



Sustainable Urban Region – water management for Asian cities

Ken Fukushi, Ph.D.

Associate Professor of Transdisciplinary Initiative for Global Sustainability (TIGS), Integrated Research System for Sustainability Science (IR3S), The University of Tokyo, Japan

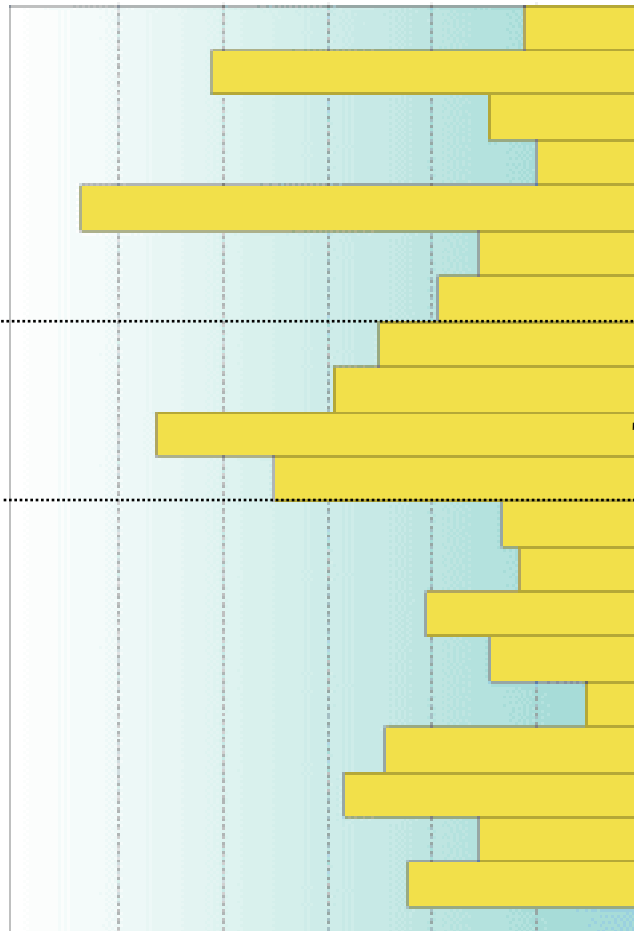
Urban water problems in developing regions

- **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

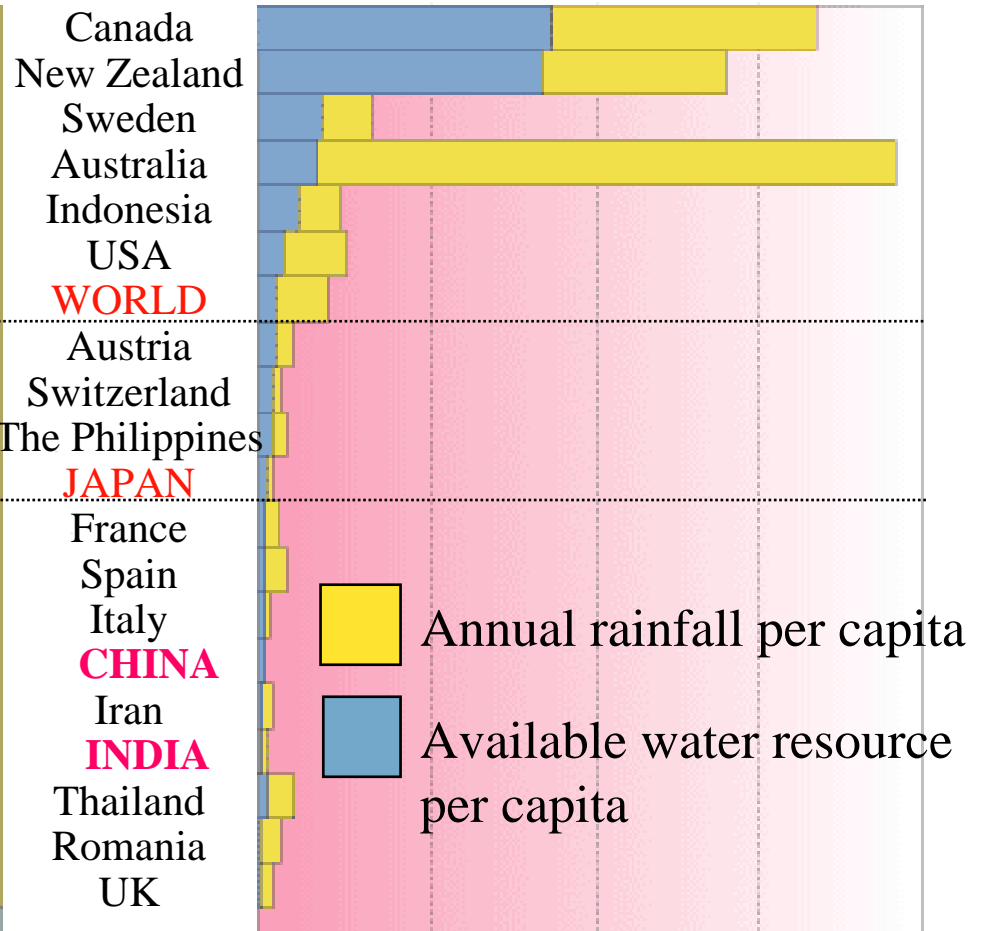
Annual rainfall (mm year⁻¹)

