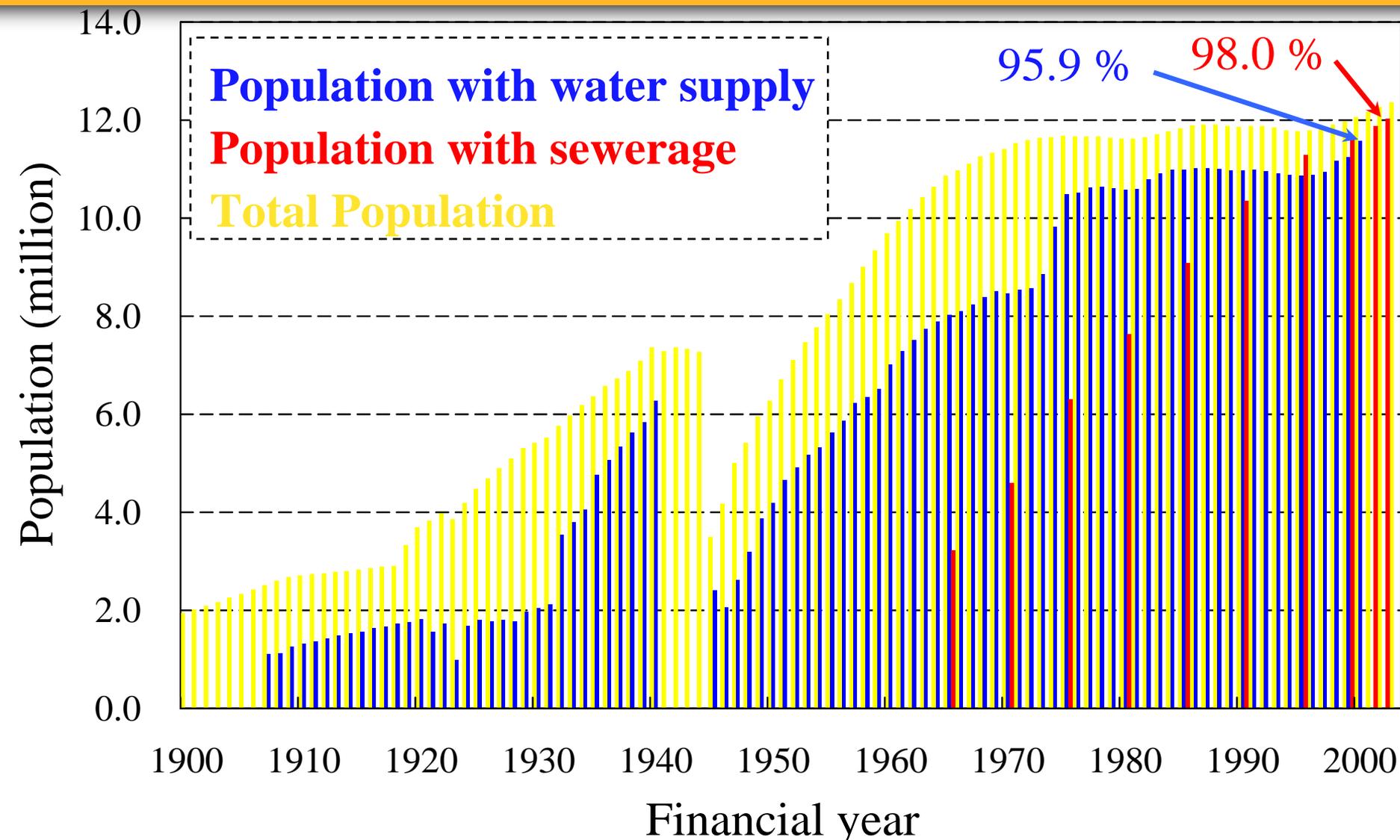




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Water management in Tokyo

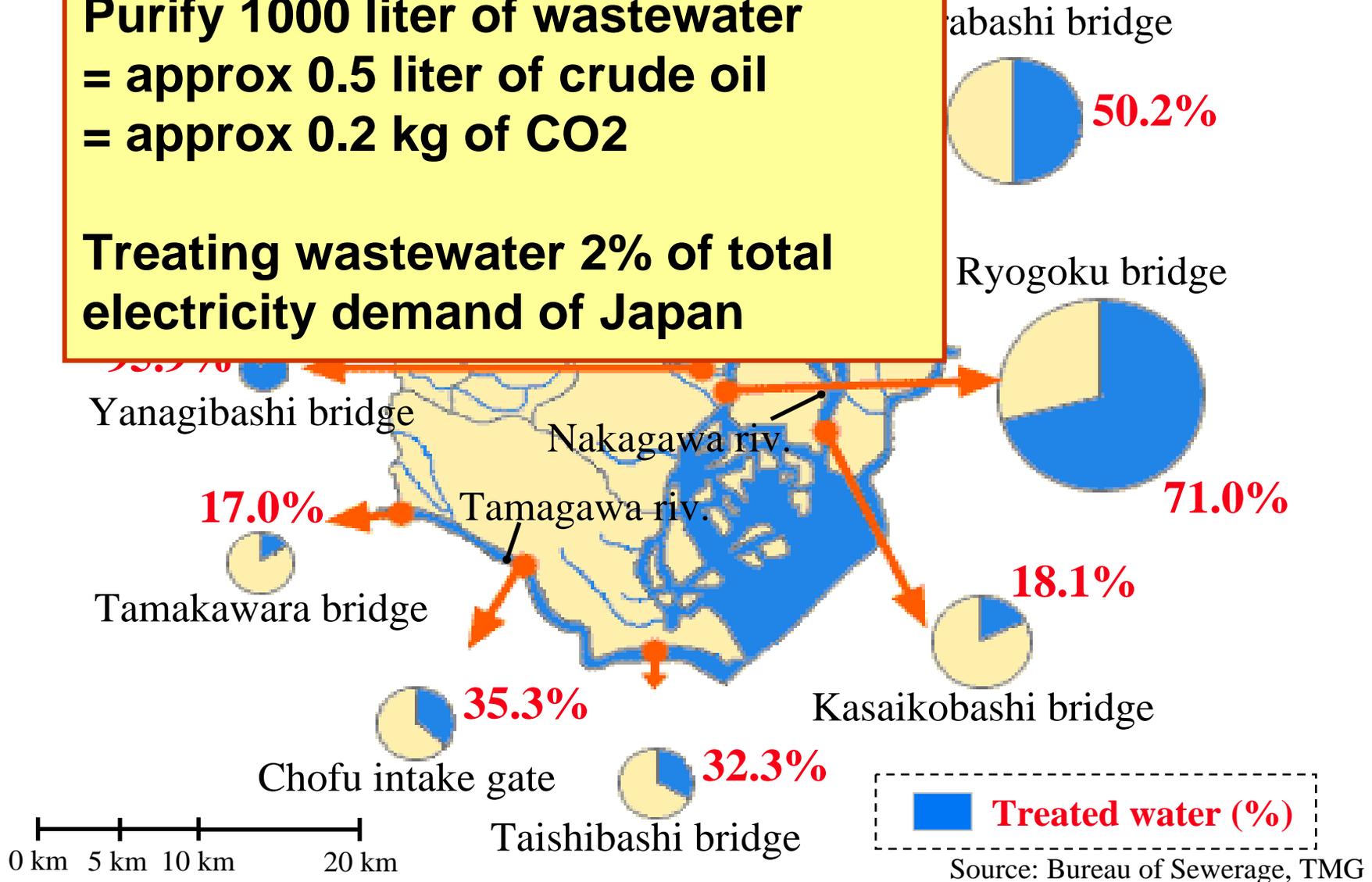
Population with water supply/sewerage in Tokyo



