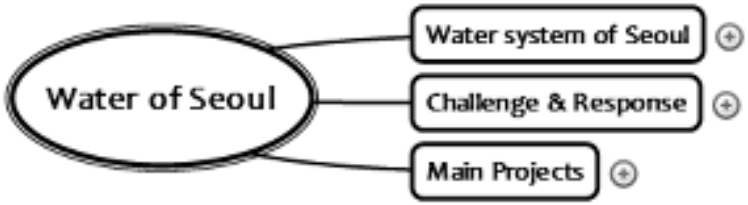
2019 Sustainable Water Management Training Program
Water Management of Seoul
Seoul, Korea
June 23 - 30, 2019

Water of Seoul

Young J. Choi

General Manager, Chief R&D Officer
Seoul Water Institute
Seoul Metropolitan Government



Contents

- **Water System of Seoul**
- **Challenge and Response**
- **Main Projects**
- Q&A and Discussion

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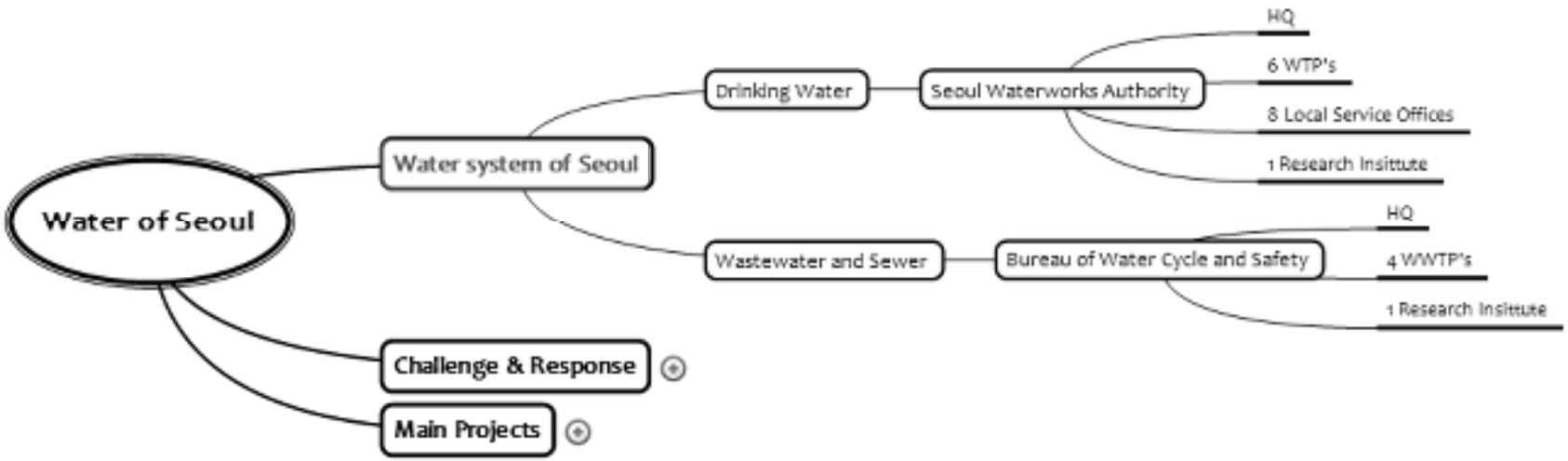


Seoul Waterworks Authority

SWA

Drinking water production and supply
As of Oct. 2018

Organization

- 1 HQ (5 Bureaus)
- 1 Research Institute (2 Bureaus, 1 Center)
- 8 Local Service Offices
- 6 WTP's
- 1 Procurement Center
- 1,896 staffs

Budget: 737 M USD

Production

- Total capacity 4.8 M m^3/day
- Production by advanced process 3.6 M m^3/day
- Average production 3.2 M m^3/day (Max. 3.5 M)

