Monitoring Wastewater:
A Novel Environmental Infrastructure for Preventing Disease Outbreak in Urban Areas
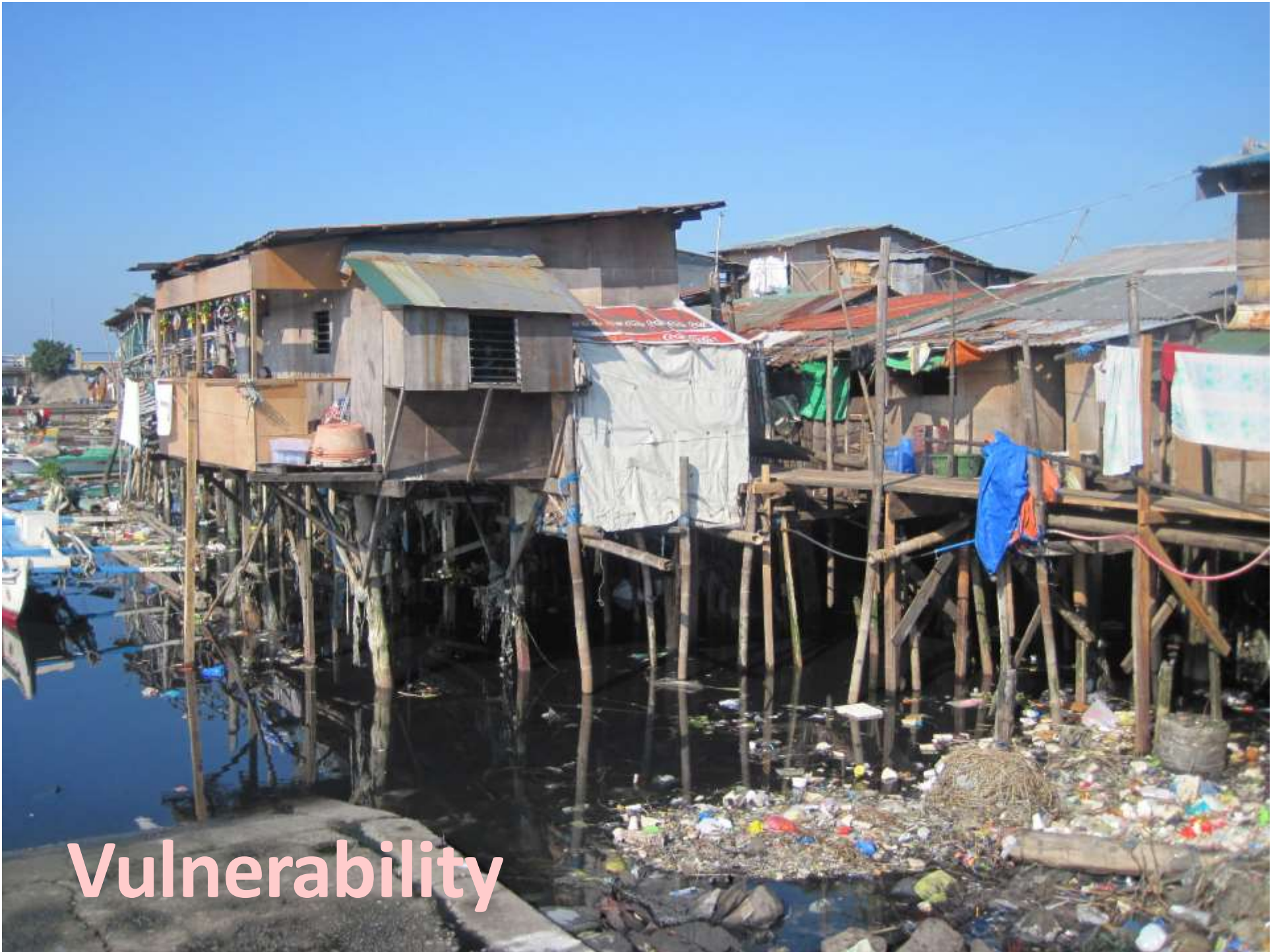
Kensuke FUKUSHI