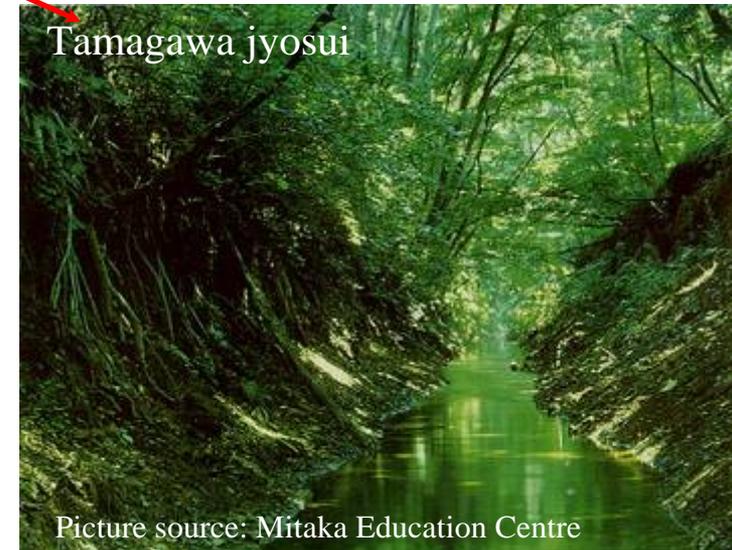
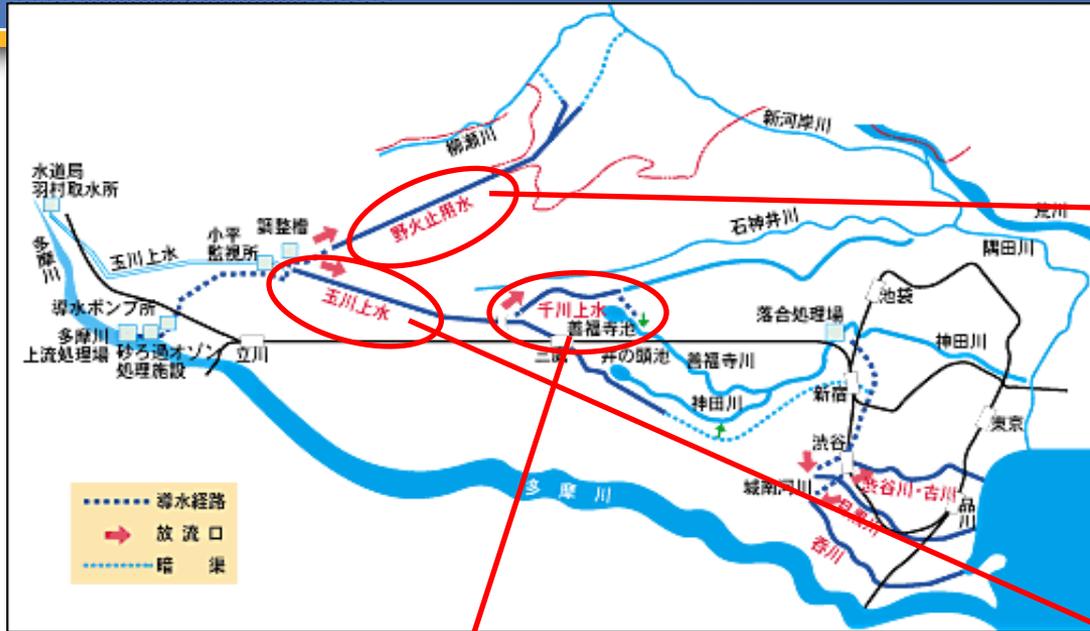
Large share of treated water in rivers

**Purify 1000 liter of wastewater
= approx 0.5 liter of crude oil
= approx 0.2 kg of CO2**

**Treating wastewater 2% of total
electricity demand of Japan**



Restoration of natural ecosystems and aquatic amenity



Water environment in Tokyo



Ochanomizu station



Kandagawa riv.

Picture source: Tokyo Canal Project



Sumidagawa riv.