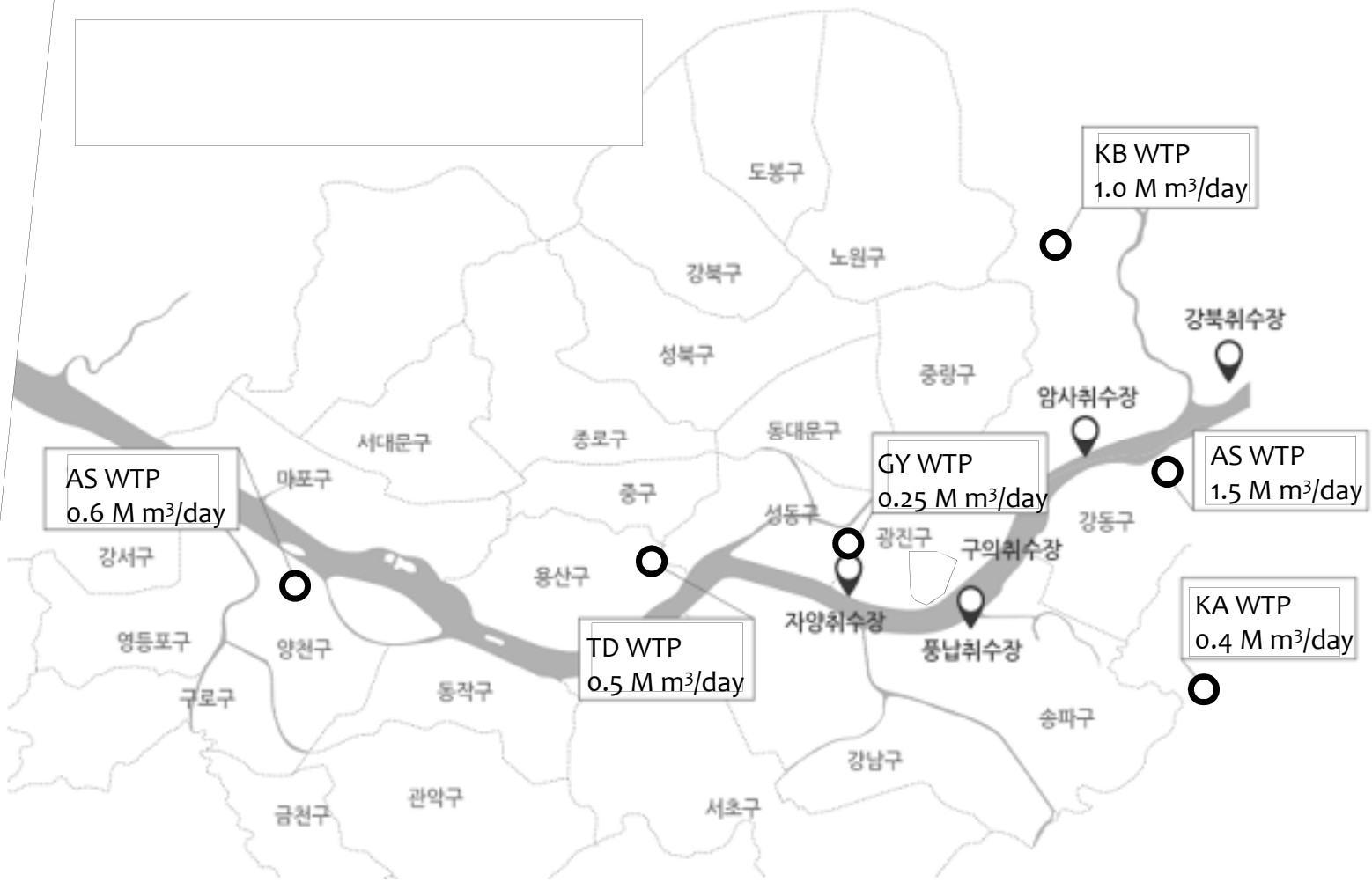
Supply

- Pipe network 13,587 km
- Reservoirs 101 (2.4 M m^3)
- Booster stations 211
- Water posts 2.2 M

Source Water Intake Stations & WTP's

5 SWIS and 6 WTP's

The 3 source water intake stations out of 5 are located within the boundary of Seoul.
The 3 WTP's cover the northern part of Seoul while the other 3 for the southern part.