Institute for Future Initiatives
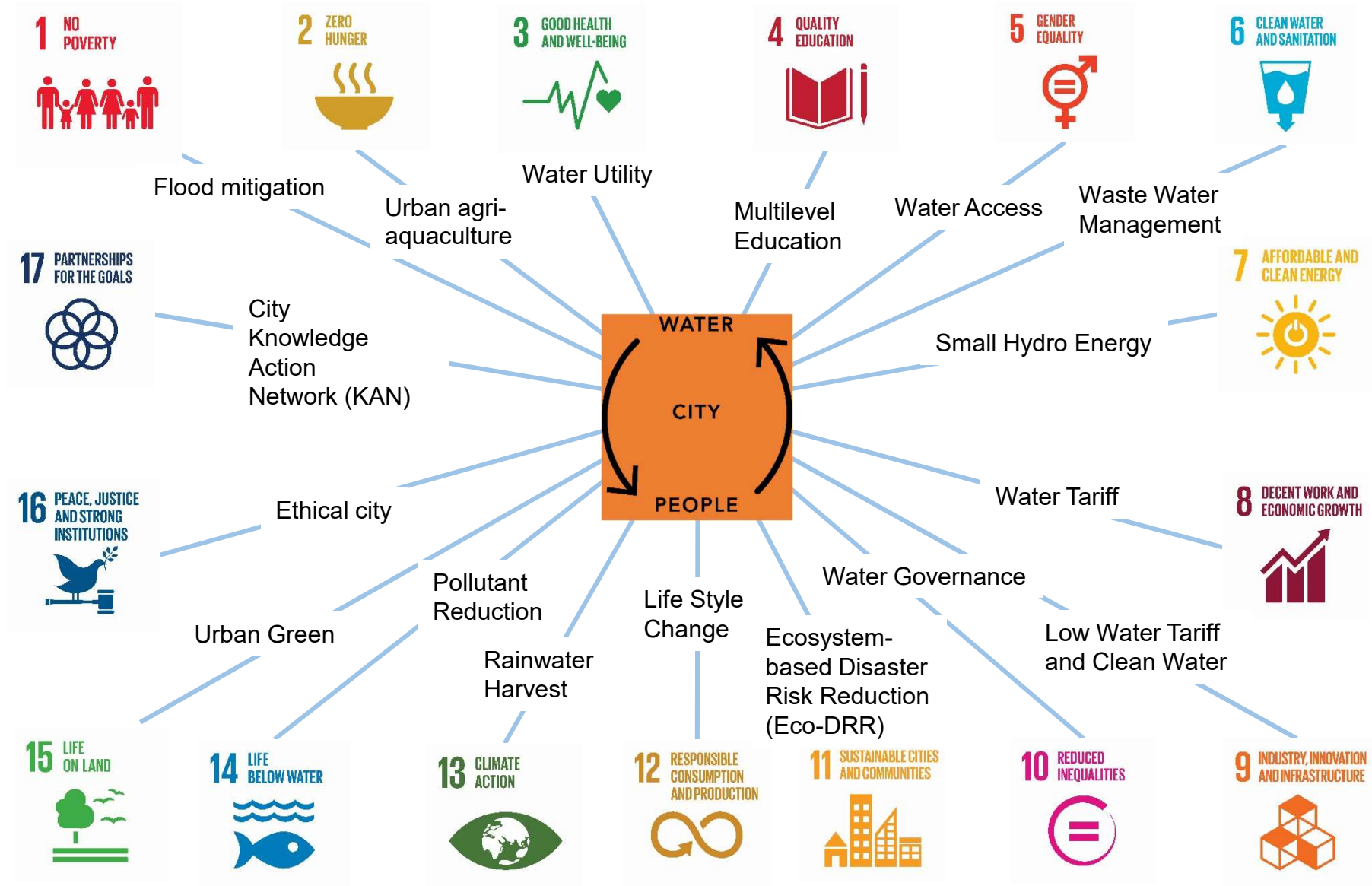
The University of Tokyo