Picture source: Tokyo Canal Project



Nihonbashi

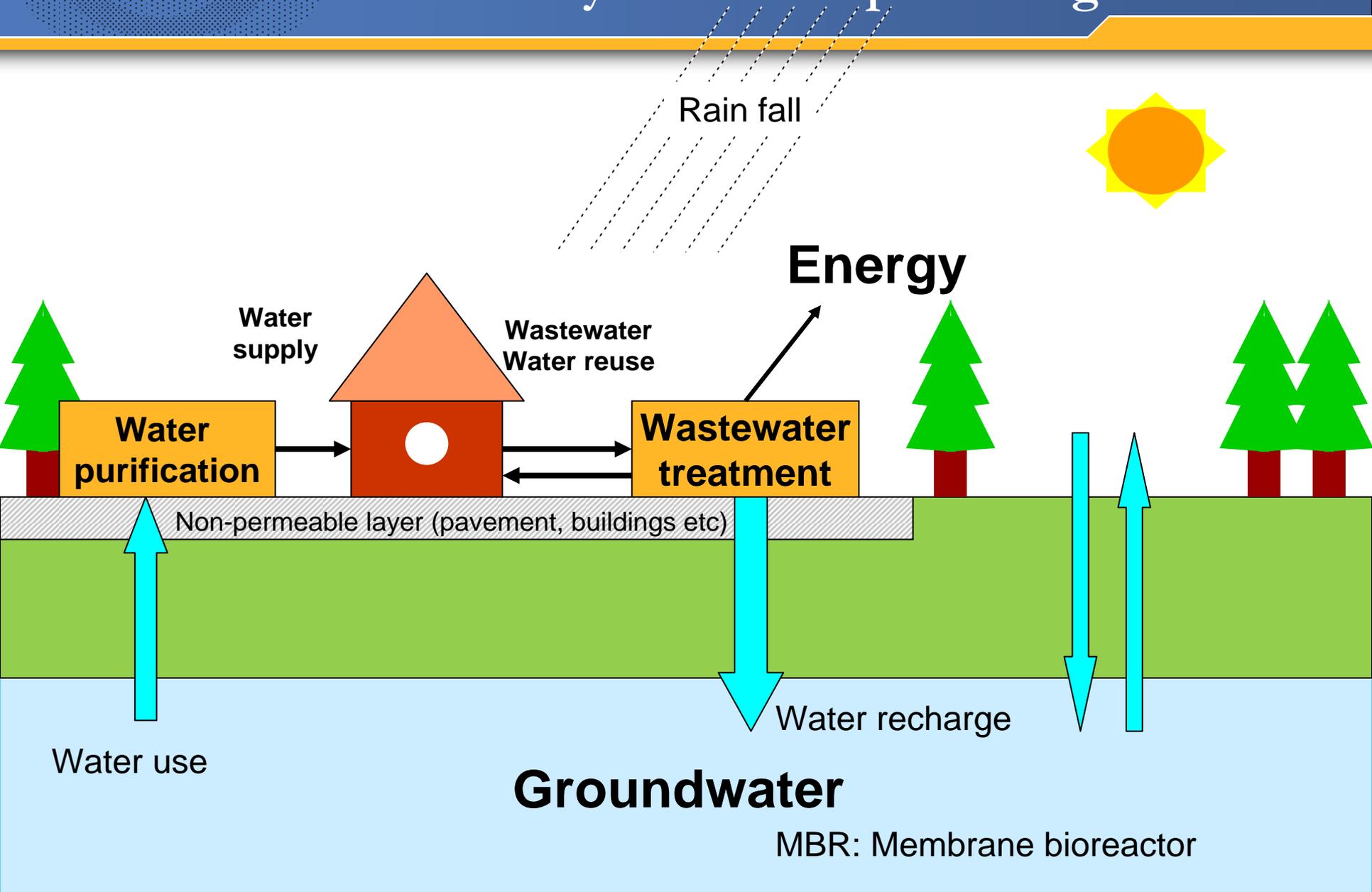
Picture source: Tokyo Canal Project

Centralized water management system

- “Developed countries apply energy-intensive technologies to keep urban water environment clean, however, such approach may not be appropriate for sustainable water environment management ” (modified from Wagner, Ohgaki and Zehnder et al. in Ambio)
- “Design, approval of the planning and the lay out of the piping and sewer networks is time consuming and swallows about 80% of the total investment costs”. (Peter Wilderer)
- “Estimating the cost of worldwide implementation of centralized system, it become evident that the capacity of global money market would not be sufficient to cover the need for investment capital”. (Peter Wilderer)
- However, in old time, the centralized system is the only choice since treatment technology was not available in small scale

Proposal of decentralize water management system

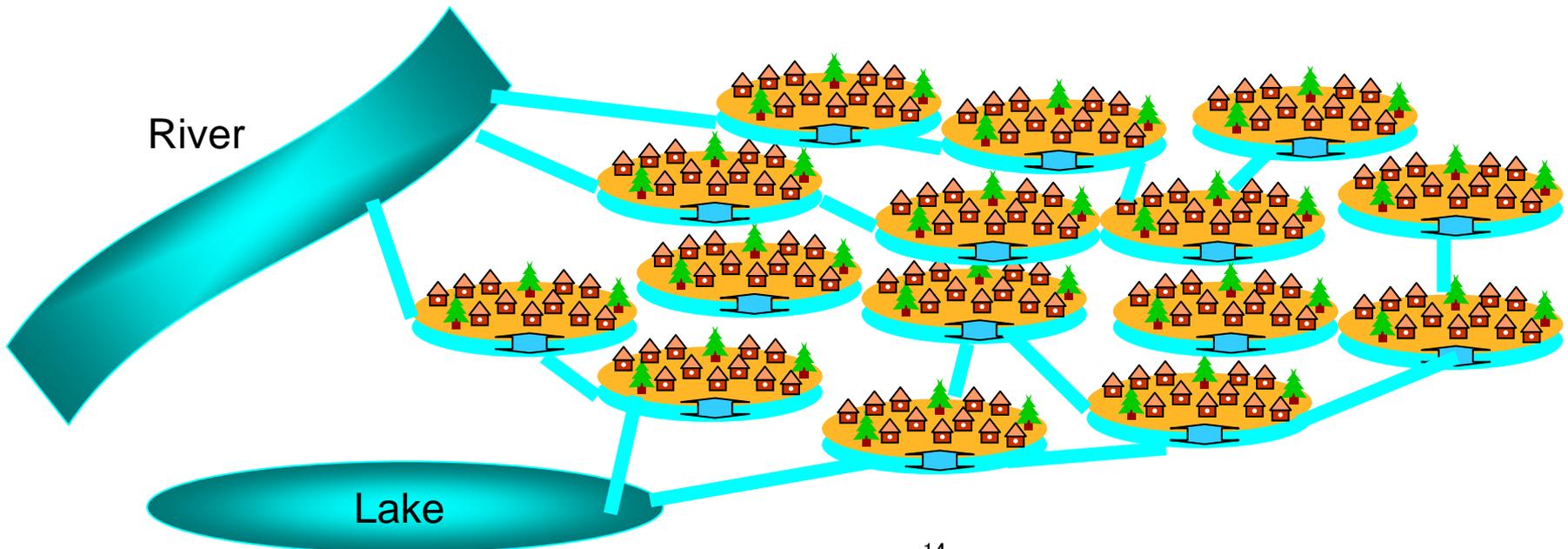
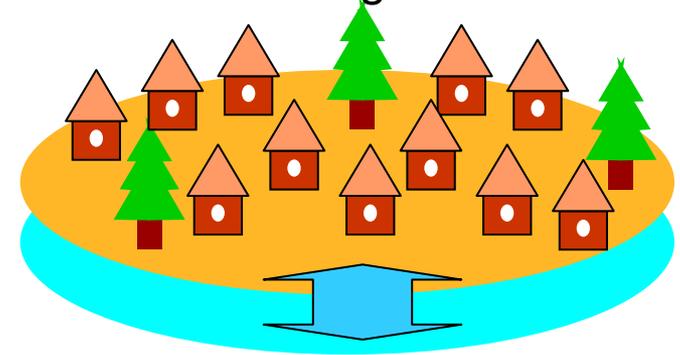
Decentralized water system: example of single unit



Decentralized water management: urban area

- **Community-based management**
- **Groundwater as stock**
- **Durable for various risks**

