東京大学 THE UNIVERSITY OF TOKYO
Research Center for Water Environment Technology
School of Engineering, the University of Tokyo

Climate change and water use management based on CREST project outcomes

Hiroaki FURUMAI
Professor
Research Center for Water Environment Technology,
School of Engineering, The University of Tokyo

CREST Symposium on Development of Well-Balanced Urban Water Use System Adapted to Climate Change
-Toward Sustainable Water Use-
Nov. 7, 2012, at Hanoi

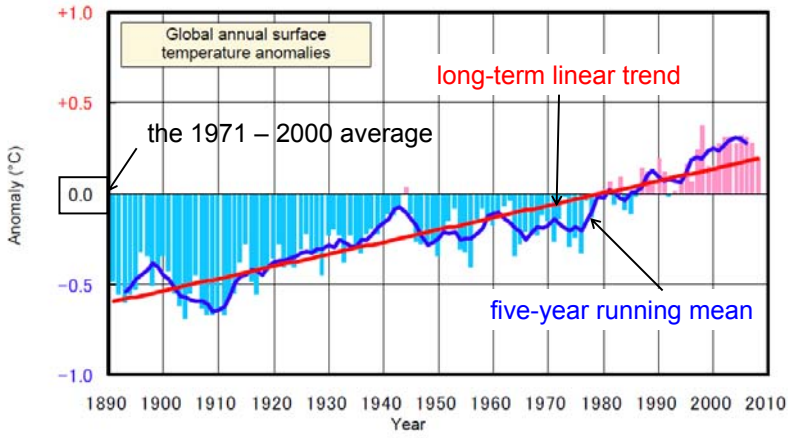
Contents

Climate variability & Climate change

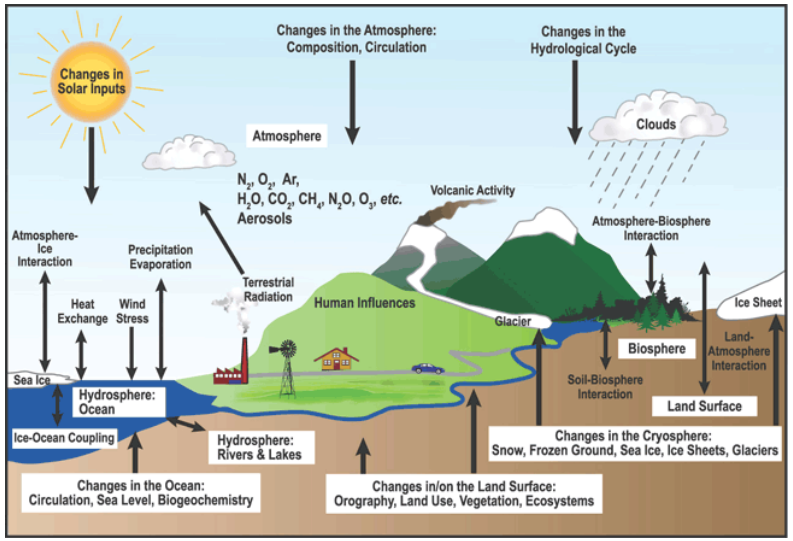
- "Climate variability" means variations from the average climate or other statistics (standard deviations, frequency of extreme values, etc.) on all temporal and spatial scales larger than individual weather events. It includes short-term variations on temporal scales of seasonal, interannual, and longer.
- "Climate change" refers to a *long-term changing trend of climate*. It means clearly noticeable changes in the average state of climate over a period of at least several decades, captured by such recognition of weather as warmer as or drier than before, or of duration of sunshine as longer or shorter than before.