Japan

Pollution

Flooding

Vulnerability

SDGs in Urban and Water Environment

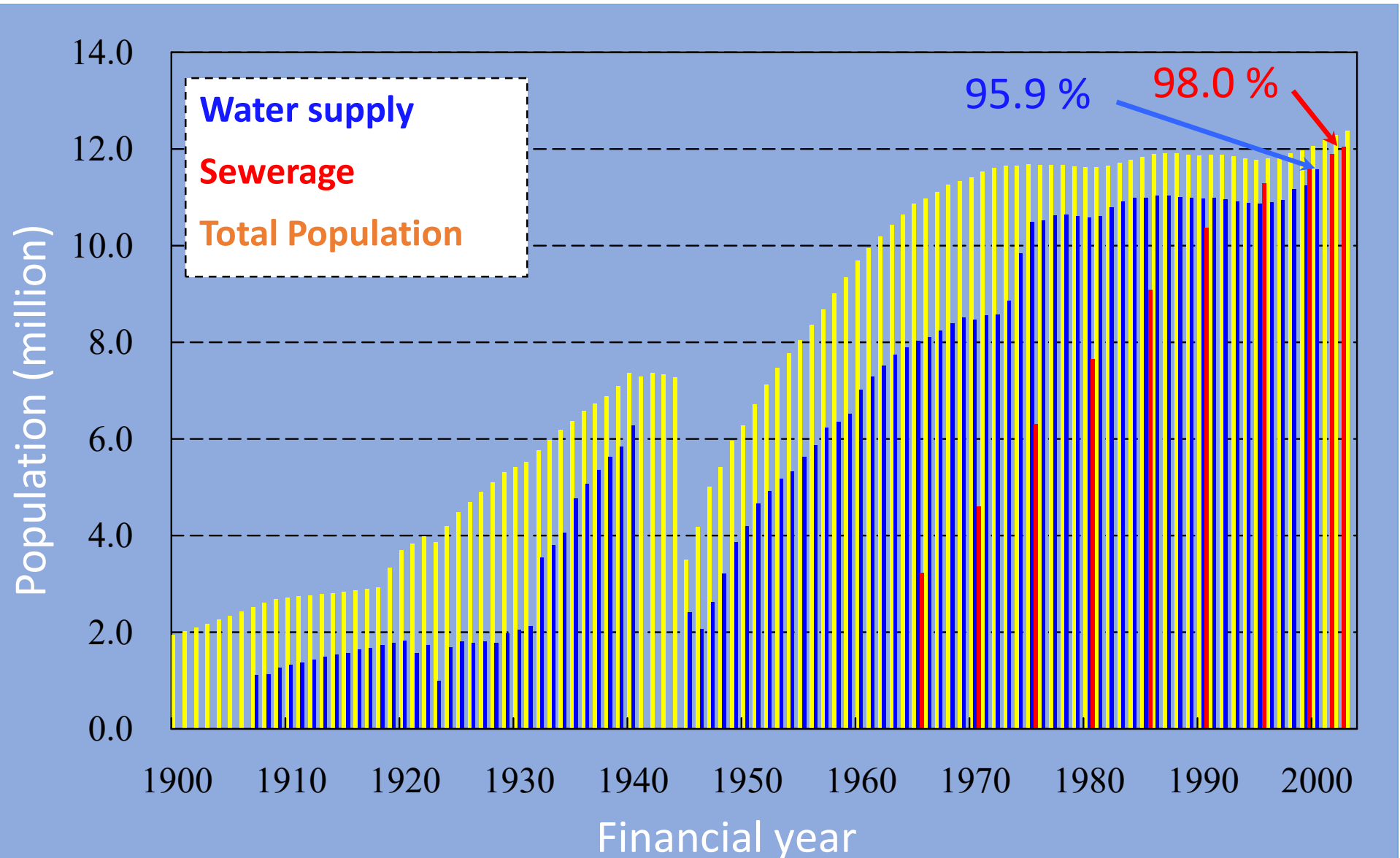Rivers of Tokyo in 1970s

TAMA river in 70s

Population with water supply/sewerage in Tokyo

© S.Ishii, COE Project, Tokyo University
Created from the sources: Bureau of Waterworks, TMG; Keihin Office of River, MILT Japan; Bureau of General Affairs, TMG