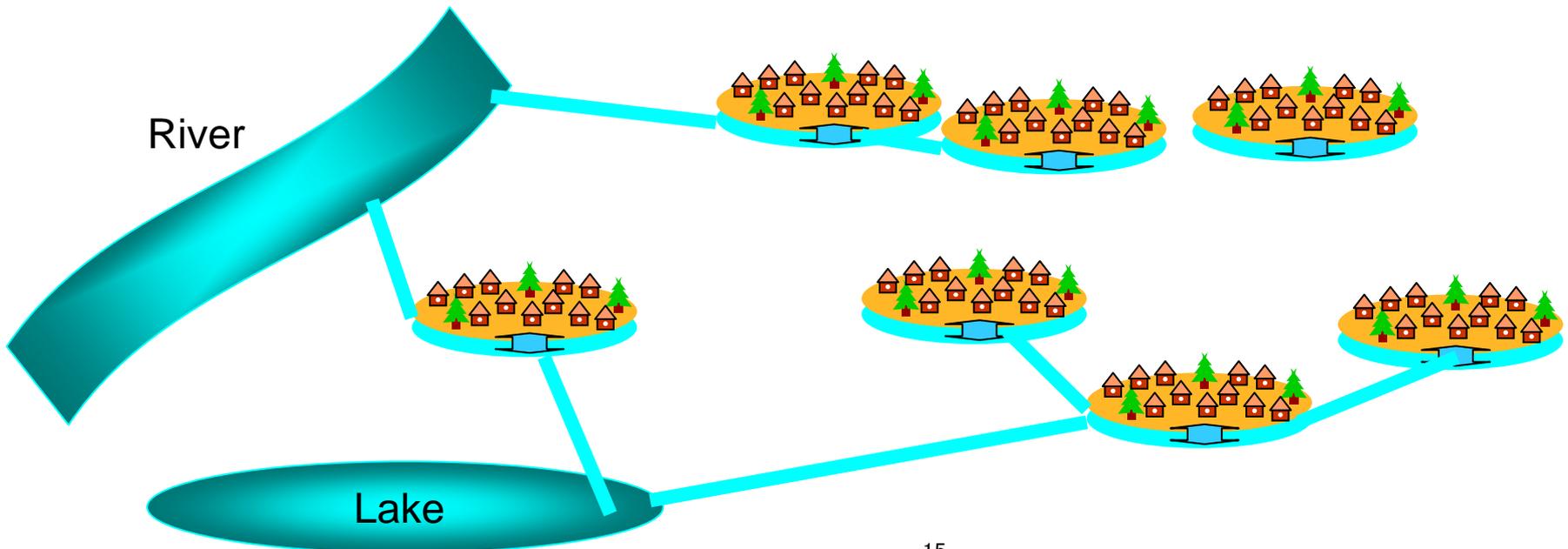
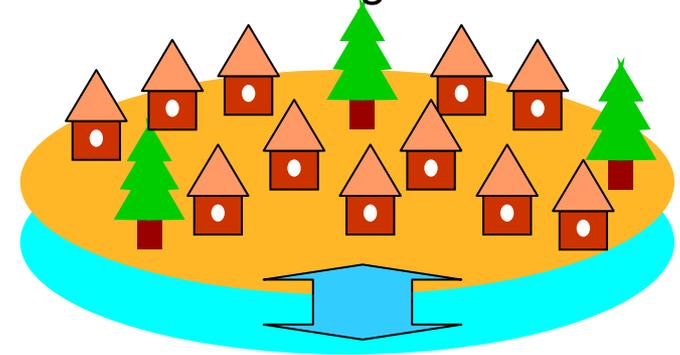
Water Management Unit



Decentralized water management: urban area

- **Community-based management**
- **Fast development**

Water Management Unit



Demand of high-efficiency process

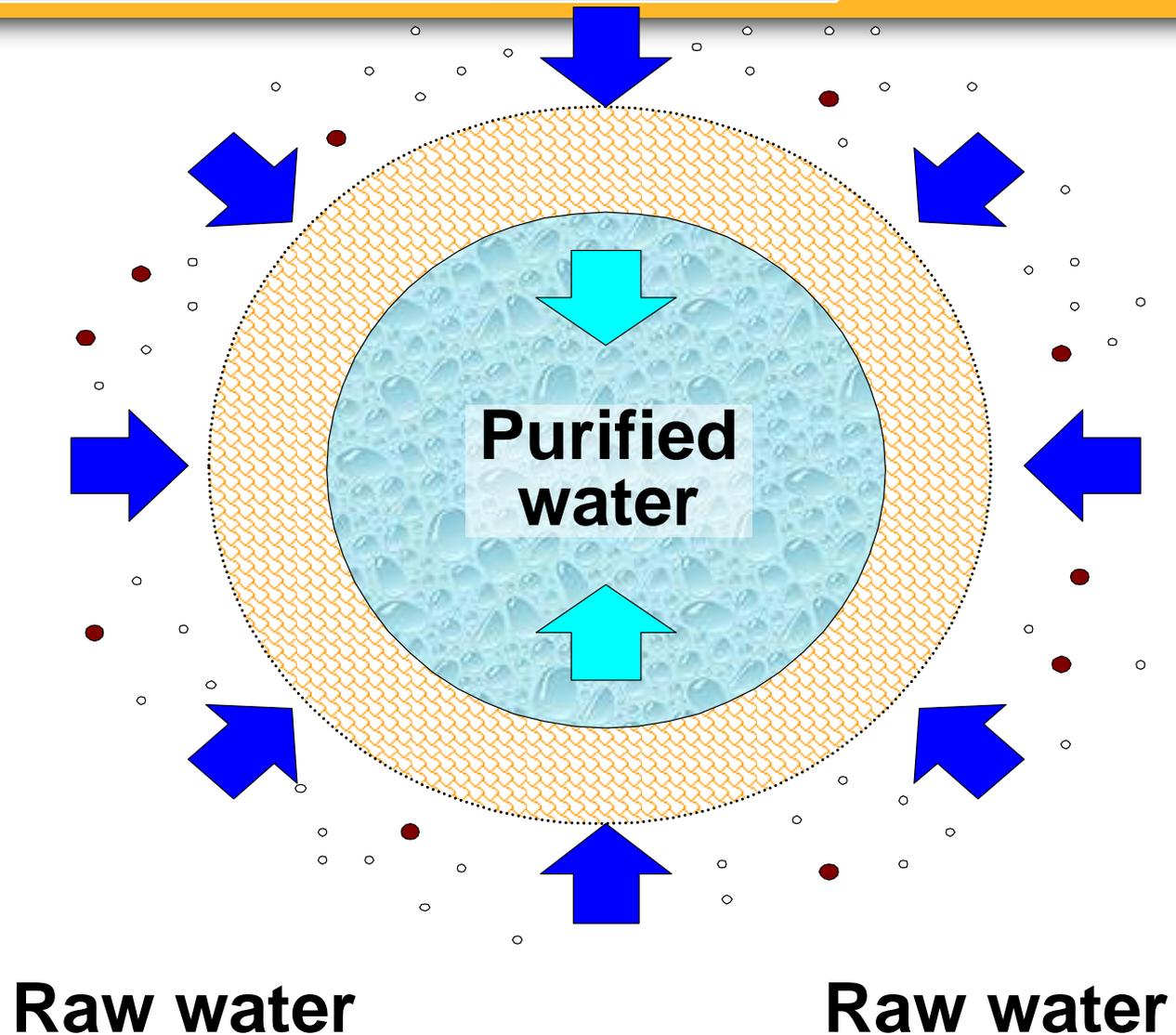
- **Upstream**
 - High demand of people
 - Prevention of pollution of water from pollutants in environment
- **Downstream**
 - Prevent contamination of environment
 - Production of high-quality treated wastewater for reuse