Japan-MEXT, JMA and MOE (2009) Climate Change and Its Impacts in Japan

Global annual surface temperature anomalies from 1891 to 2008

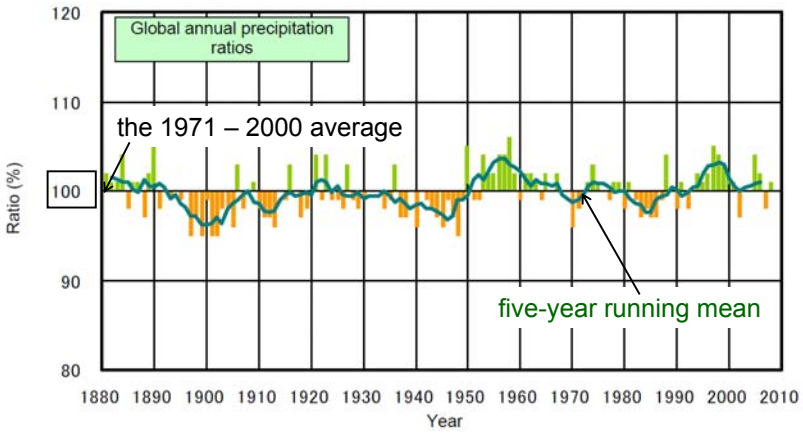


Schematic view of climate system

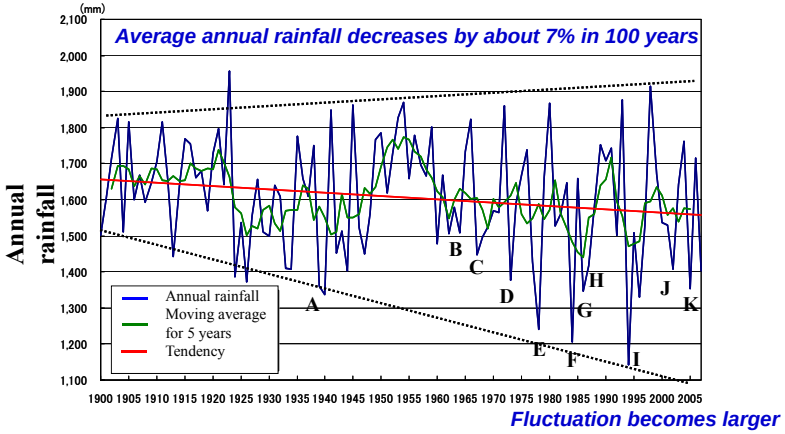


http://co2now.org/Know-the-Changing-Climate/Climate-System/ipcc-faq-climate-change-weather.html

Global annual precipitation ratios from 1880 to 2008

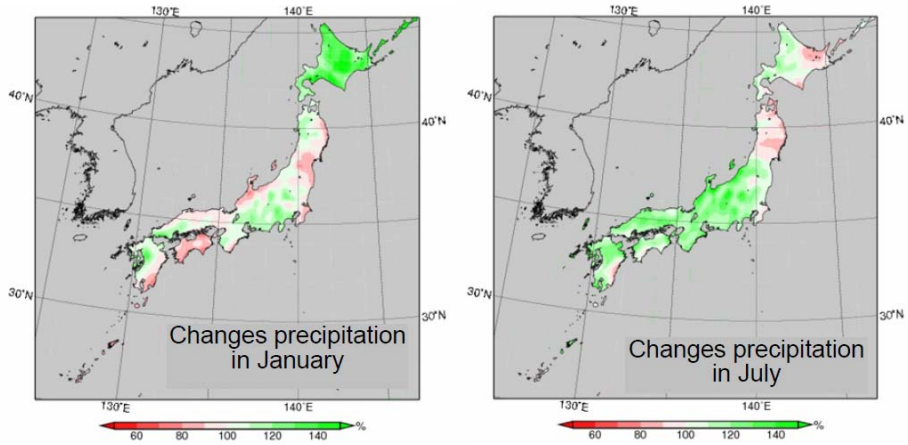


Fluctuation of annual rainfall and occurrence of drought in Japan (1900-2005)



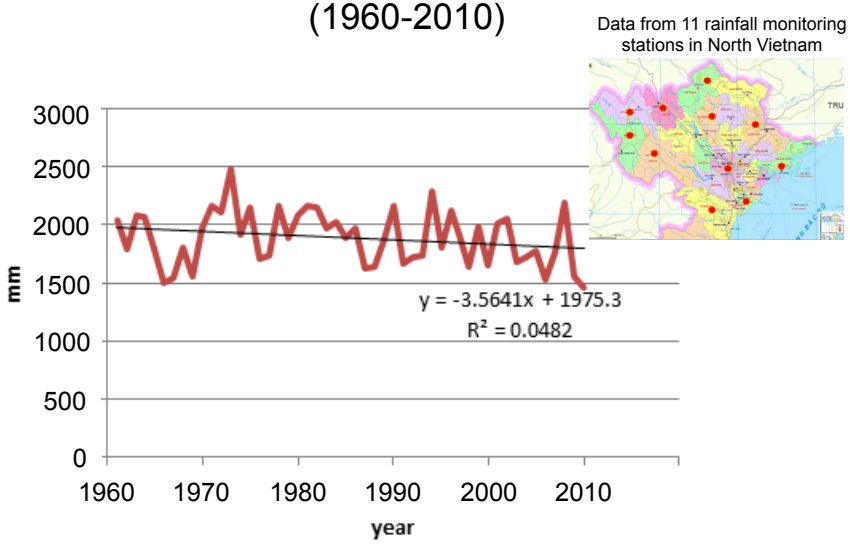
A: Lake Biwa drought(1939), B: Tokyo Olympic drought(1964), C: Nagasaki drought(1967), D: Takamatsu desert(1973), E: Fukuoka drought(1978), F: Nationwide winter drought(1984), G: West Japan winter drought(1986), H: Metropolitan area drought(1987), I: Japan Islands drought(1994), J: Matsuyama drought(2002), K: Chubu and Shikoku area drought(2005)

Projection of change in precipitation



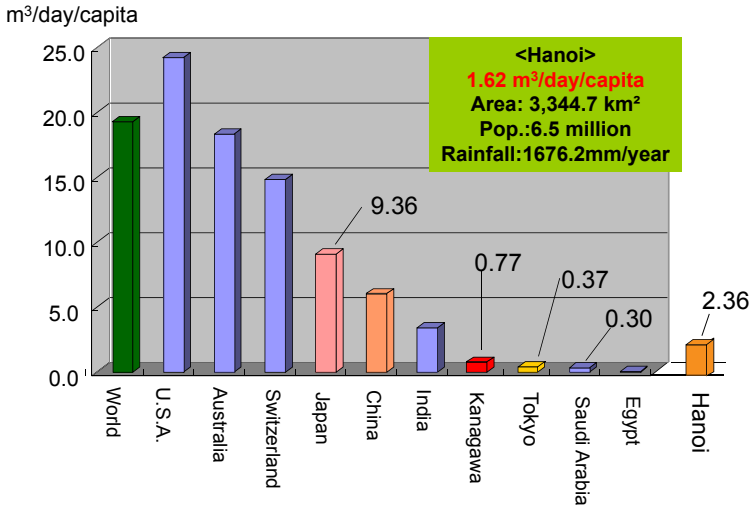
These are comparisons between the 20-year average from 1981 to 2000 and that from 2081 to 2100. Precipitations are shown as percentages (%). These are projected results under the A2 scenario that use RCM20.