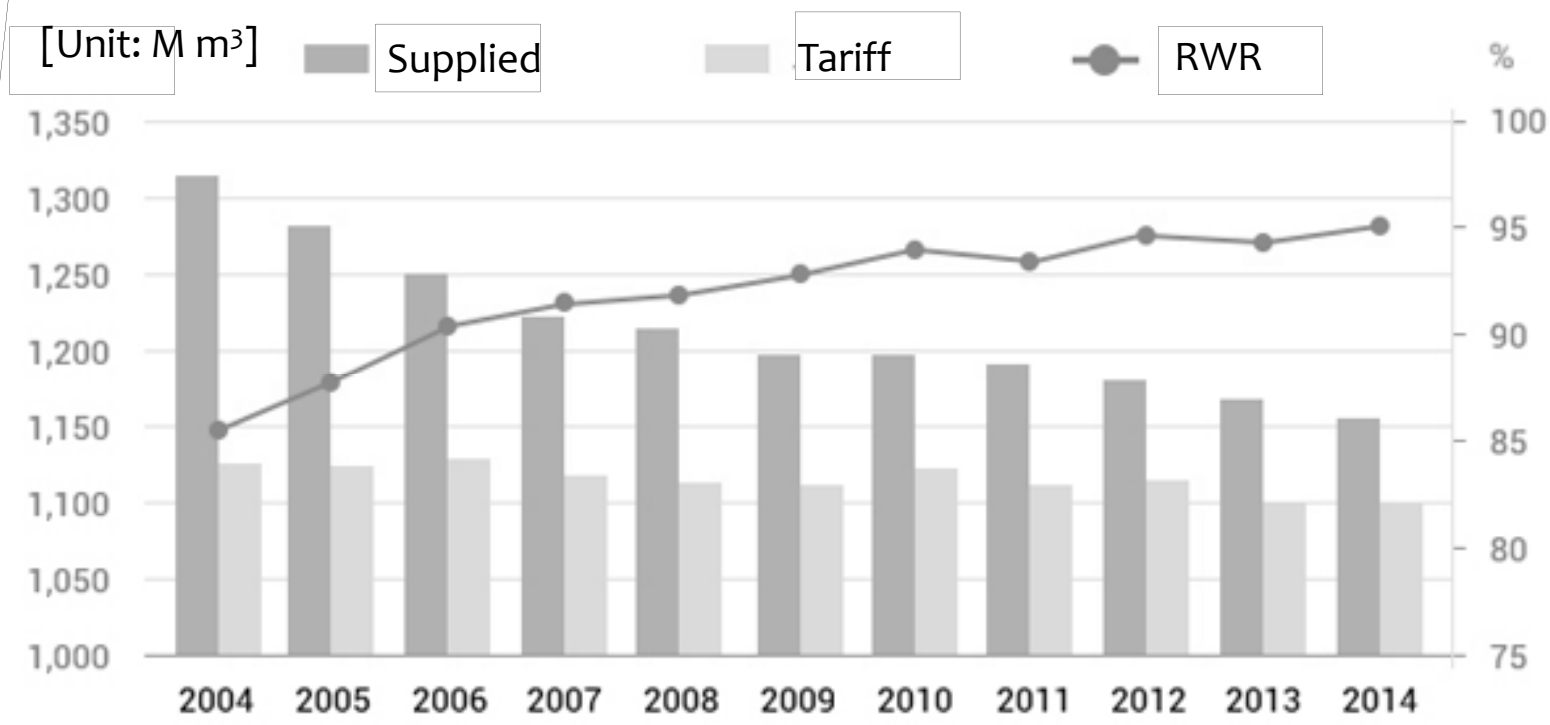
Revenue Water Ratio (RWR)

RWR 95.6% (as of 2018)

The RWR is the opposite concept of the NRW. RWR is widely used in Korea and Japan rather than NRW.

Revenue Water Ratio (RWR)

- The ratio of the volume of water paid by the customers to the volume of water supplied to the customers



Bureau of Water Cycle and Safety

BWCS

Wastewater treatment plants
Sewer system
Urban drainage system
Stream management

Organization

- 1 HQ (4 Bureaus)
- 1 Research Bureau
- 4 WWTP's
- 646 Staffs

(The local sewers are managed by the local autonomous government)

