Water Resources Management for Mega-Cities

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The 13th Session of The United Nations Commission on Sustainable Development (CSD-13)
11-22 April, 2005, at UN Headquarters in New York

The thematic issues were:
- to provide measures to facilitate and enhance implementation in themes of
  water,
  sanitation and
  human settlements.
World Environment Day: June 5th 2005

UN Secretary-General Kofi Annan said, by 2030, more than 60% of the world’s population will live in cities. The growth poses huge problems, ranging from clean water supplies to trash collection.

(Bangkok Post, June 6th, 2005)
World mega-cities (over 5 million population)

1950: only 8 cities in the world

2015: 31 cities in Asia out of 58 cities

2020: 1 billion in Asia

(By courtesy of Dr. Takizawa, The Univ. of Tokyo)

©National Geographic, Nov. 2002
Detail Distribution of Urban Population (over 100,000)

(drawn by Dr. Ohta, Center for Sustainable Urban Regeneration, The Univ. of Tokyo)
Distribution of Urban Population from Africa to Asia

10 million

(Dr. Ohta, Center for Sustainable Urban Regeneration, The Univ. of Tokyo)
Urban and peri-urban areas are faced with many kind of threats to water resources and water environment.
Water problems with poverty in urban area

(Source: Global Environment Outlook 3, UNEP, 2002)
case study cities

by
Freshwater Resources Management Project,
Institute for Global Environment Sustainability, Japan

Singapore
Anaerobic polluted river (in Colombo, Sri Lanka)

(Heavily eutrophic river)

(photo by Ohgaki, S., 2005 April)
Bandung, Indonesia

SEVERAL EVIDENCE FOR LAND SUBSIDENCE AT BANDUNG BASIN

Land Cracking at Monitoring Well

Land Depletion on the High Way

Land Subsidence at Production Well

Source: Geological Environment, 2003

(by Mr. A.D. Sutadian)
The Construction Goes Down
**Bangkok, Thailand**

**Groundwater Problems (1) Quantity**

- **Groundwater Depletion**
  - Water level drawdown
  - More difficulty in extracting water

- **Land Subsidence**
  - Damage to infrastructure
  - Flooding
  - Disturb/deteriorate drainage systems

(by courtesy of Dr. Babel, AIT)
Bangkok, Thailand

Groundwater Problems (2) Quality

- Water Quality Deterioration
  - saltwater intrusion
    Saltwater of 2000 ppm intruded more than 80 km from the sea

Layer 2:
Phra Pradaeng Aquifer

Source: JICA 1995
Data collected in 1993
(by courtesy of Dr.Babel, AIT)
Tianjin, China
Groundwater Use and shortage of water

- South part = salt water areas
- 50% of GW use is for agriculture
- All GW use for agricultural is not counted = large different from the actual use volume?

(by courtesy of Dr. Xu He, Nankai Univ.)
TSUNAMI destroyed groundwater quality, also.

(Photo by Ohgaki, 2005 April)
**Before**

- **Fresh Groundwater**
- **Pond, Paddy Field etc.**
- **TSUNAMI WAVES**
- **Dug Well**
- **Dry Soil Cover**
- **Water Table**
- **Sea Level**

**After**

- **Saline Water Intrusion**
- **Saline Groundwater**

*Drawing by Dr. Gemunu HERATH and Shinichiro OHGAKI, (2005)*

*Freshwater Resources Management Project, Institute for Global Environmental Strategies, Hayama, Japan*

*Original concept by Dr. Atula SENARATNE, Senior Lecturer in Geology, University of Peradeniya, and also the current Chairman of Water Resources Board, Sri Lanka*
Water in Tokyo and Surrounding Urban Area as a super mega city

(population : around 26 million)
Water environment in Tokyo

Downtown, Sumidagawa River & Tokyo Bay

Surburb

Water Resources: Ogouchi Reservoir
Population with water supply/sewerage in Tokyo

Fiscal year

Total Population
Population with water supply
Population with sewerage

© 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
Artery of water in Tokyo downtown

Copyright:Hajime Ishikawa@Tokyo Canal Project  
上水本管の配置
Vein of water in Tokyo downtown

Copyright:Hajime Ishikawa@Tokyo Canal Project
Combined Sewer Overflows Problem in Tokyo

When the rain comes...