Fluctuation of annual rainfall and its trend
(1960-2010)

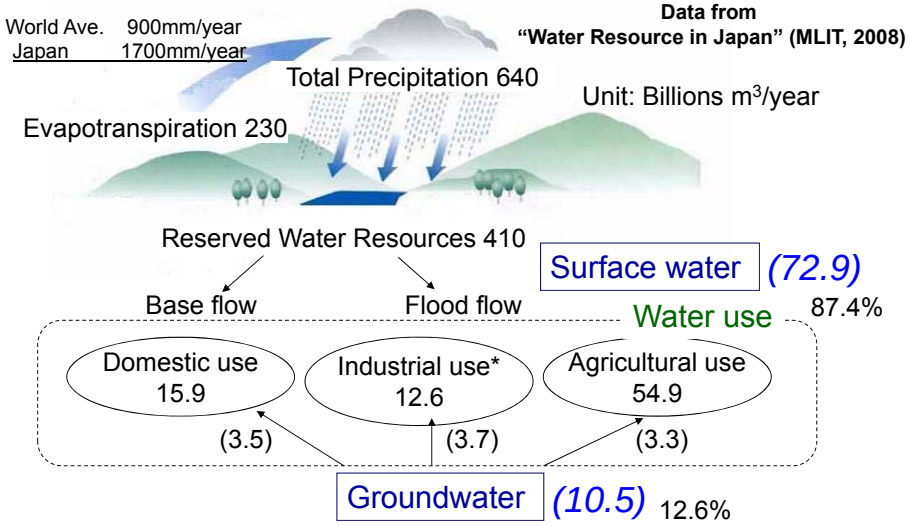


Courtesy to Dr. Taniguchi (Kanazawa Univ.)

Available amount of water resource

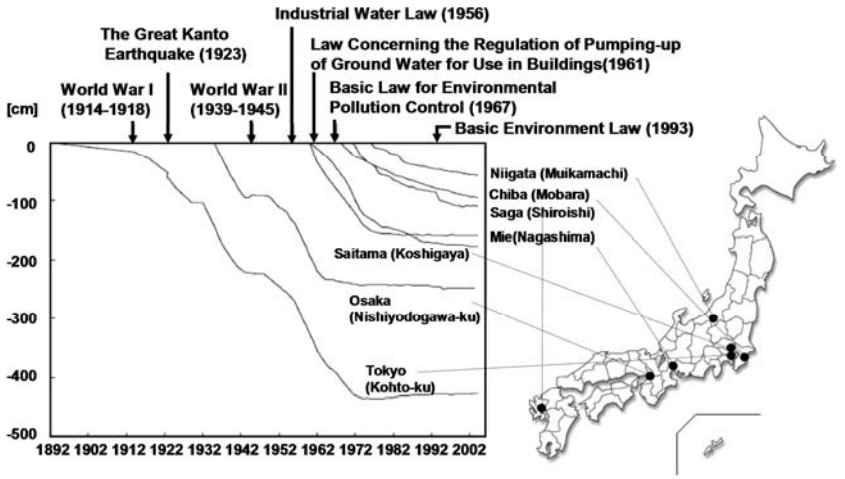


Water resource and use in Japan

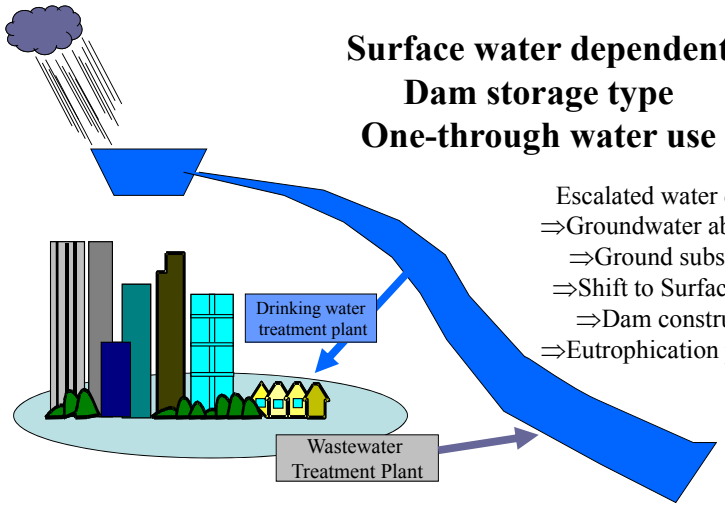


* Recycle ratio is about 80% in industrial sector.