Budget: 1.1 B USD

Treatment Capacity

- Total treatment capacity 5.0 M m^3/day
- Average treatment 4.3 M m^3/day

Sewer system

- 10,616 km

Urban drainage system

- 16 Drainage Areas with 239 Unit Drainage Areas

Wastewater Treatment Plants

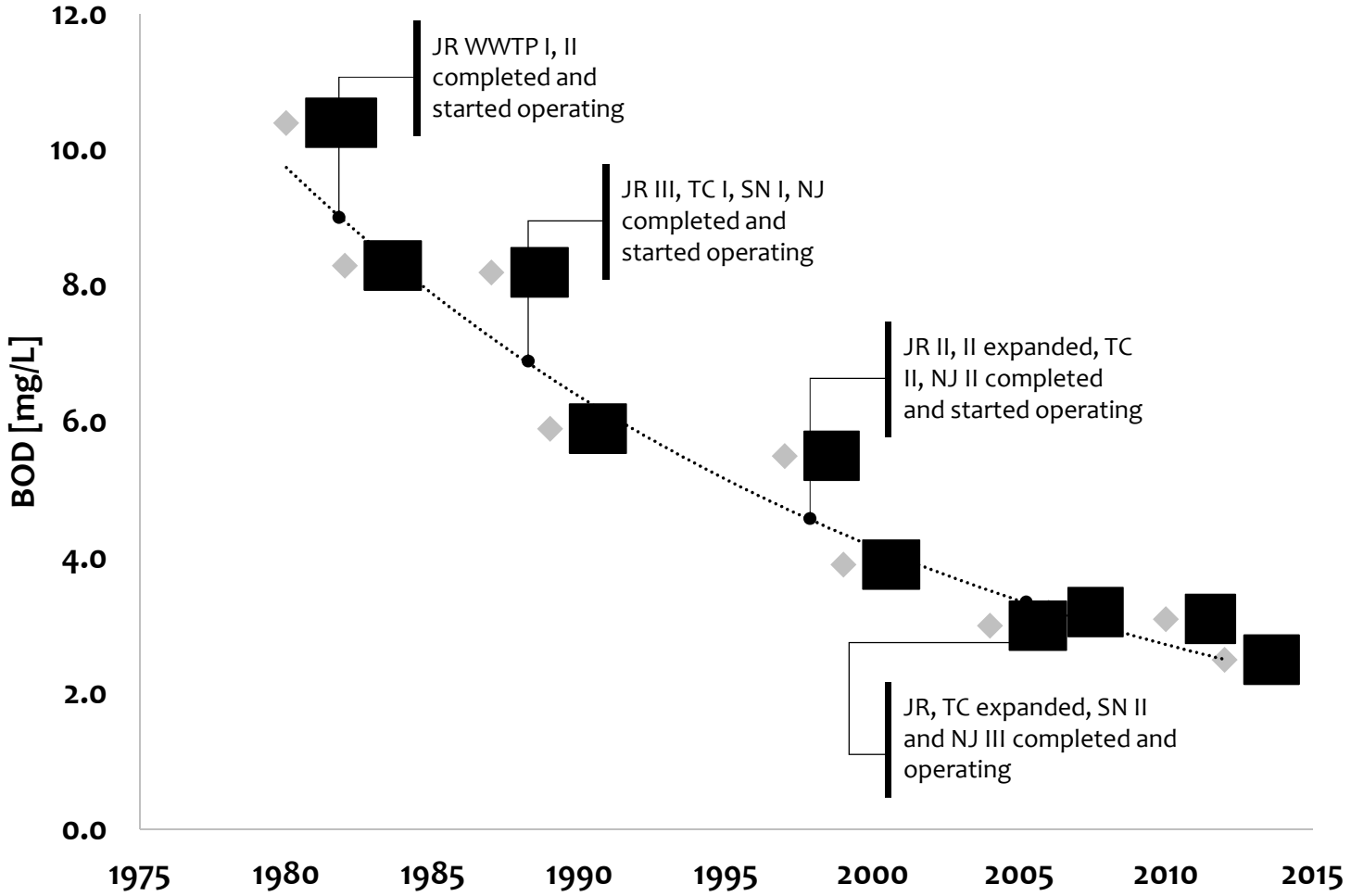
4 WWTP's

There are 4 WWTP's in Seoul, which has 12 M population including the commuters and tourists. Each WWTP is huge.

Water Quality of the Han river

BOD of the Han river

The river water quality was monitored at the mouth of the Han river.
The water quality seemed to be closely related with the capacity of wastewater treatment plants.