Technology has not been available

Membrane technology

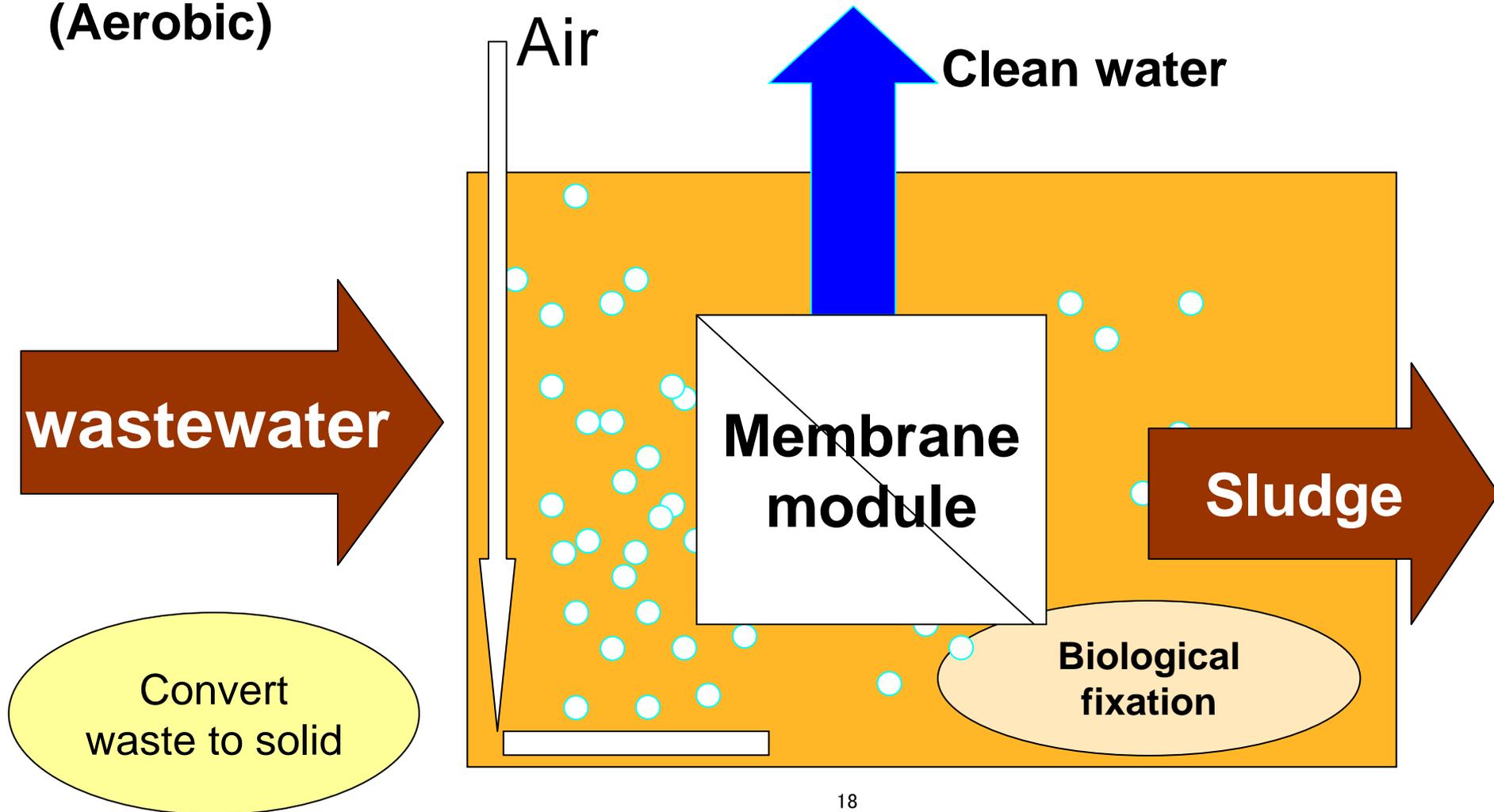
Membrane process: hollow fiber

- Production of extremely high quality water
- Used for bottled water production, seawater desalinations, wastewater treatment etc.

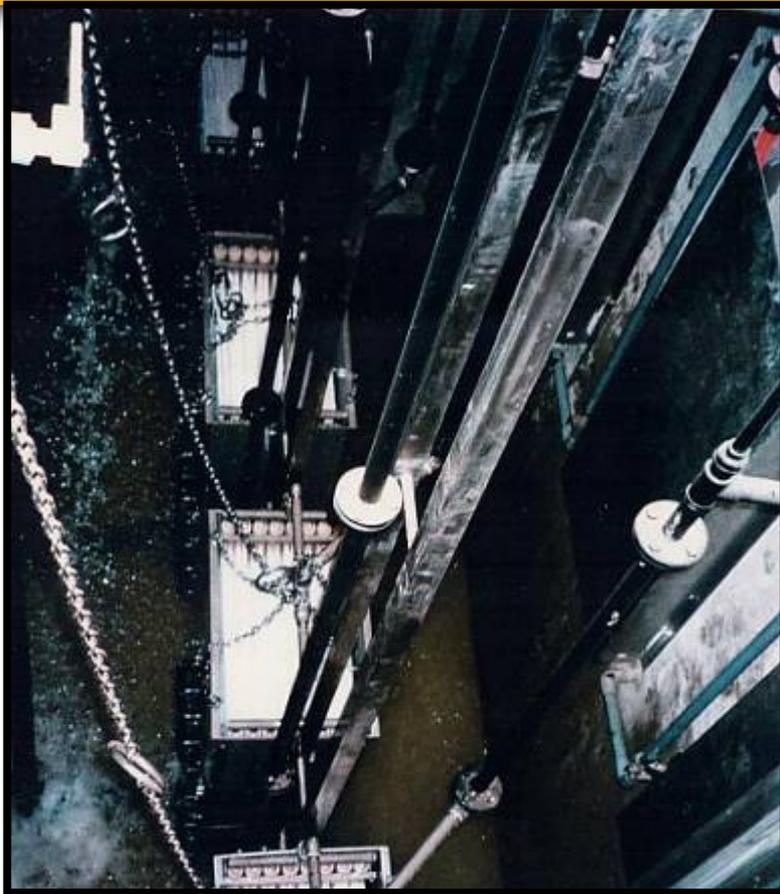


Wastewater treatment

**MBR: membrane bioreactor
(Aerobic)**



Actual MBR system



Membrane modules
placed in tanks



The inside of a aeration tank



The treated water

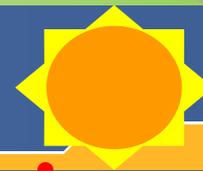
Advantages of MBR

- **Clan effluent**
 - Pathogen free
 - Low pollutant concentration
 - Rechargeable to groundwater
- **Small footprint**
 - Suitable for decentralized system
- **Easy maintenance**
 - Membrane failure can be detected by trans membrane pressure only