History in escalated water demand - ground subsidence in Japan



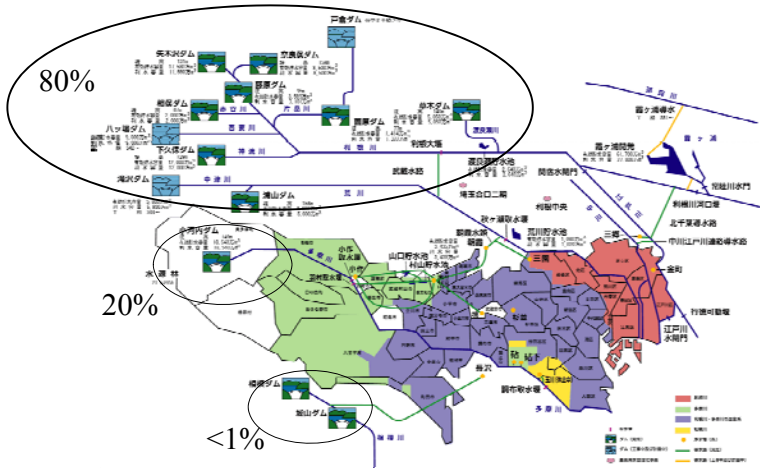
Conventional Water Resource Development and Urban Water Use in Japan



Surface water dependent
Dam storage type
One-through water use

Escalated water demand
⇒Groundwater abstraction
⇒Ground subsidence
⇒Shift to Surface water
⇒Dam construction
⇒Eutrophication problems

Water resource and Water supply system in Tokyo



Concern about the sustainability of urban water use

- Increased water demand had led to the dam construction at the upstream and the extensive water withdrawal from rivers in Japan.
- Stable water supply and efficient water use have become concerning in growing mega cities in Asia.
- Efficient water use have been implemented to reduce water intake from natural water system and to secure the sound water cycle.
- Achievement of the sustainability is required ensuring a long-term water supply with adequate quality and minimizing adverse economic, social and ecological impacts.

Research area: Innovative Technology and System for Sustainable Water Use

http://www.jst.go.jp/kisoken/crest/en/category/areah21-4.html

Climate change *Water scarcity*

Problems Recognition

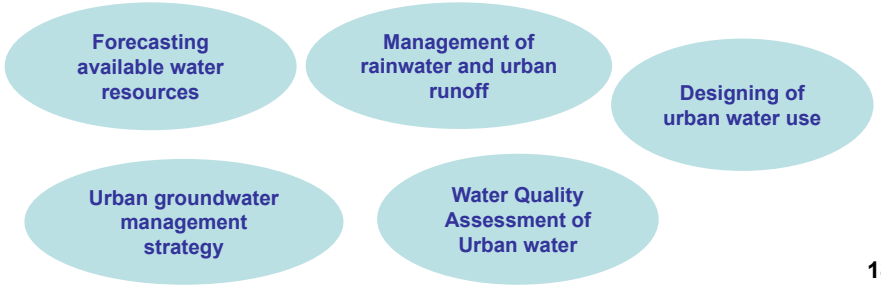
- Safe and stable water supply is strongly required in highly-populated metropolitan areas in Asia. However, the current water resources are vulnerable in those cities.
- Climate change would accelerate localization of available water resources and consequently it would become more difficult to keep stable water supply.
- To assure the safe and stable urban water supply, we must discuss the availability of "rainwater", "groundwater", and "reclaimed water" as well as surface water.
- Such "urban self-owned water resourcces " are precious and very important to solve water resource issues in urban area.

Core Research for Evolutional Science and Technology (CREST)

Research area
Innovative Technology and System for Sustainable Water Use

"Development of well-balanced urban water use system adapted for climate change"

Research Director: Prof. Hiroaki FURUMAI, University of Tokyo
Research Period: From 2009 to 2014

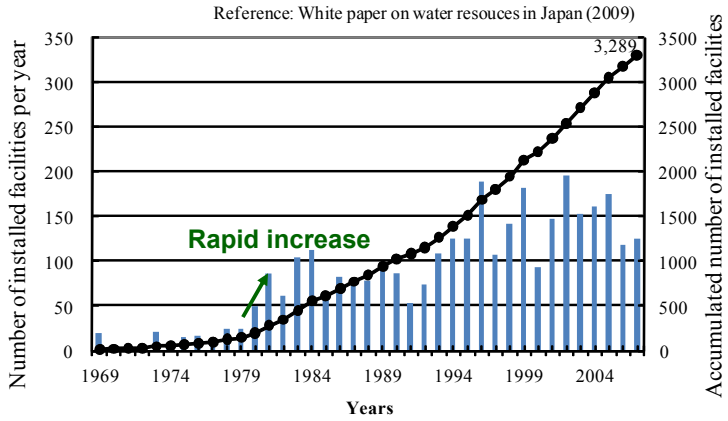


Project outline

- Reexamination of the use of rain water, ground water, and reclaimed water is required to cope with the further localized water resources due to climate change.
- We develop novel evaluation approaches for risk and stability of water quality and devise methods for water use design by considering environmental cost evaluation and preferences of various users.
- In order to create innovative strategies for urban water use under climate change conditions, comprehensive predictions is carried out to evaluate changes in weather and hydrological conditions in watersheds resulting in dynamic variations of water quantity and quality.
- Finally, we propose well-balanced urban water use systems in which the equilibrium between water supply and demand is maintained.