797 CSO-outlets

Combined type

Separated type

(by courtesy of Prof. Furumai, The Univ. of Tokyo)
Tama River flows through Densely Inhabited Area (22km from the river mouth)

Source: Web site of Ministry of Land and Transport, Japan
Large share of effluent from STPs in rivers

Shishigebashi bridge. 50.6%

Kodairabashi bridge 50.2%

Yanagibashi bridge 95.9%

Ryogoku bridge 71.0%

Tamakawara bridge 17.0%

Nakagawa riv.

Tamagawa riv.

Sumidagawa riv.

Shingashi riv.

Chofu intake gate 32.3%

Taishibashi bridge 35.3%

Kasaikobashi bridge 18.1%

Modified from the source: Bureau of Sewerage, TMG
Current issues associated with the water environment in urban area in Japan

- How to allocate a future water resource in watersheds
  (rational beneficial use/reuse of water)
- How to accommodate the multiple functions of “water” in urban area
  (need of co-existence between human and ecosystems)
- How to maintain and upgrade the existing infrastructures
  (e.g. aging sewerage systems, combined sewer overflow problem)
For sustainable water resources and water environment of mega-cities

We are far from the ideal sustainable cities in both economically developing and developed regions. And the water is one of the most complicated social issues, but we have and are obtaining our knowledge and tools on innovative science and technology, on new policy measures, on new implication methods, and on new system management.

For example,.....
Some Technological Policies and Practices for Water resources in mega-cities in Asia
Rainwater
for
toilet flushing and cooling water
In
Tokyo
Rainwater use

**National Sport Stadium**
- Daily use: 20.9 m³ (70% of total)
- Tank capacity: 1,000 m³
- For toilet flushing / cooling water

**Tokyo Dome Stadium**
- Daily use: 186.3 m³
- Tank capacity: 1,000 m³
- For toilet flushing
Reclaimed wastewater from a sewage treatment plant for toilet flushing reuse in a skyscrapers area in Tokyo
Shinjuku Skyscrapers and Tokyo City Hall
Shinjuku Area

Ochiai Sewage Treatment Plant
Sinjuku wastewater reuse centre

Daily supply: 2,740 m³ (30% of total)
Tank Capacity: 8,000 m³

For toilet flushing only
Reclaimed wastewater reuse systems in operation in Tokyo (*at March, 2002*)

<table>
<thead>
<tr>
<th>Category</th>
<th>Number of system</th>
<th>Volume (m$^3$ day$^{-1}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual building</td>
<td>293</td>
<td>43,809</td>
</tr>
<tr>
<td>Group of buildings</td>
<td>170</td>
<td>20,167</td>
</tr>
<tr>
<td>Large area scale</td>
<td>97</td>
<td>17,062</td>
</tr>
</tbody>
</table>

Source: Bureau of Urban Development, TMG
Reclaimed wastewater reuse for Landscape regeneration in Tokyo
Landscape regeneration using reclaimed wastewater

Picture source: Bureau of Sewerage, TMG

Senkawa jyosui

Tamagawa jyosui

Dry up

Picture source: Mitaka Education Centre
Seawater Reclamation
Experimental Facility
with
UV radiation
at
Tokyo Bay Seashore
Tokyo Downtown

ODAIBA

Tokyo Bay

Picture source: Bureau of the Environment, Tokyo Metropolitan Government:
Seashore and the Outlet of Reclaimed Seawater in a Pilot Study (Started from July 2003)

Odaiba Seashore Park
System on Reclamation of Seawater

Ariake WWTP

Discharge

Ariake Canal

pumped up

Bio-membrane filtration

UV disinfection

Medium-pressure UV lamps (1.9kW × 12)

Discharge

effluent (5000m³/d)

Odaiba seashore

(Oguma and Ohgaki, 2003)

(Photo by Masago June 2003)
Cascade system for hand-washing water followed by toilet-flushing in an individual house in Tokyo
Singapore  (population = 4.2 million)