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

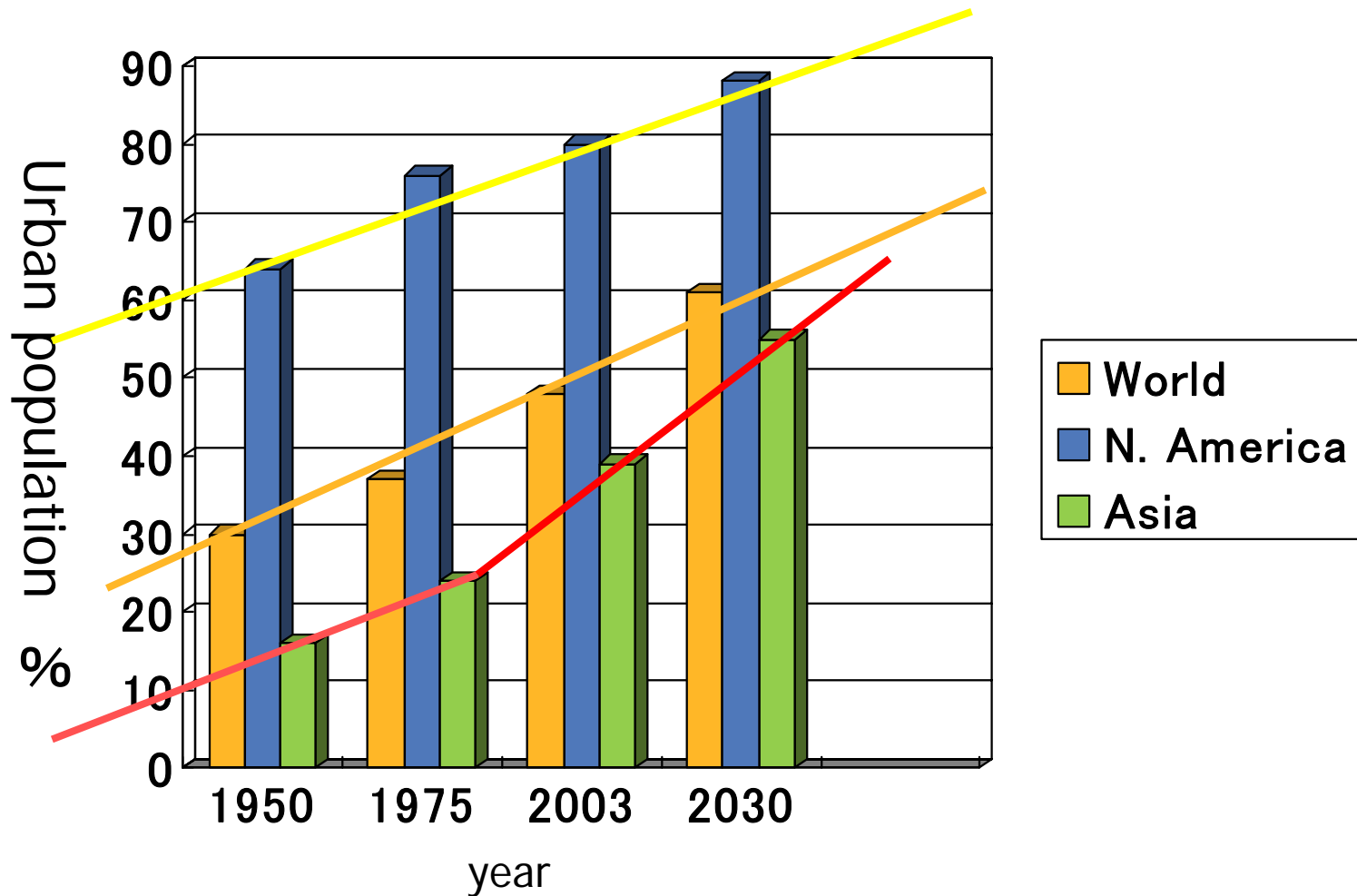


per capita (m³ year⁻¹ capita⁻¹)