Installation of rainwater and reclaimed water use facilities

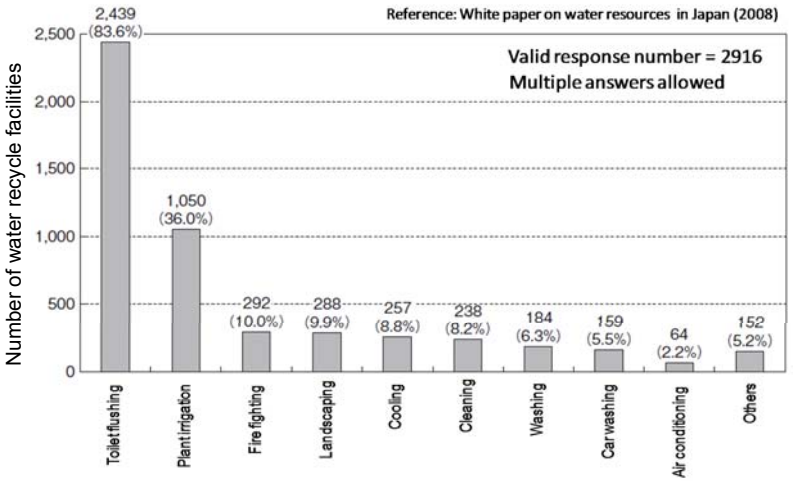
Total : 3289 facilities in 2007



The number of facilities has been increased since 1980s, in which government financing system was introduced.

Rainwater harvesting facilities: ap. 1600 in 2007

Application of rainwater and reclaimed water

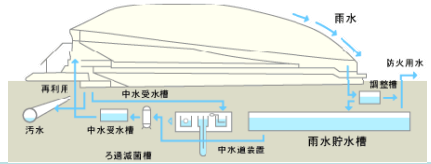


Milestones of rainwater harvesting facility

Sumo-wrestling Arena
(Kokugi-kan) 1984

Tokyo Sport Stadium
(Tokyo Dome) 1988

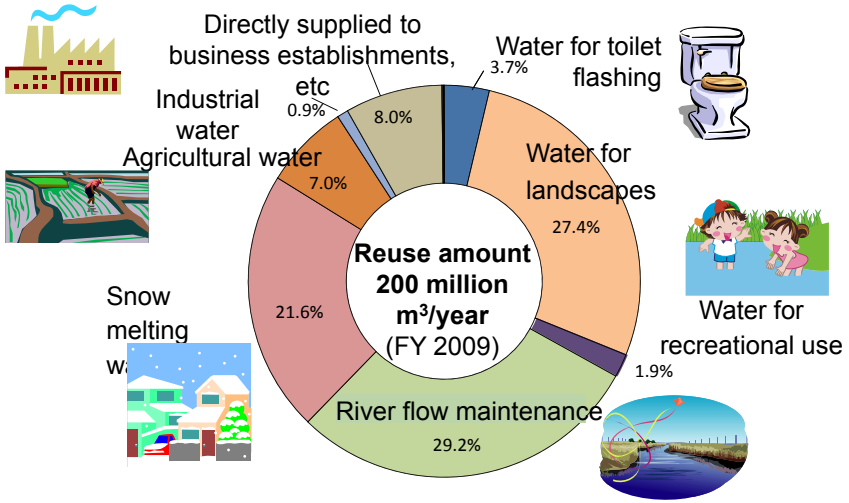
Tank Capacity of 1000m³



Tank Capacity of 3000m³
1000m³ for flood control
1000m³ for miscellaneous water use
1000m³ for emergency water use such as fire events

Reclaimed water use in Japan

The annual treated wastewater is 14.4 billion m³ in Japan.
1.4 % of the treated wastewater is reused.



Applications of reclaimed water in Tokyo

River maintenance

Water source for revival of Meguro River, etc. about 68,000m³/day

Miscellaneous waters

Water for toilet flushing in West-Shinjuku and Nakano Sakaue areas, etc.: about 9,300m³/day

Miscellaneous waters

Cleaning water for train systems, YURIKAMOME: about 1,800m³/year

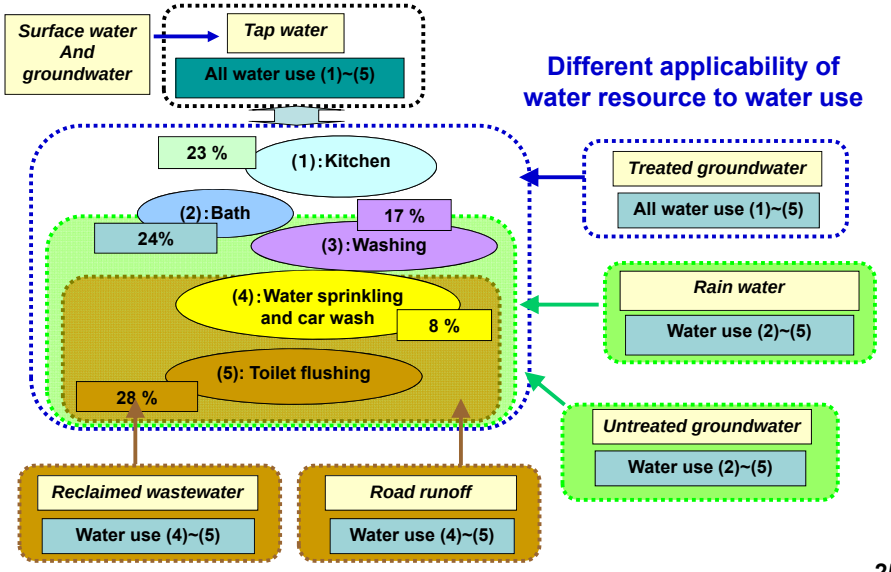
Conventional activated sludge process
+
Sand filtration or Membrane treatment
&
Ozone treatment