Seoul Water Institute

SWI

Analytical Lab
R&D
Planning & Strategies

Organization

- 2 Bureaus and 1 Center
- 11 Departments
- 91 Researchers and Staffs

Budget: 5.9 M USD (excluding salaries of the staffs)

Certified Lab

- 6 national and international certifications including ‘drinking water quality analytical lab’

Project

- 76 Research projects
- 20 Monitoring and investigation projects

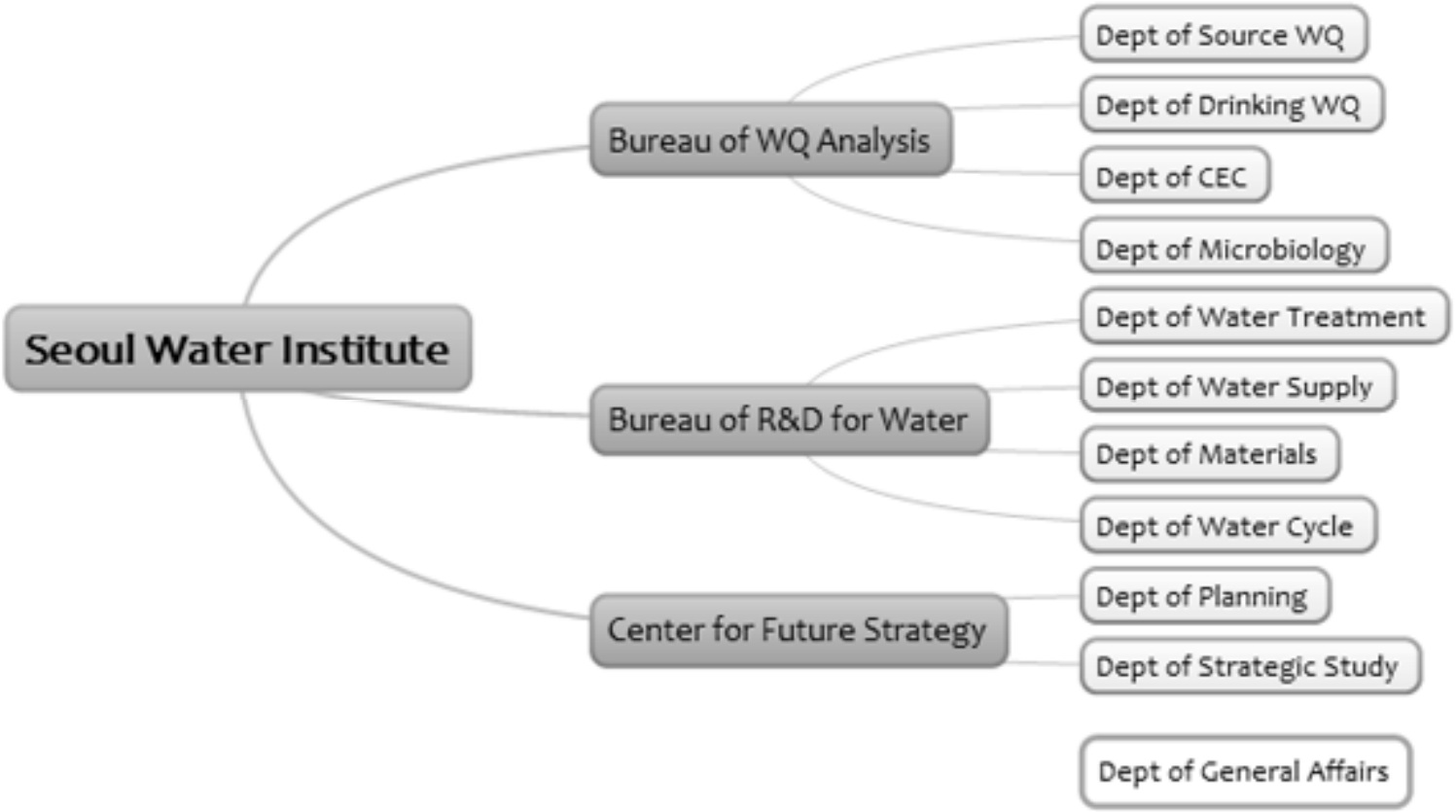
Plant & Instrument