Current water environment in Tokyo

Ochanomizu station

Kandagawa riv.
Picture source: Tokyo Canal Project

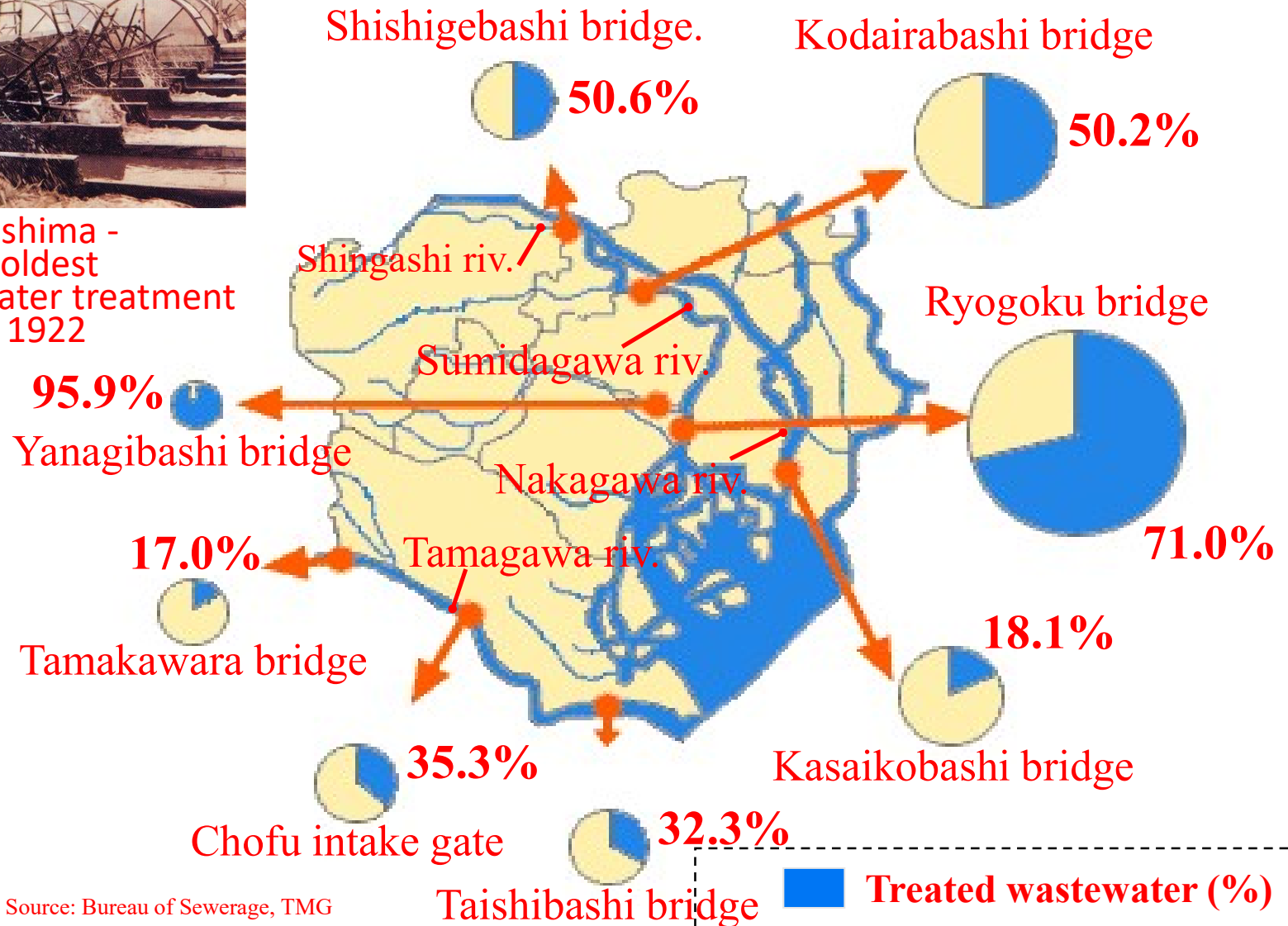Sumidagawa riv.
Picture source: Tokyo Canal Project