Total: about 78,000m³/day

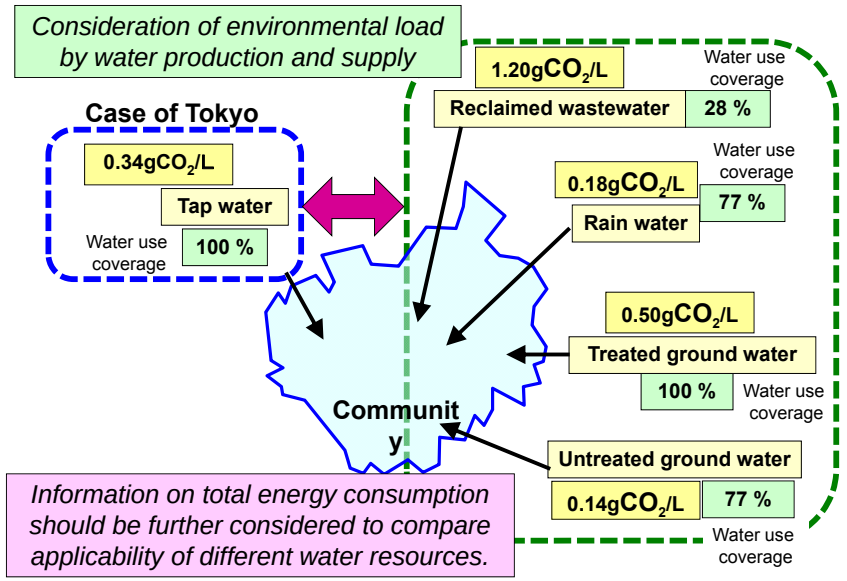
Recreational Use

Ochiai Water Reclamation Center SESERAGI NO SATO: about 16,000m³/year

Water use percentages of domestic purpose



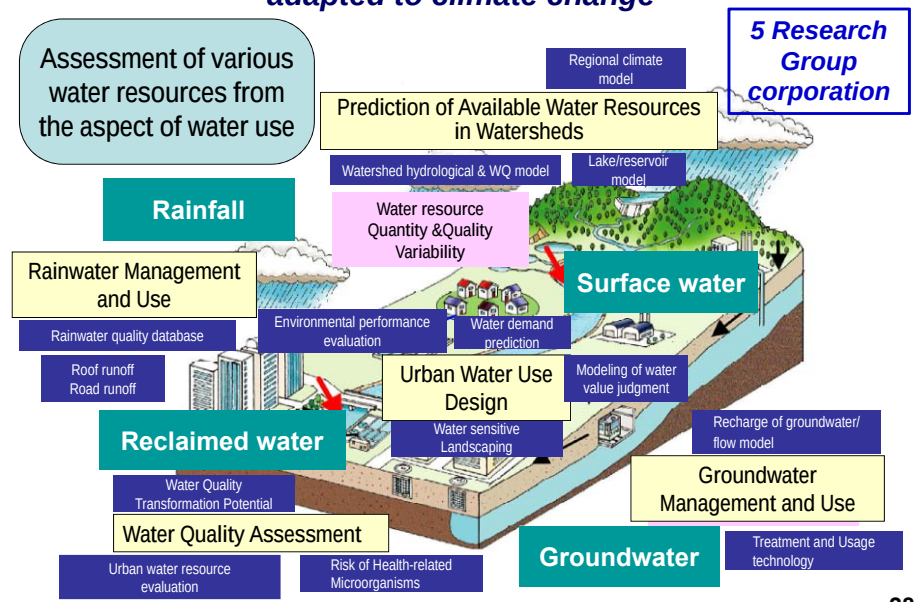
CO_2 emission for different water resources