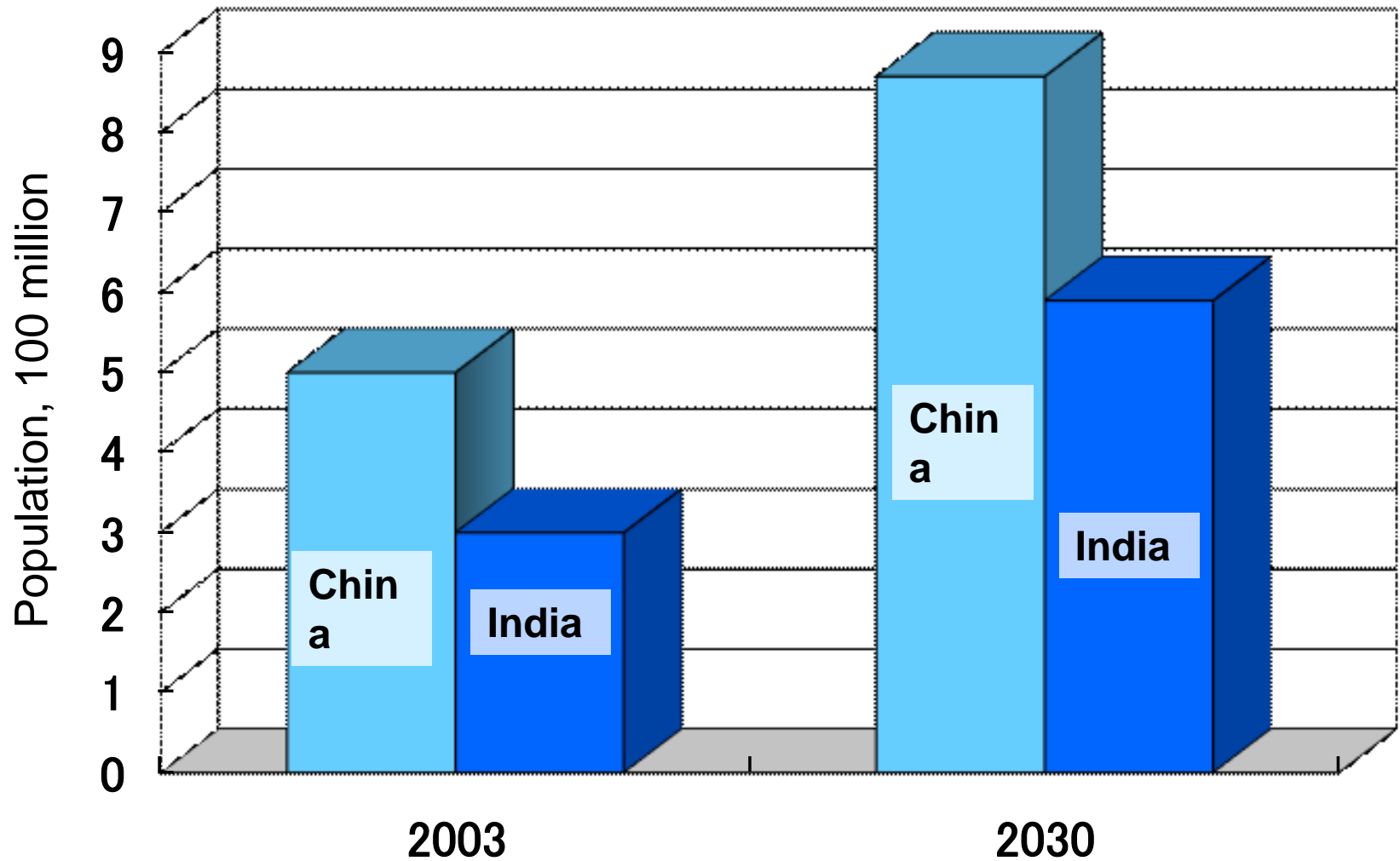
0 50,000 100,000 150,000 200,000



Increase of urban population



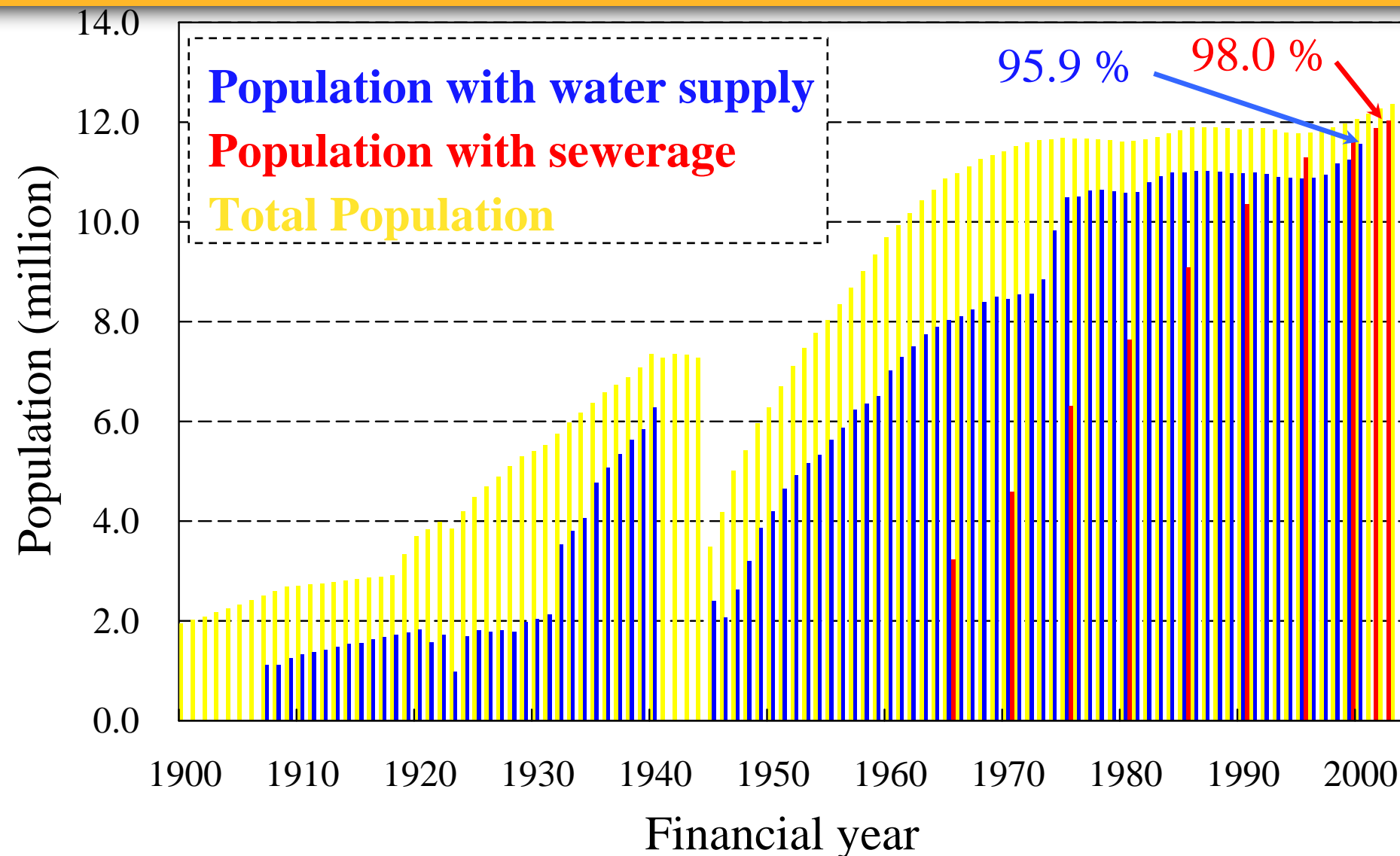
Urban population increase





Water management in Tokyo

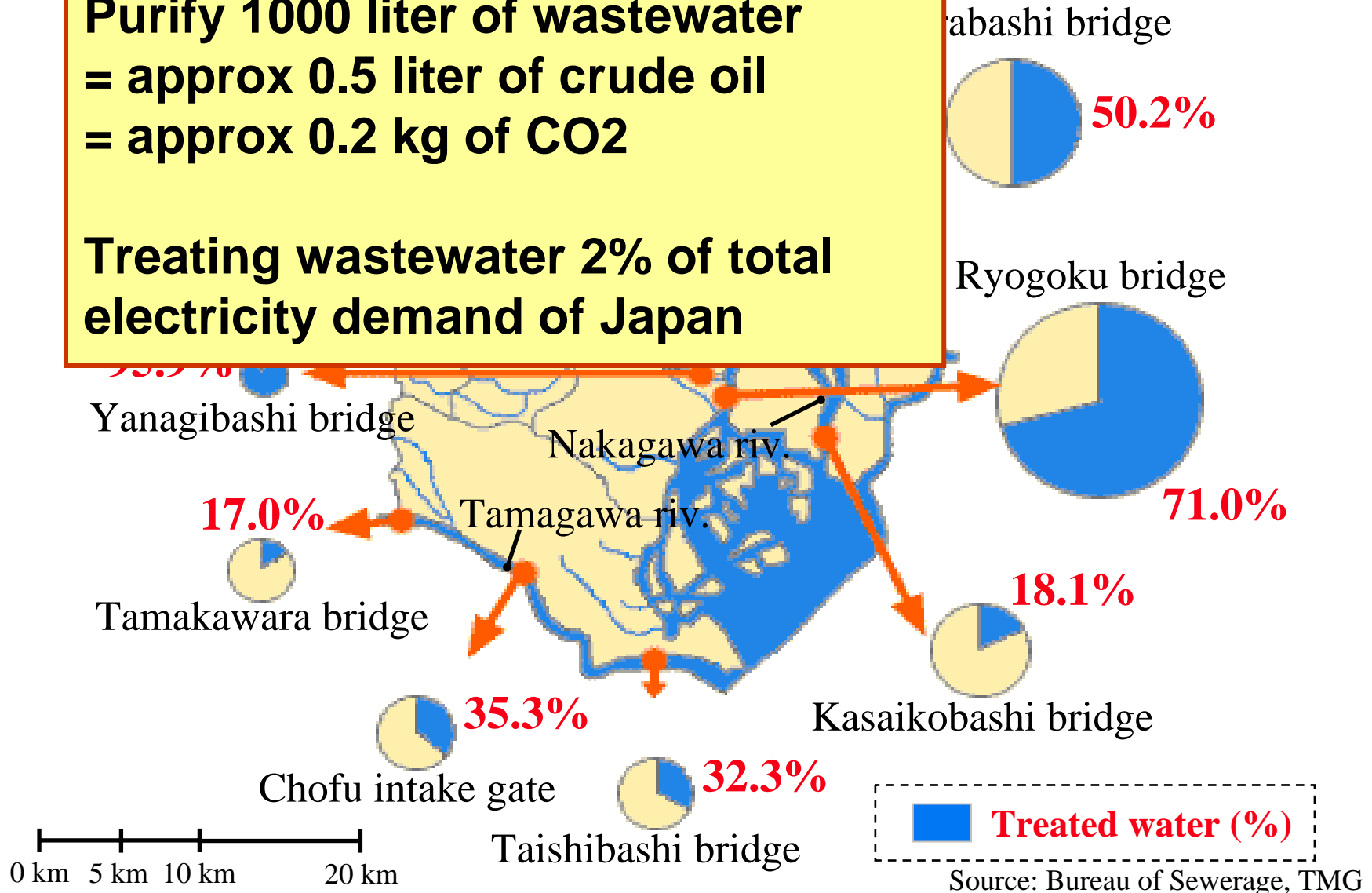
Population with water supply/sewerage in Tokyo



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**



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 management

■ Advantages

- Need small investment for sewer pipeline
- Easy to reuse treated water
- Small investment for one unit