PUB, Singapore, has ensured a diversified and sustainable supply of water for Singapore with;

**the Four National Taps**

1. Local catchment water
2. Imported water (from Malaysia)
3. NEWater (reclaimed wastewater)
4. Desalinated water (from seawater)
With the increasing scarcity of fresh water, combined with an ever increasing growth of population, the search for alternative water supplies has gained importance over the last years.
3-in-1 Concept

Benefit 1. Water Supply
The barrage, which comprises of a series of nine crest gates, will be built across the 350 m wide Marina Channel to keep out seawater. With the barrage in place, the Marina Basin will turn into a body of freshwater through natural flushing in one to two years, similar to the Kranji and Lower Seletar Reservoir schemes. The freshwater will then be treated using advanced membrane technology. This ensures that the water is safe for drinking.

Combined with Seletar Reservoir, the new Marina Reservoir will help increase the water catchment areas from half to two-thirds of Singapore by 2009. Water from local catchment is one of the Four National Taps, with the other three being imported water, NEWater and desalinated water. As one of the pillars of local water supply, Marina Reservoir will meet more than 10% of Singapore’s current water demand.

Benefit 2. Flood Control
The Marina Barrage is also part of a comprehensive low-lying areas in the city such as Chinatown, Boat Quay, and the downtown area.

Once the barrage is constructed, the steel gates will be opened to release excess storm water when it is not possible to do so during high tide, drainage capacity per second will pump out excess storm water. Pockets low-lying areas in the city will no longer be at risk of flooding.

Benefit 3. Lifestyle Attraction
As the water in the Marina Basin will be unaffected all year round. This will make it an ideal venue for all windsurfing and water-skiing. Colourful water-based yachts and pleasure craft plying between waterfront attractions for all to enjoy.
Wastewater reuse in Tianjin, China
Mobile Plant of Membrane Water Treatment System in Thailand

(By courtesy of Dr. Chavalit Ratanamskul, Chulalongkorn Univ., Bangkok)
Patchwork on Environment in Asia-Pacific Region

- Population density
- Climate (Rainfall, Temperature, ........)
- Sanitary condition
- Measures against disasters (Tsunami, Earthquake, Flooding, ....)

Pacific Ocean
Mega-cities in economically developing regions in Asia-Pacific are experiencing mainly five major surges simultaneously:

- Increasing urban population,
- Rapid economic growth and centralization,
- Unprecedented technological development,
- Social and cultural fragmentation, and
- Surge of economic globalization

(Other regions like African cities would be in the same situation.)
For future international co-operation on water issues;

Because of the patchwork-environment and the five surges in the current developing cities,

-We cannot discuss the water issues on the base of country-size but we should consider it as the specific areas.

-We should be careful that we do not misunderstand the real social issues in the specific area from the discussion on the country based data.
For possible indicators of good practices in international science and technology co-operation (especially for water):

- Does the co-operation have a clear target area?

- Is the output from the co-operation based on the facts and evidence?

- Does the output from the co-operation clarify the priority of policy options?
Acknowledgements

Colleagues and friends of

- Center for Sustainable Urban Regeneration, The Univ. of Tokyo
- Dept. of Urban Eng., The Univ. of Tokyo
- Asian Institute of Technology, Bangkok
- Chulalongkorn Univ., Thailand
- Institute for Global Environment Strategies, Hayama, Japan
  Ms. Kataoka, Y., Dr. Hara, K., Dr. Gemunu HERATH
- PUB, Singapore

- Tianjin, China
  Dr. Xu He and his team,
  Institute of Environmental Science and Engineering,
  Nankai University
- Bandung, Indonesia
  Dr. Setiawan Wangsaatmaja and his team
  West Java Environmental Protection Agency
- Bangkok, Thailand
  Dr. Mukand Singh Babel and Ms. Niña Donna Sto. Domingo
  Asian Institute of Technologies
- Ho Chi Minh City, Vietnam
  Dr. Nguyen Phuoc Dan and his team
  Ho Chi Min City University of Technology
Thank you