Summary

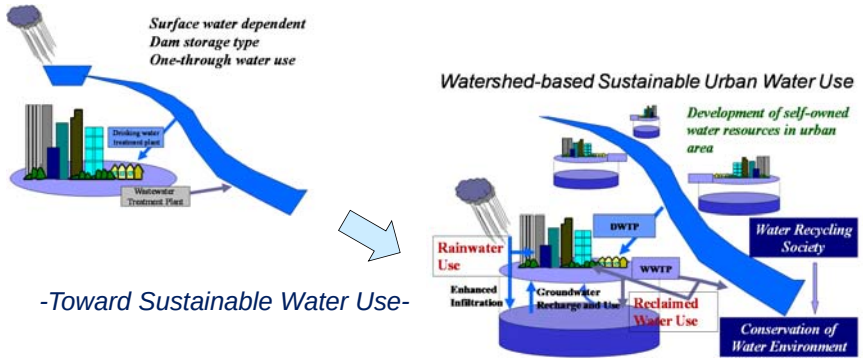
- Rainwater and reclaimed water have been applied to meet the increased water demand in urban area. From the viewpoint of sustainable water use, they have been recognized as precious urban self-owned water resources. They can be applied for multiple purposes of miscellaneous water use.
- In order to promote the rainwater and reclaimed water use, water quality should be managed to secure the sanitary safety and aesthetic appearance. Therefore, we have to pay attention to possible contamination in rainwater and proper control of water reclamation. For the purpose, WQ standard should be established based on available treatment technology.
- We also have to consider the necessary energy consumption to produce and supply the alternative water, comparing with current water supply system. In addition, we have to provide information on the various water resources to water users.

Development of well-balanced urban water use system adapted to climate change



Thank for your attention

Hiroaki FURUMAI
furumai@env.t.u-tokyo.ac.jp
Professor, The University of Tokyo

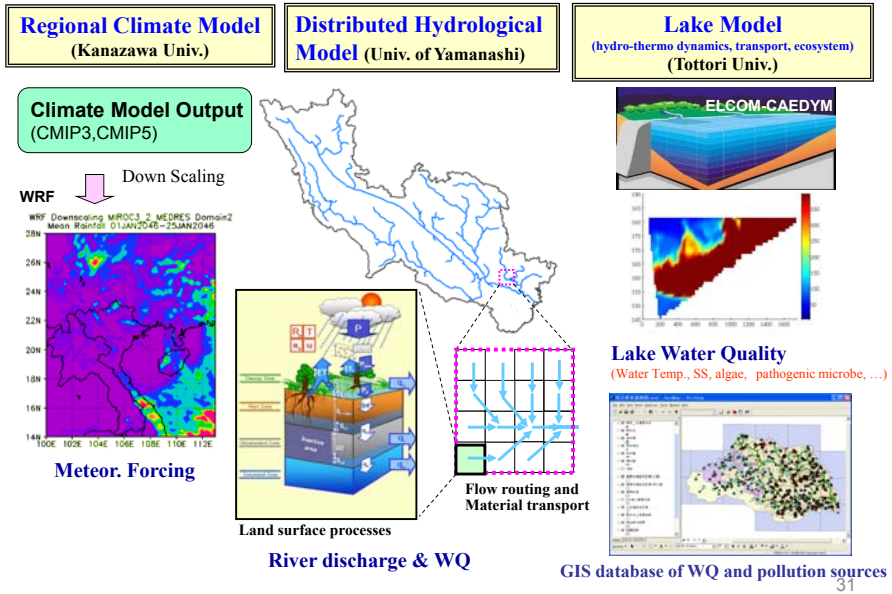


-Toward Sustainable Water Use-

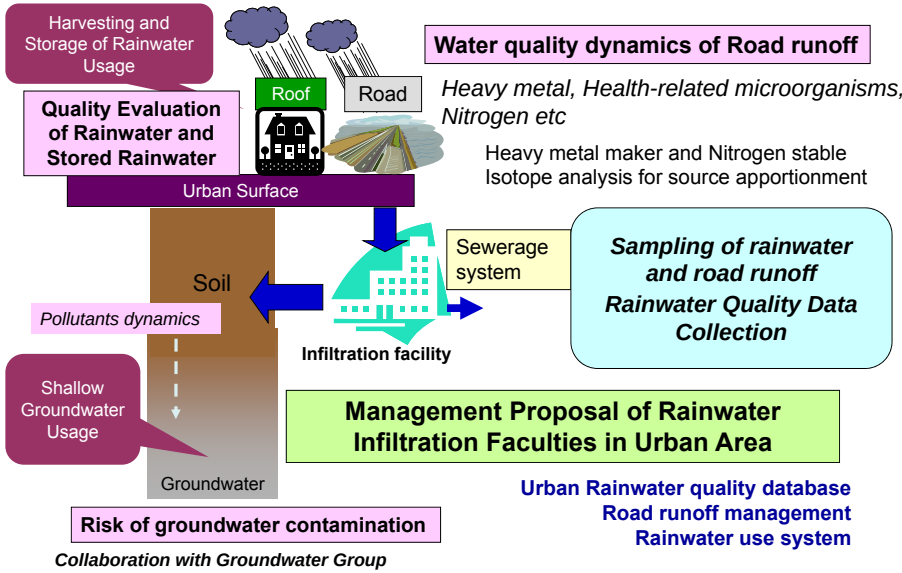
Appendix

1) Watershed Water Resources group conducts advanced hydrological simulations in watersheds to evaluate the influences of climate change on the availability (quantity and quality) of surface water and lake water.
2) Urban Rainwater Management and Use group collects information on amount and quality of rainwater and runoff water and then discuss possible strategies of rainwater harvesting and groundwater recharge by promoted infiltration.
3) Urban Groundwater Management and Use group investigates the current status of groundwater quality and recharge mechanism. Additionally, this group develops an innovative treatment technology including arsenic removal to provide safe water.
4) Water Quality Assessment group develops and proposes a comprehensive method and a novel index to evaluate quality risk of surface water, rainwater, groundwater, and reclaimed water. The method is for "comprehensive risk of health-related microorganisms" in which infectivity or viability of pathogenic microorganisms including virus is incorporated in risk evaluation. The index is named as "water quality transformation potential" in which biological stability of water during storage and distribution is examined.
5) Urban Water Use Design group devises a totally systematic method for designing water use by evaluating environmental cost and user preferences. Through the designing process, information and knowledge on the various water resources are shown to water users utilizing the outcomes of above four groups.