■ Disadvantages

- Need effective maintenance system
- More energy consumption for operation

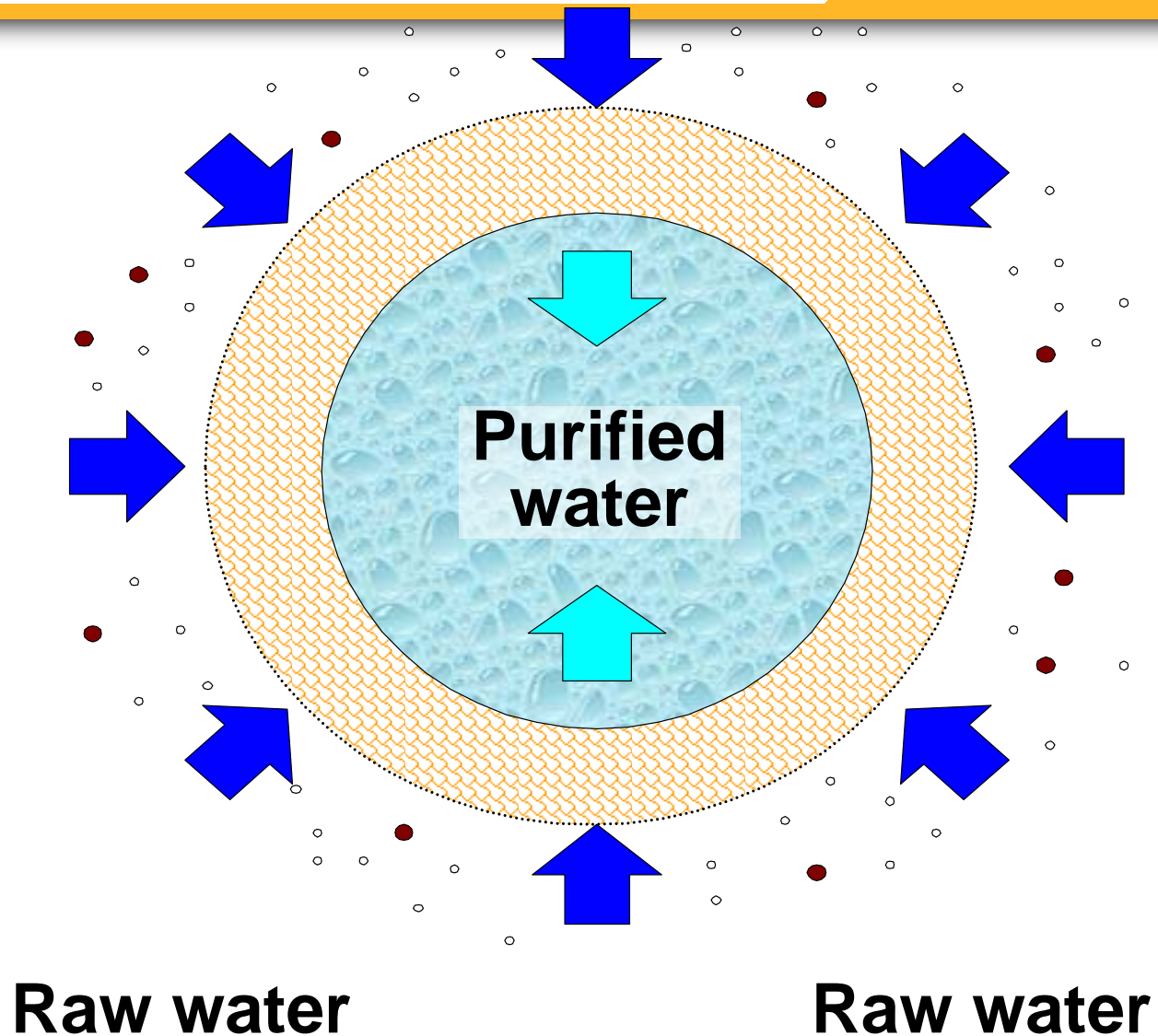
Develop commercial maintenance industry

Total energy demand will be low

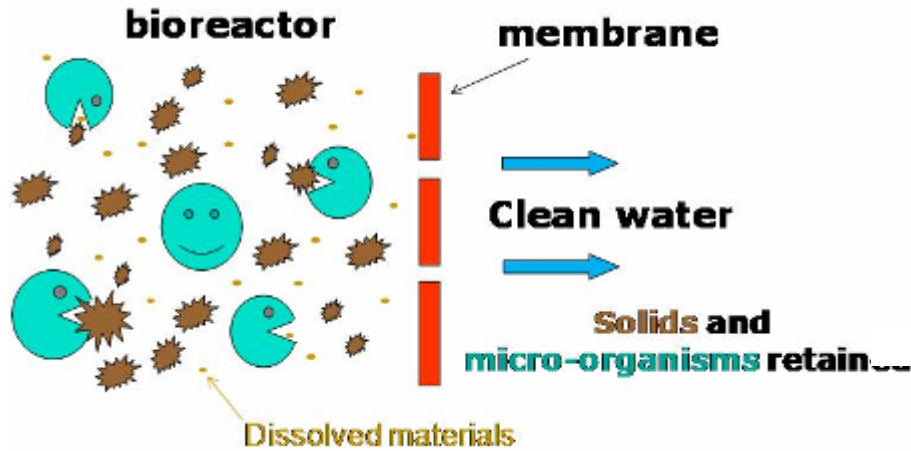
Need technology development

Membrane process: hollow fiber

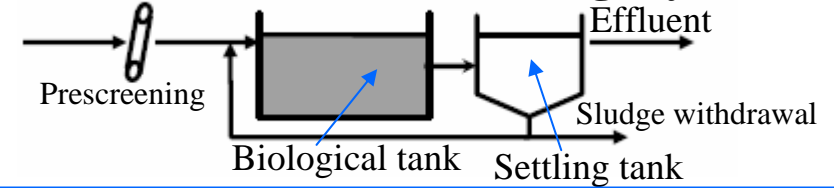
- Production of extremely high quality water
- No need of high-tech for MF membrane fabrication



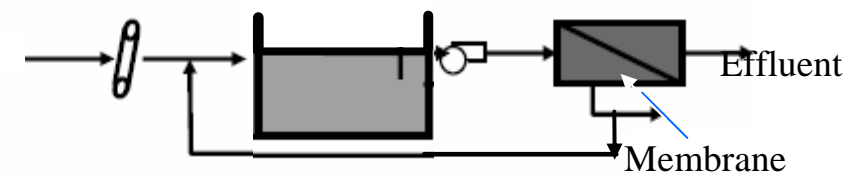
Membrane Bioreactor (MBR) technology (key technology)