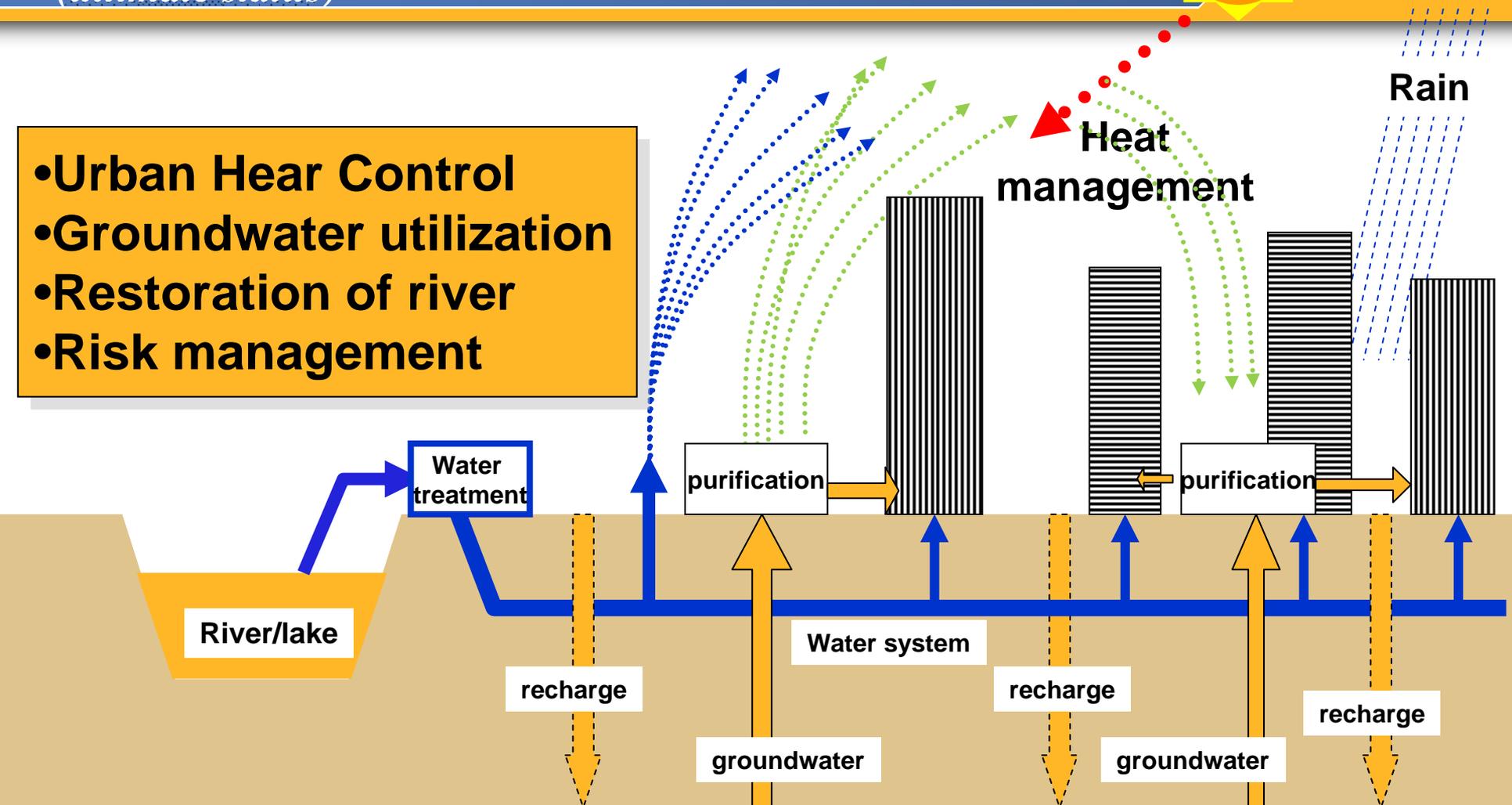
Suitable for independent small-scale system

Decentralized water management system

(ultimate status)



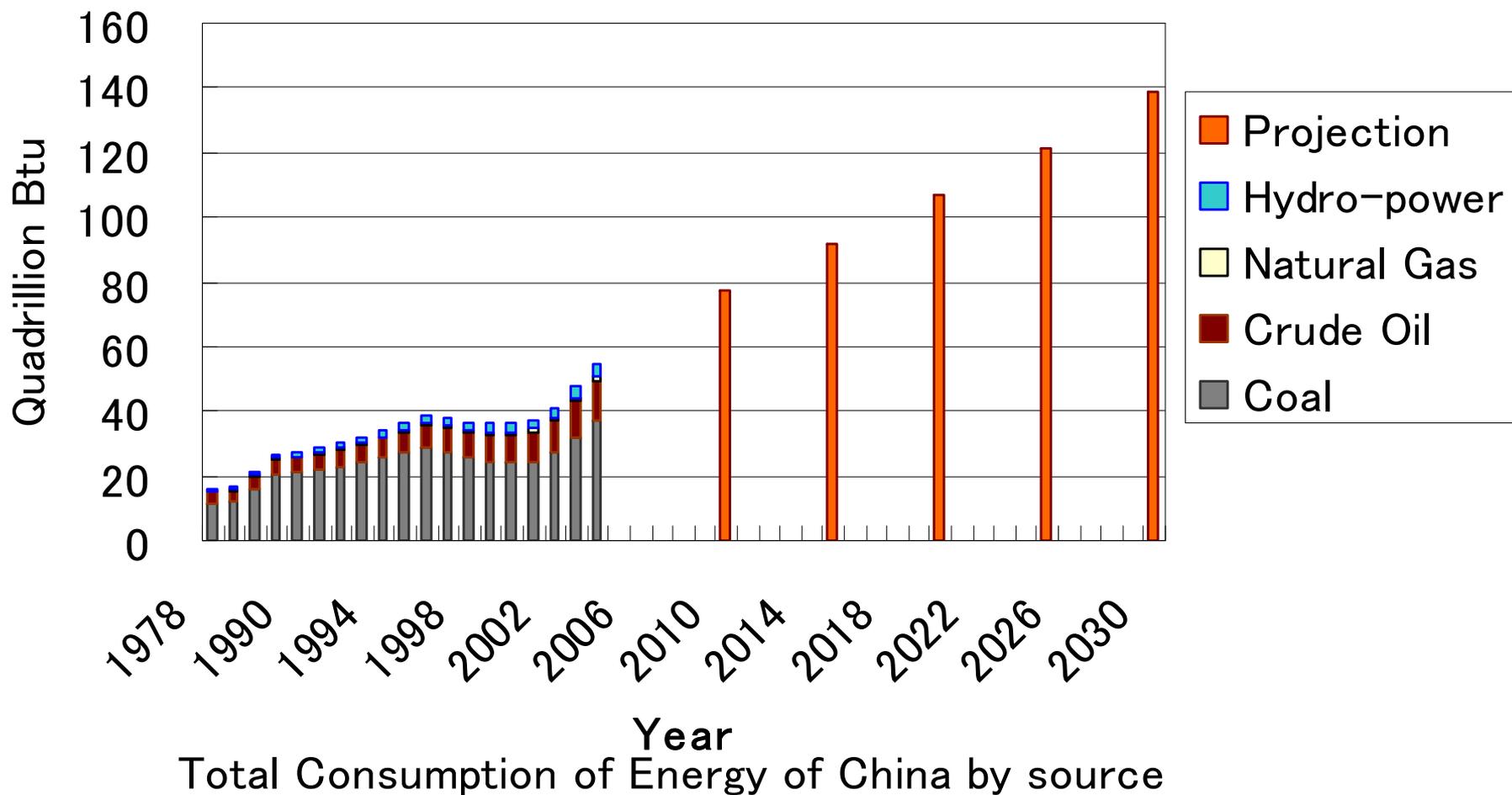
- Urban Heat Control
- Groundwater utilization
- Restoration of river
- Risk management