Framework Water Resource Research Group



Framework Urban Rainwater Research Group

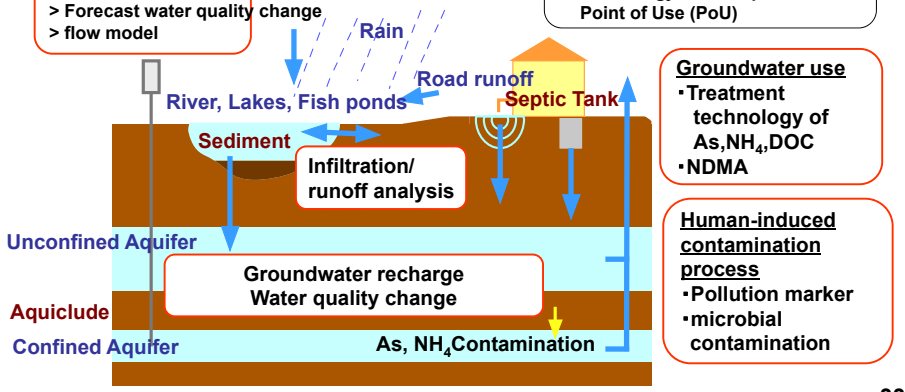


Framework Urban Groundwater Research Group

In corporation with other groups…
Evaluation of Ground water use comparing with surface water resources

Research purpose
1. Propose a new ground water management method as an ubiquitous water resources
2. Develop a new treatment technology of micropollutants at Point of Use (PoU)

Groundwater resources management technology
> Observe water level and temperature distribution
> Forecast water quality change
> flow model

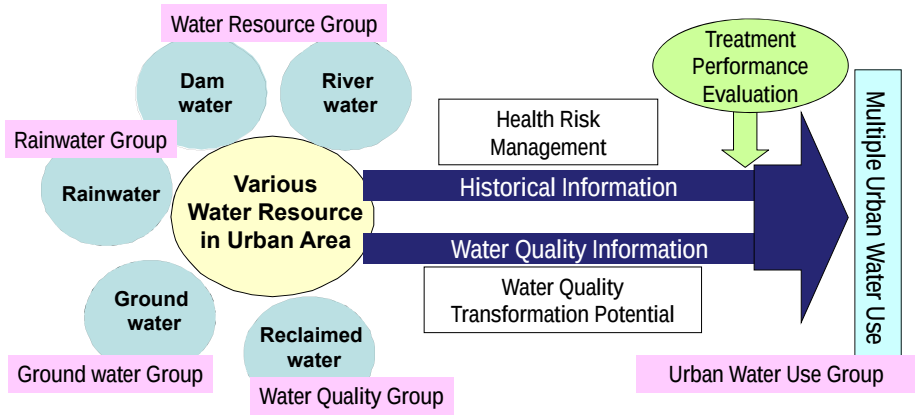


Groundwater use
- Treatment technology of As,NH_4,DOC
- NDMA

Human-induced contamination process
- Pollution marker
- microbial contamination

Framework Water Quality Assessment Group

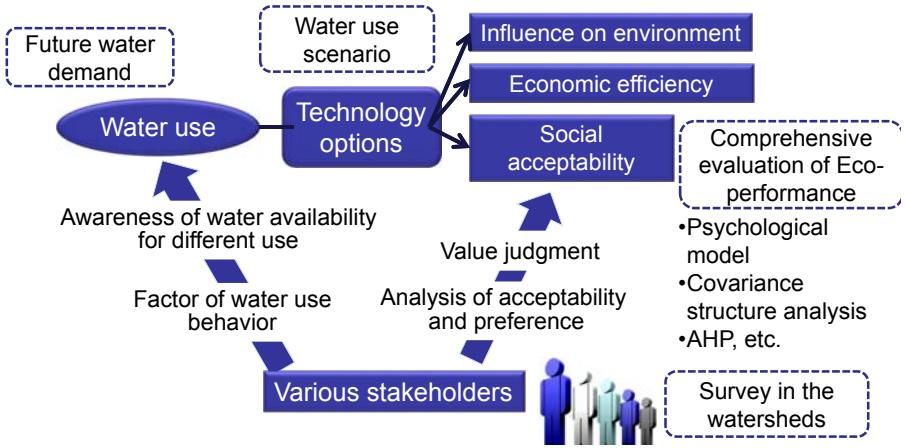
Novel Evaluation of Fecal Contamination using Virus Indicators for Water Safety



Evaluation and Prediction of Water Quality Stability during Water Storage and Distribution

Framework Urban Water Use Design Group

Proposal of design method for sustainable urban water use system considering environmentally-conscious technology and societal system



Information on available amount and detailed quality of water resources should be given to stakeholders of water use.