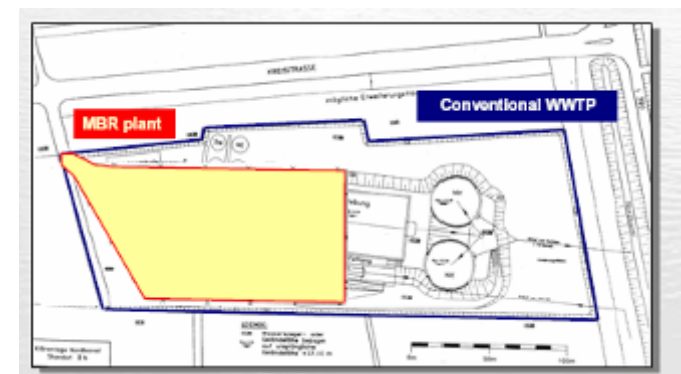
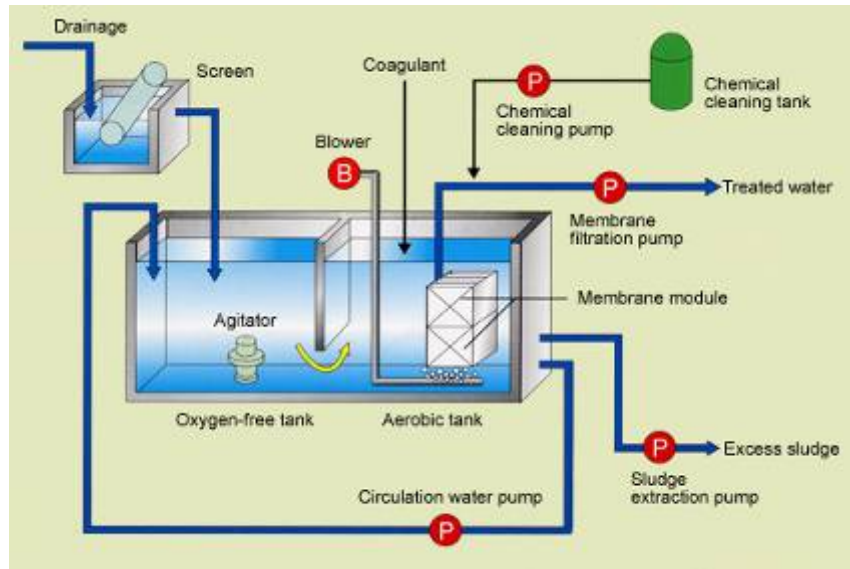
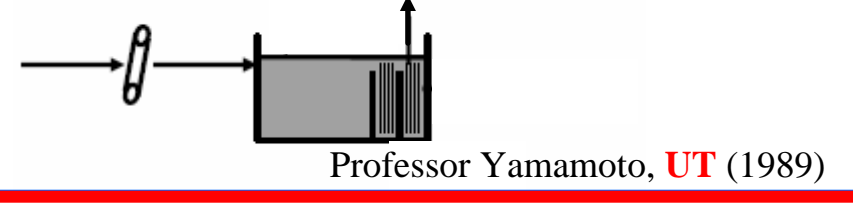
Conventional activated sludge system



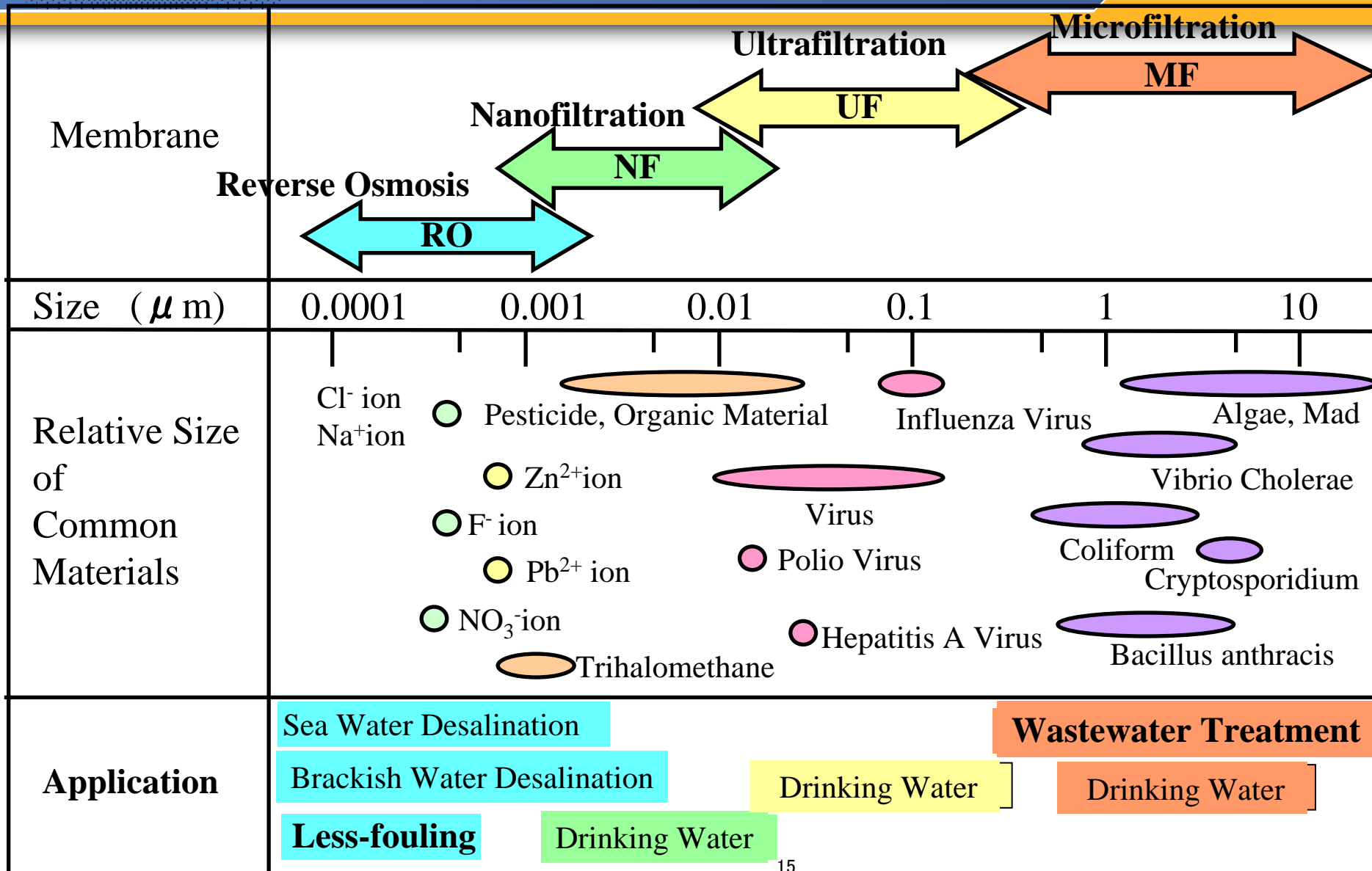
Side stream MBR (1st generation)