Nihonbashi
Picture source: Tokyo Canal Project

Large share of river water in Tokyo is treated wastewater

CR: cSUR, UTokyo

Mikawashima - Japan's oldest wastewater treatment plant in 1922

Shishigebashi bridge.
50.6%

Kodairabashi bridge
50.2%

Shingashi riv.

Sumidagawa riv.

Ryogoku bridge
71.0%

95.9%
Yanagibashi bridge

Nakagawa riv.

17.0%
Tamagawa riv.

Tamakawara bridge

18.1%
Kasaikobashi bridge

35.3%
Chofu intake gate

32.3%
Taishibashi bridge

Source: Bureau of Sewerage, TMG

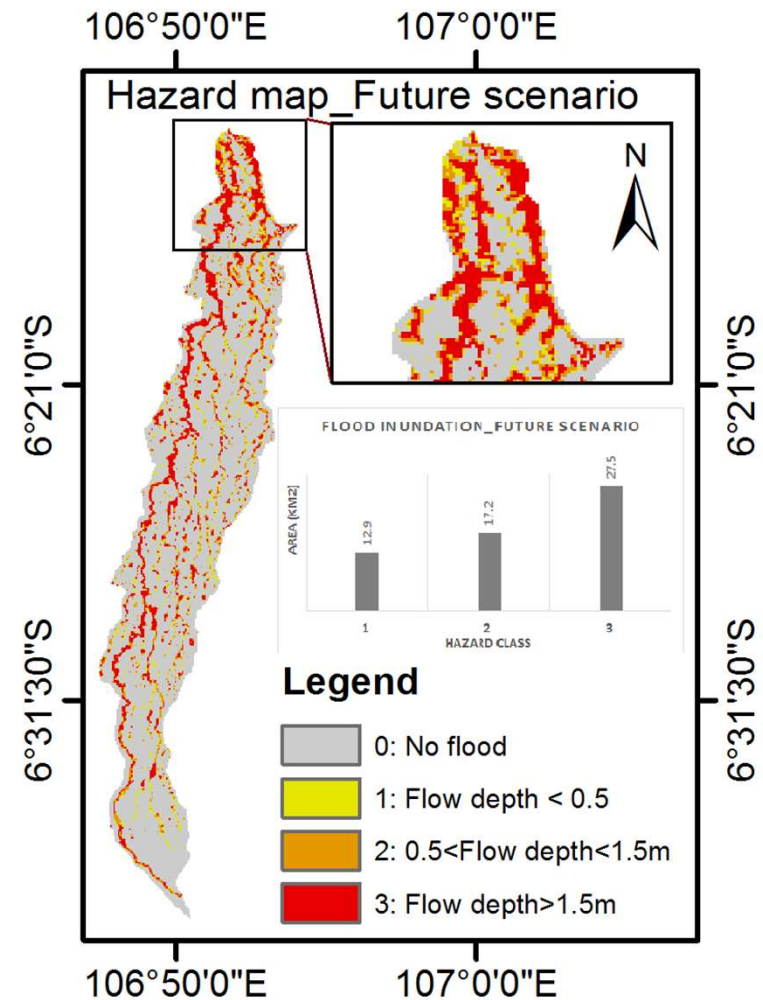**Treated wastewater (%)**

Jakarta : Projection of urban flooding
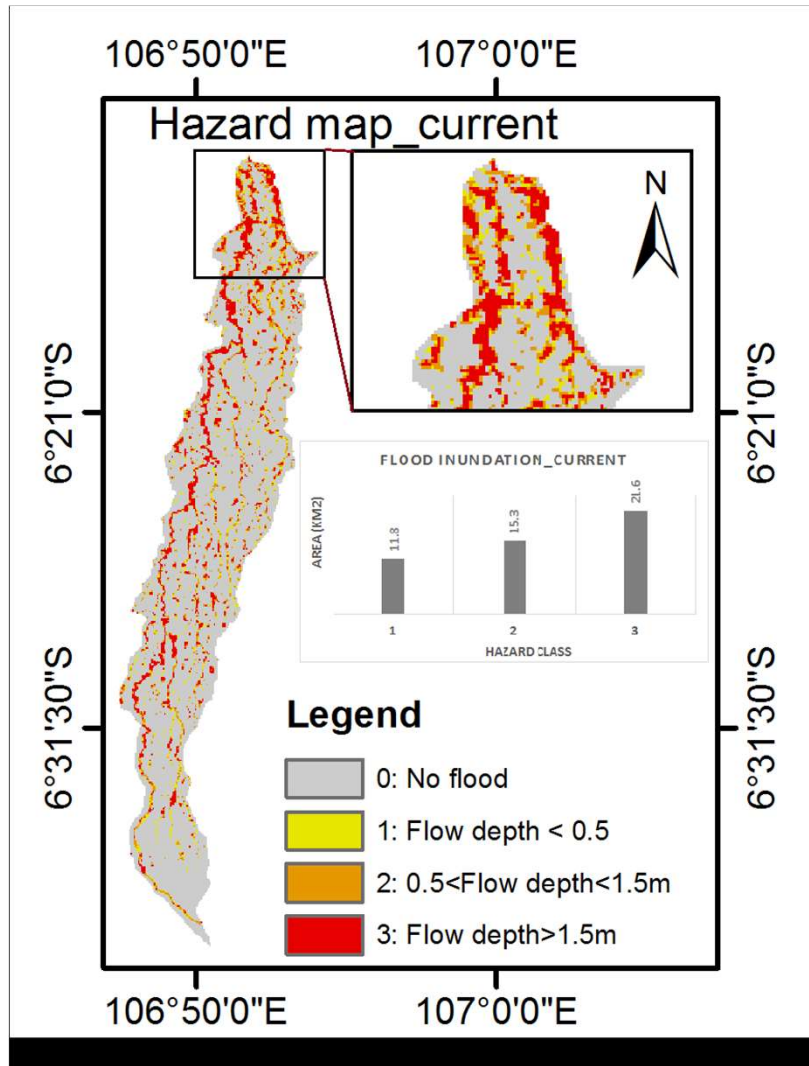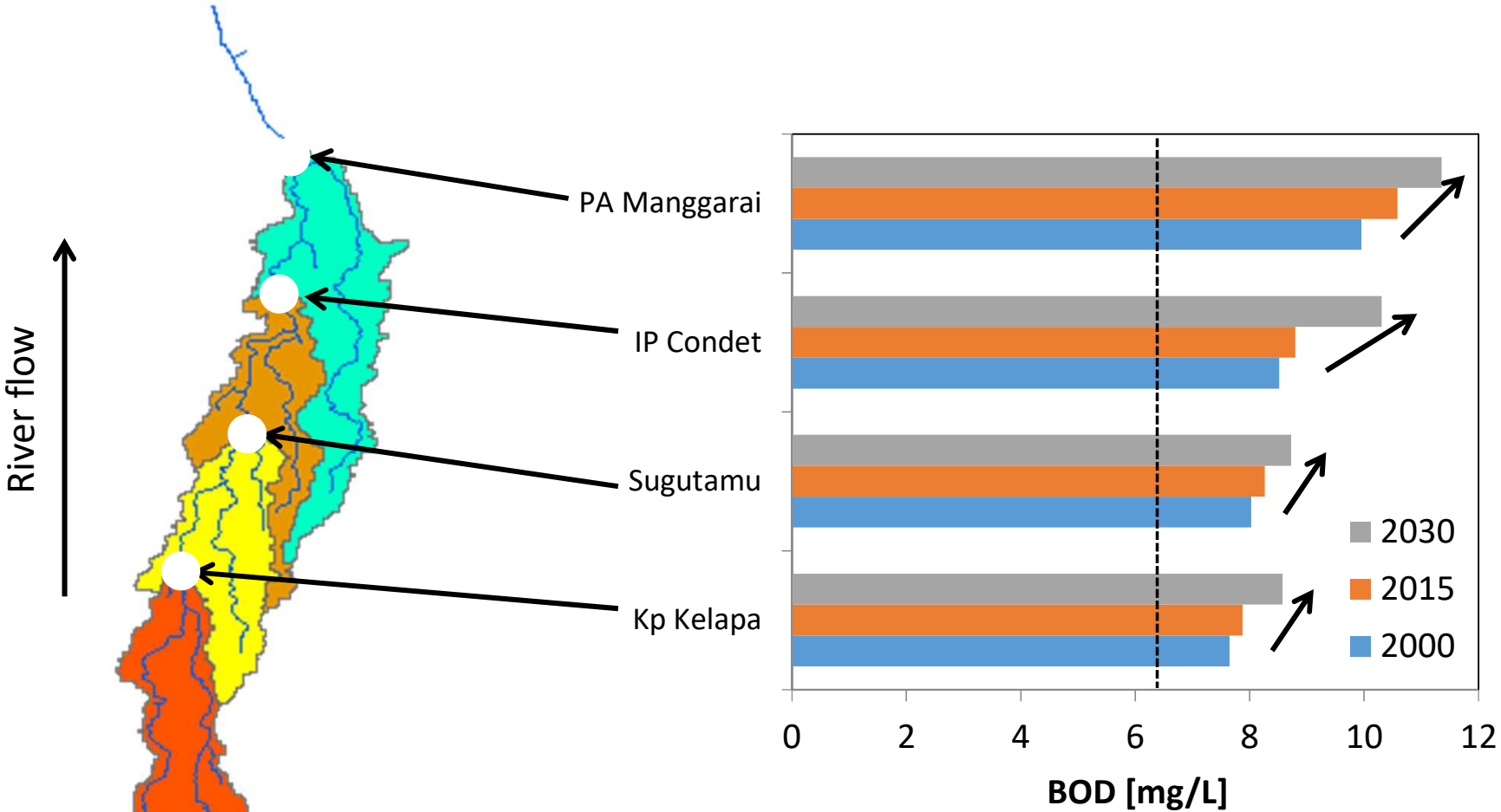
Current (2015) **Future (2030)**