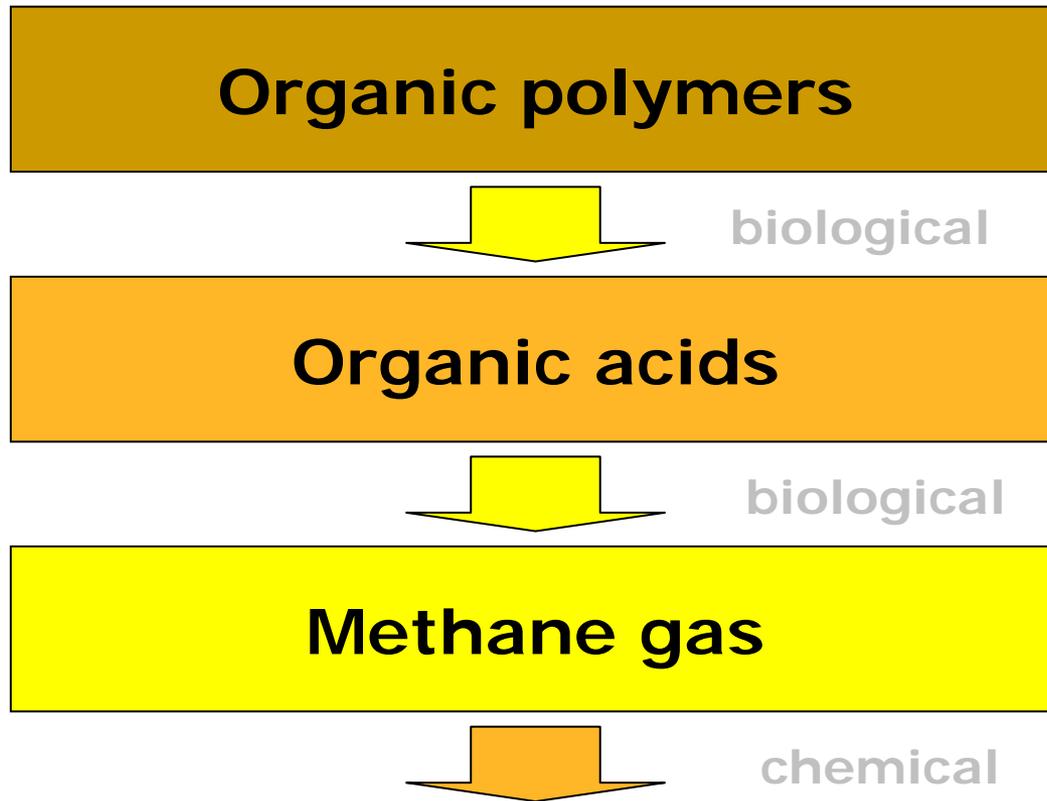
Urban water stock

Groundwater flow analysis

Energy demand projection in China



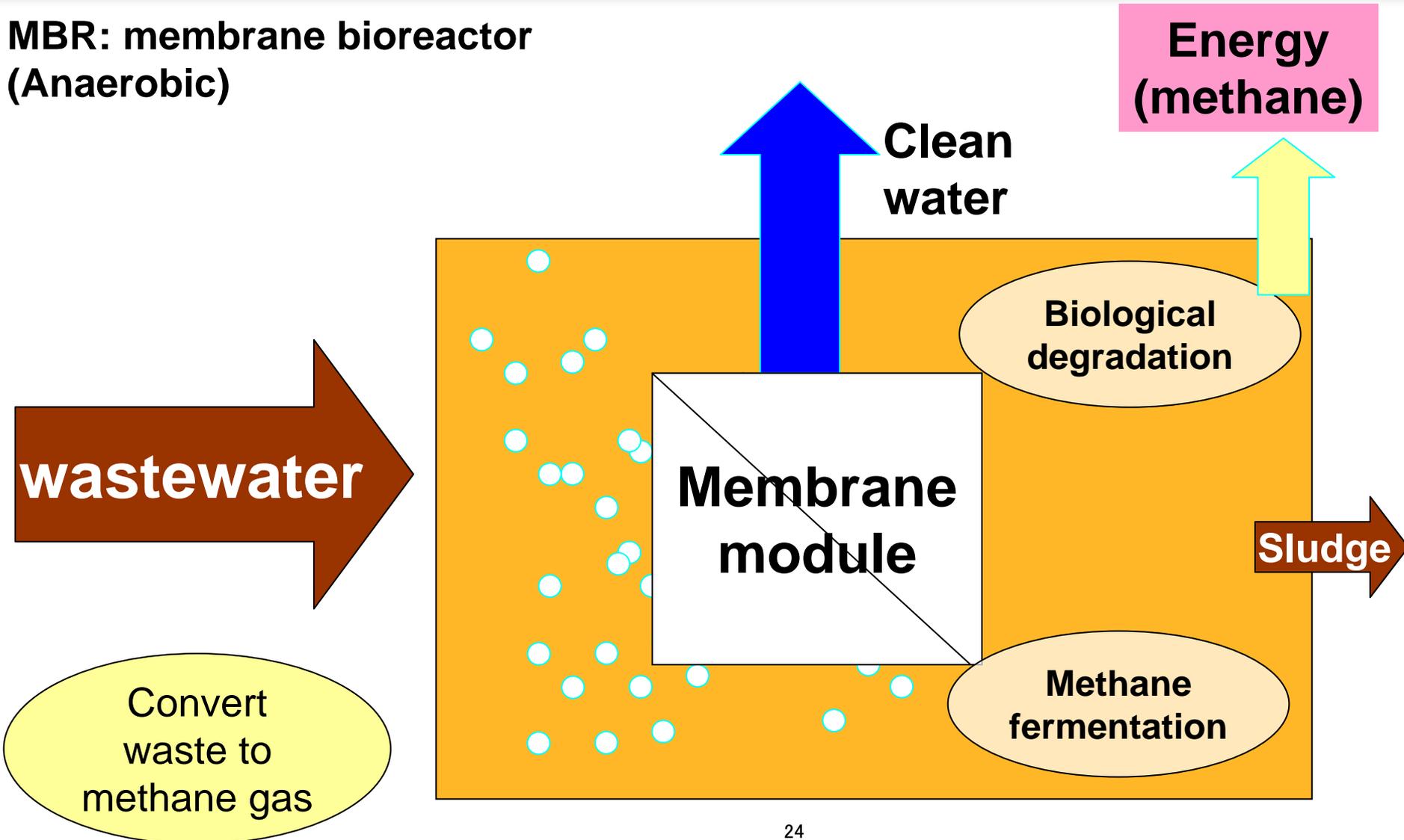
Biological conversion of heterogeneous wastes