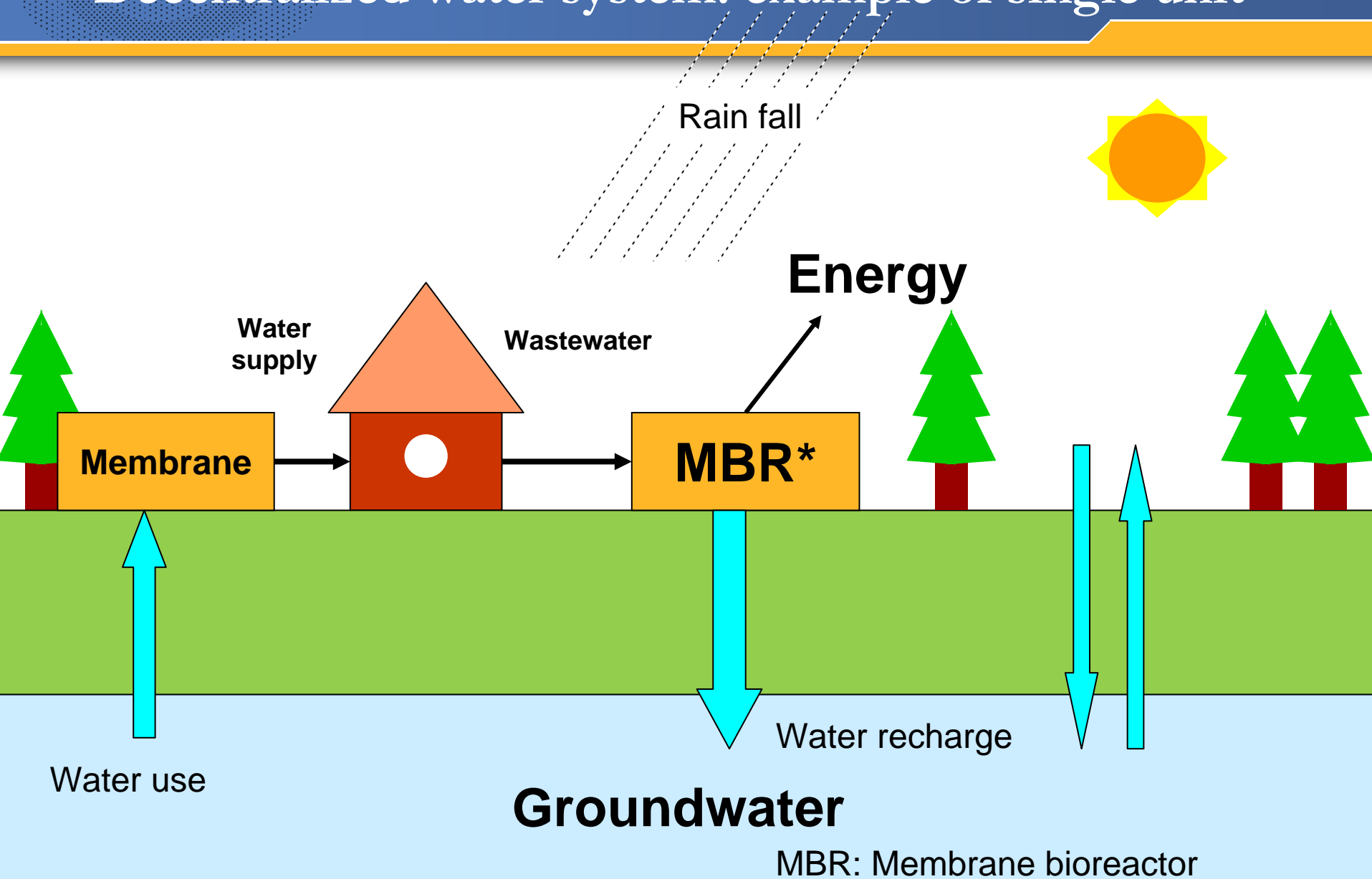
Submerged MBR (2nd generation)



Membrane categories (Prepared by TORAY)