Jakarta : Projection of water quality

CR: UNU-IAS

BOD > 6 mg/l considered as not suitable for aquatic life (WHO, 2006)

Jakarta : Future projection summary

Current (2015) **Future (2030)**

Water pollution

+ 7.6%

Flood area

+ 19%

Infectious diseases

+ 98%

How to design future water environment of Asian cities

- **Wastewater treatment**
  - Centralize and decentralize combination
  - Recycle at decentralized treatment system
- **Water environment**
  - Optimize quality of life of residents and tourists
  - Design landscape and other function
  - Utilize groundwater for water resource
  - Minimize health risk

Asian cities – living with water

- **Sustainable city** with adequate and equitable/affordable access to water and sanitation

- **Resilient city** for future climate and urbanization

- **Low carbon city** through integrated water management and innovation of technology

- **Scientific knowledges** needed for science-based policymaking and urban planning. However, we should know that science can describe only a part of the phenomena.

Wastewater as indicator of health risk

The New York Times   May 1, 2020

Is It Safe to Come Out of Lockdown? Check the Sewer

Wastewater could provide early, painless and localized data about the rise or fall of coronavirus levels.

Researchers from Brazil's National Institute of Science and Technology collected sewage samples to test for coronavirus in Belo Horizonte last month. Douglas Magno/Agence France-Presse — Getty Images

By Carl Zimmer

- New coronavirus is found in feces (regrowth in small intestine)
- Utilizing wastewater to project status of outbreak of the city
- Enumeration method is not established (as of Jan 2021)
- Sampling of raw wastewater is difficult under the state of emergency

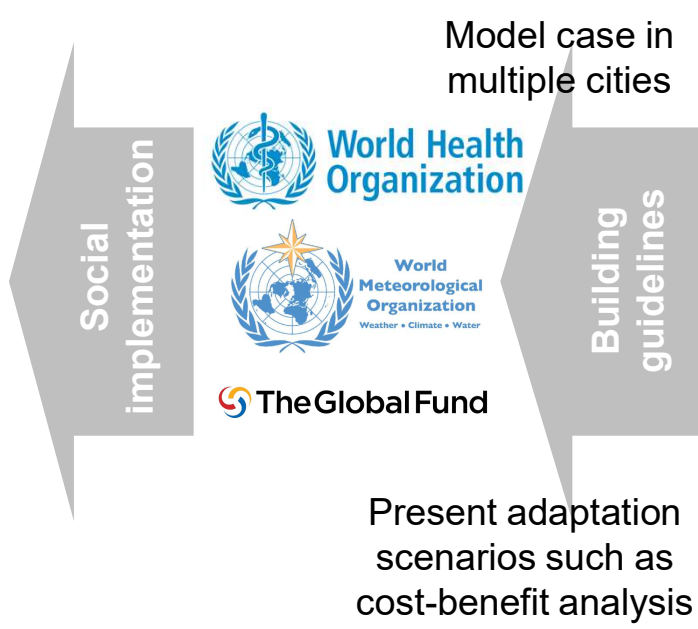# Prediction and response policy of urban infectious diseases by submersible virus measurement and geographical spatial distribution

Academic evidence building

Time series analysis

Delayed epidemiological data and statistical estimation of potential infections

Trend curve

Virus concentration in sewage

Early outbreak detection by virus information

Predicting and detecting epidemics based on sewage virus concentration

Geospatial analysis

Input: Infection history, attributes, geographic data etc

Infection history

Geospatial Information

Verification with real data

Bayesian data assimilation

Estimate hotspots from limited epidemiological data

Elucidate the uneven distribution of vulnerable populations and infection networks

Towards evidence-based policy promotion and strategic implementation at the local level

Model case in multiple cities

Social implementation

World Health Organization

World Meteorological Organization
Weather · Climate · Water

The Global Fund

Building guidelines

Present adaptation scenarios such as cost-benefit analysis

Empirical verification in target cities of developing countries + data collection and model construction in many countries

N
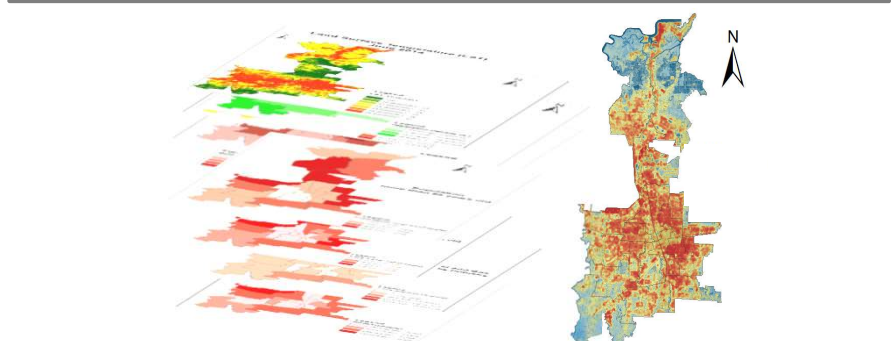
· **Recommendation of strategic intervention considering spatiotemporal uneven distribution**
· **Urban management with limited public health budget and infrastructure (presentation of model cases)**

Monitoring Wastewater:
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Preventing Disease Outbreak in Urban
Areas

- Monitoring wastewater:
  - A new and mandatory asset for sewer system
  - Prevent outbreak of known/unknown diseases
  - Secure privacy, yet identify area or infection
- Challenges
  - Water recycle
  - Decentralized water management
  - Data security

Challenges in the 21st century