Heat, power, electricity

MBR: membrane bioreactor (anaerobic)

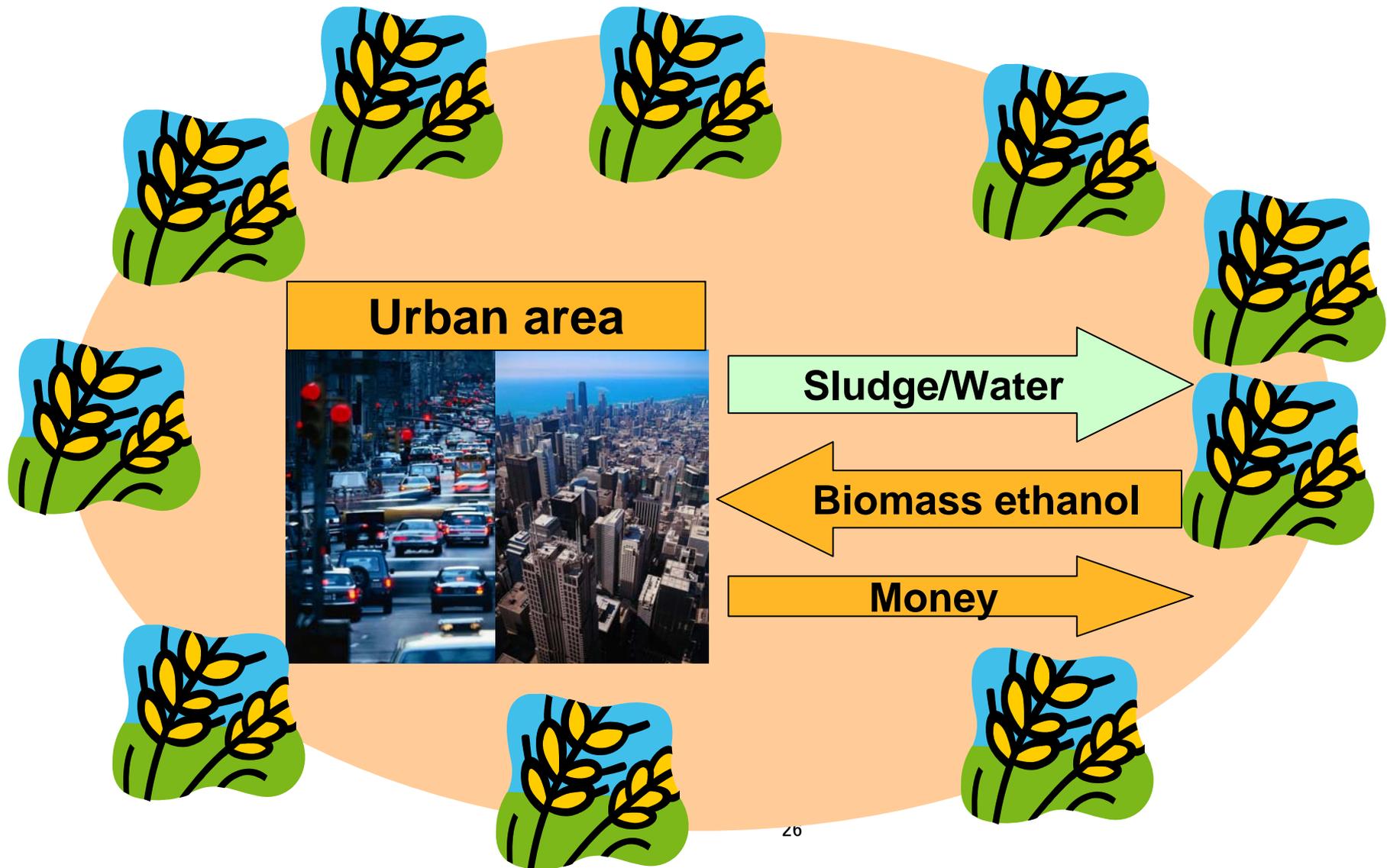
MBR: membrane bioreactor
(Anaerobic)



Byproducts of wastewater treatment

- **Fertilizer from sewage sludge**
 - Production of fertilizer (rich in P and N), from digested/composted sewage sludge is popular in many places
 - Marketability of such sludge is not always high in urban area
 - Perceived risk of heavy metals, arsenic, toxic organic chemicals, pathogens, VOCs etc.
- **Treated wastewater**
 - It may be clean enough for house use
 - It may be used for irrigation
 - However, these use may not be acceptable for people in modern society

Example of solution: sustainable bioethanol production



Conclusions and proposal

- **Appropriate water management is vital for developing urban region**
- **Urban water management in developing region does not need to follow developed countries**
- **New technologies may change the structure of management**
- **Water management, risk assessment, low-carbon society etc. may need to optimize strategically**
- **Since the subject are extremely complicated, we have to bring high-technology from all academic fields (science, engineering, social science, etc.). Contribution of academia and international collaboration are important**

謝謝

Thank you

ありがとうございます

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