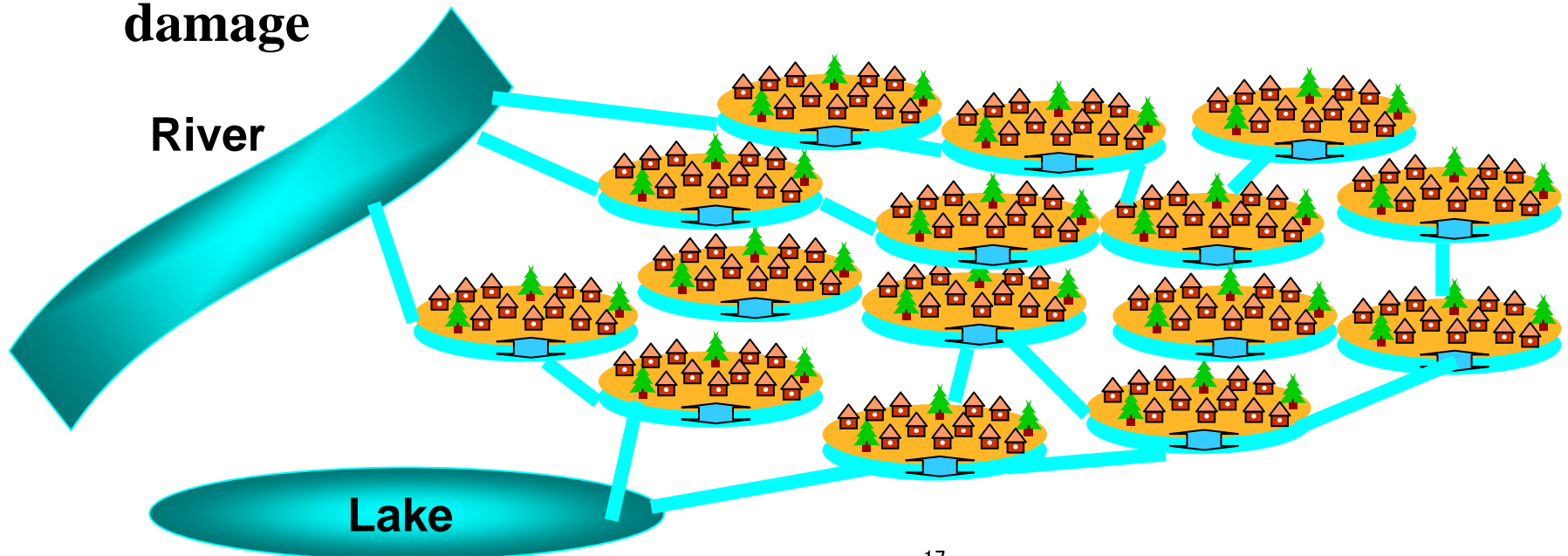


Decentralized water system: example of single unit



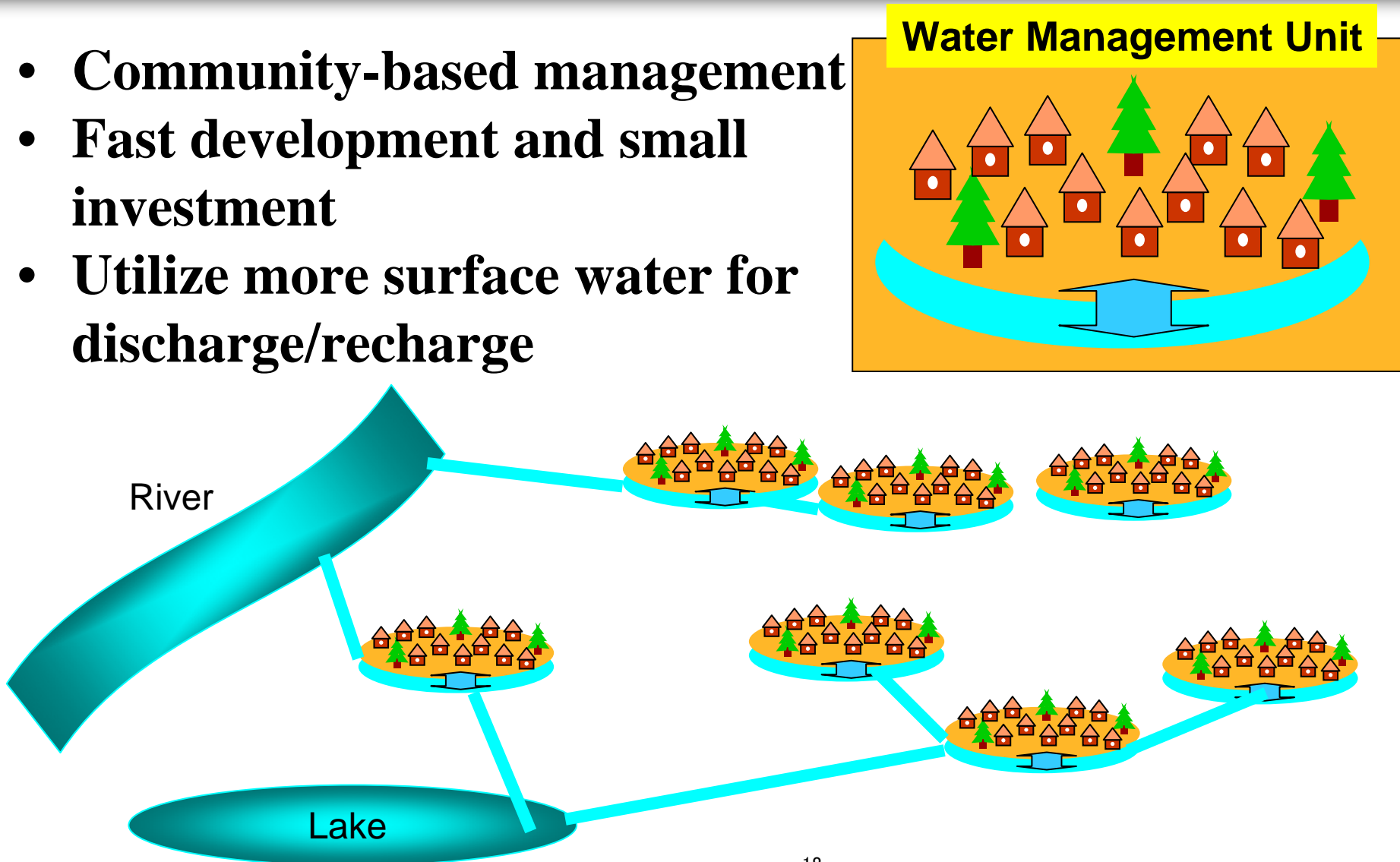
Decentralized water management: urban area

- **Community-based management:**
- **Outsourcing**
- **Groundwater as water stock**
- **Utilize existing water and wastewater piping**
- **Fast system recovery from damage**



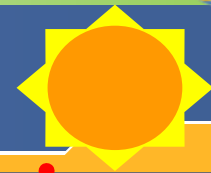
Decentralized water management: urban area

- **Community-based management**
- **Fast development and small investment**
- **Utilize more surface water for discharge/recharge**

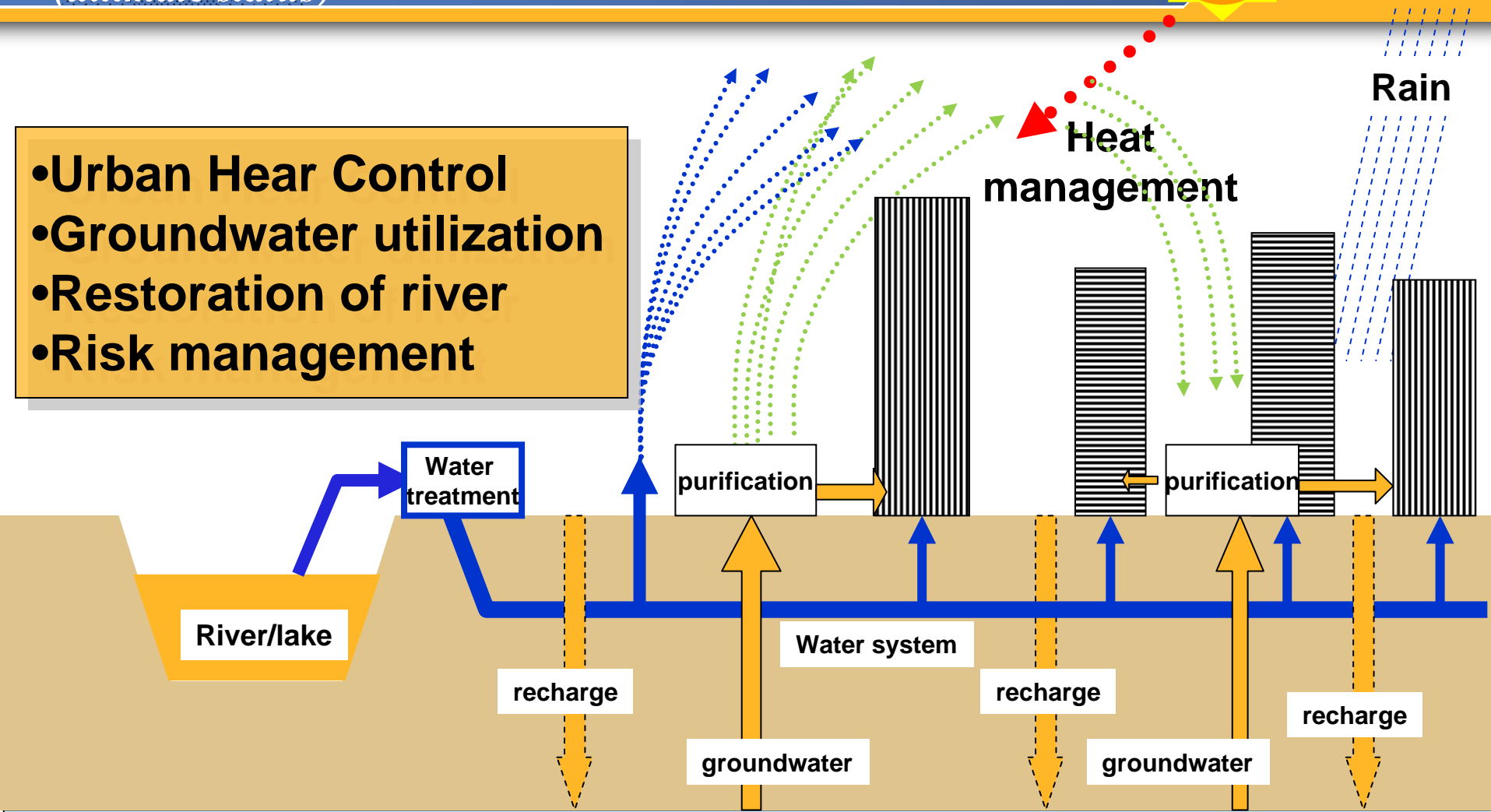


Decentralized water management system

(ultimate status)



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

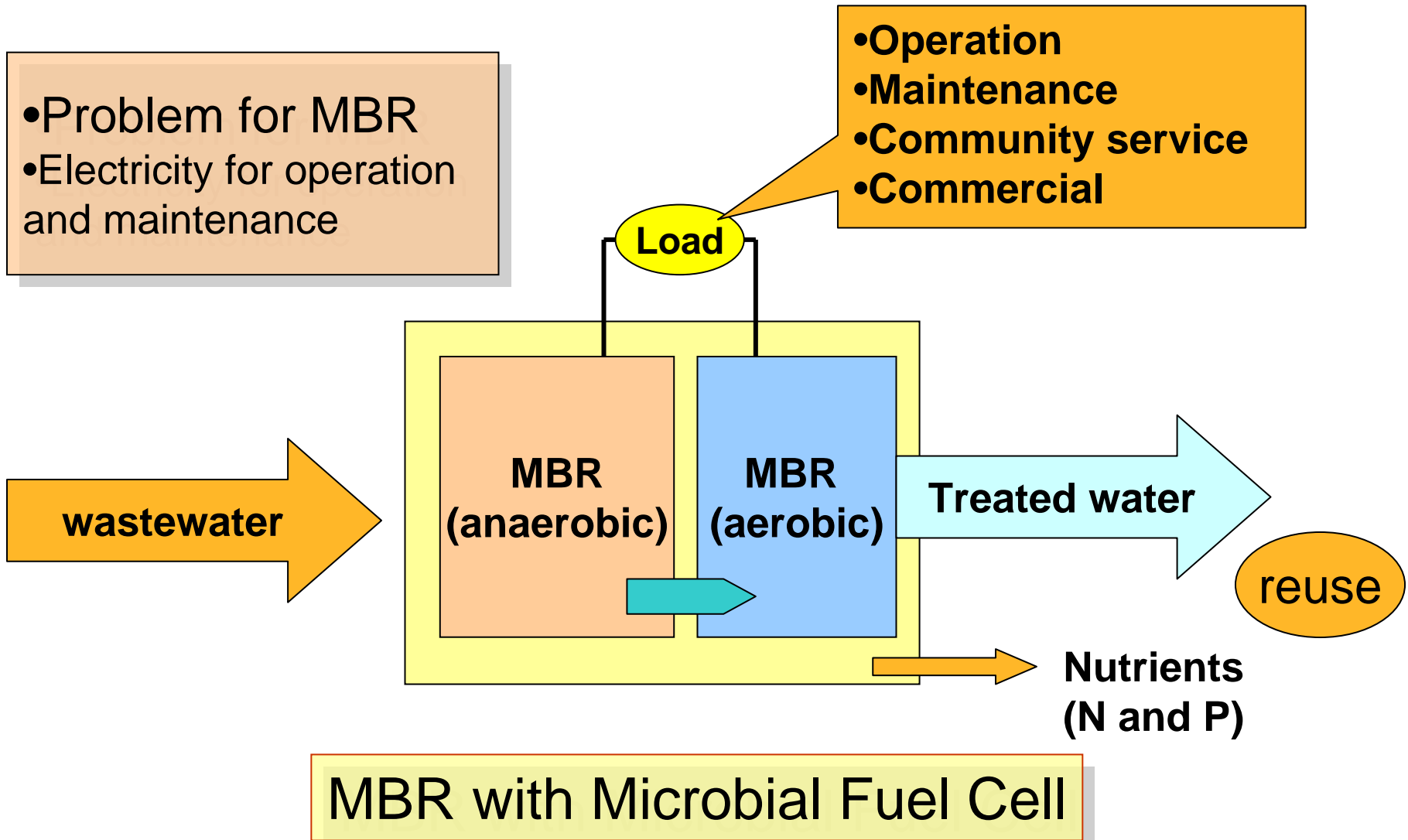


Urban water stock

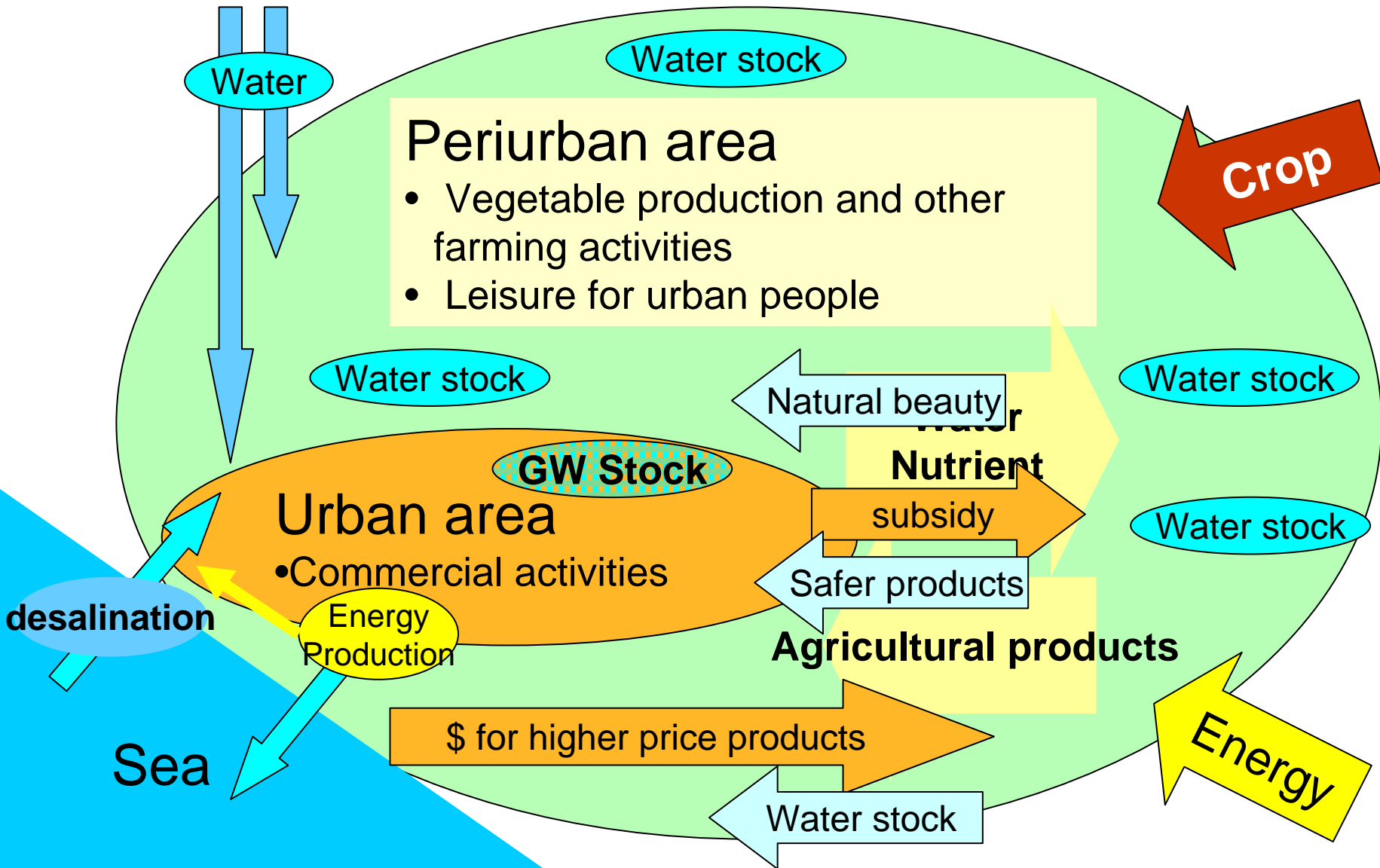
Groundwater flow analysis



Other potential for wastewater: zero-energy wastewater treatment



Future Asian cities



A scenic view of a lake with a couple in the foreground and buildings in the background. The couple is standing on a grassy bank, looking at each other. The lake is calm, and the background features a dense line of trees and several buildings, including a prominent white building with a blue roof and a modern glass skyscraper. The sky is overcast.

Thank you

Ken Fukushi

fukushi@ir3s.u-tokyo.ac.jp