- 8 pilot plants
- 711 analyzing instruments

Organizational Structure

2 Bureaus, 1 Center, 11 Depts

Bureau of WQ Analysis
Bureau of R&D for Water
Center for Future Strategy



Water Quality Monitoring

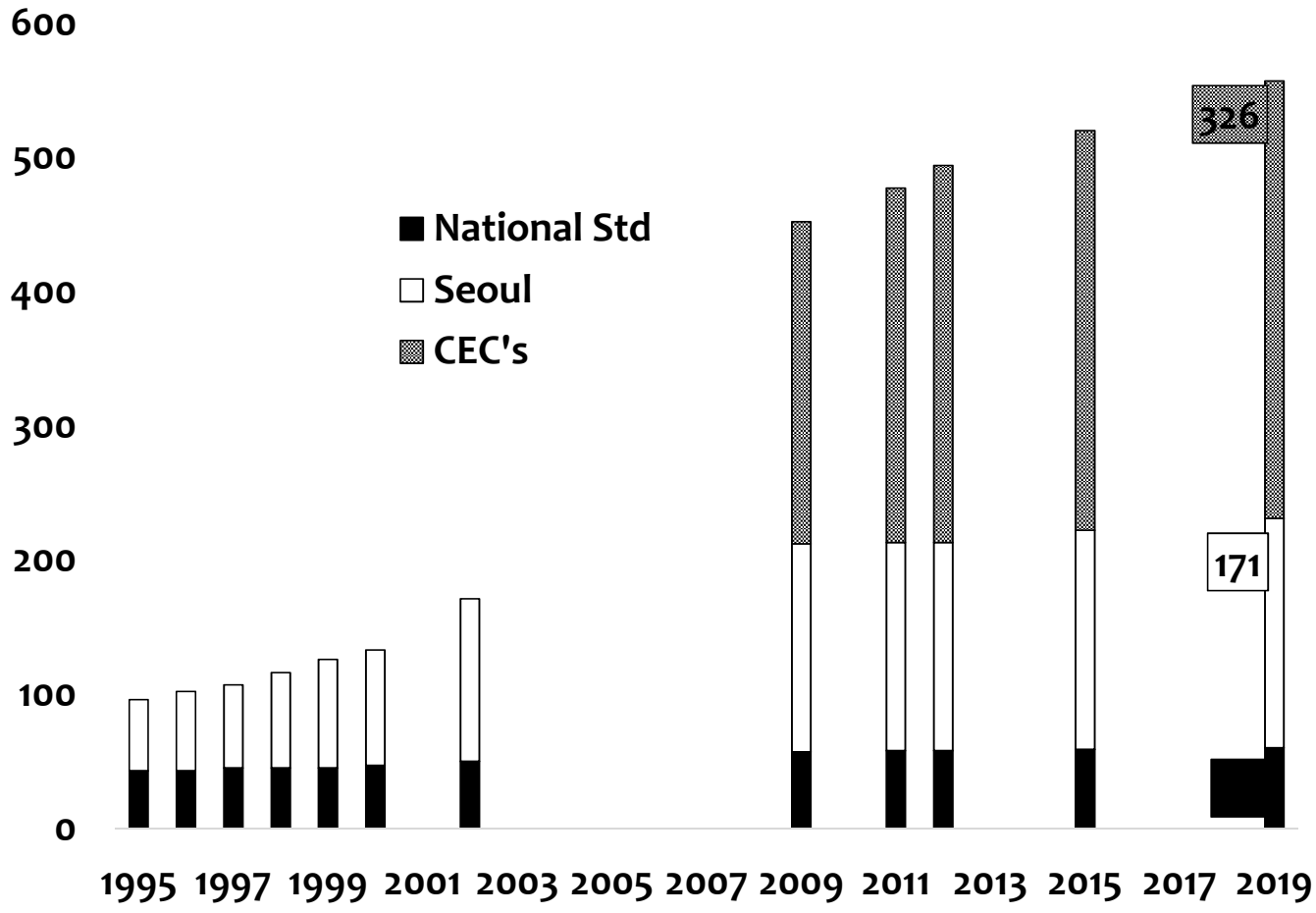
171 WQ Items

The institute monitors 171 water quality items for drinking water and 148 items for the source water

Clean & Safe Water

326 WQ Items

The number of water quality items to be monitored:
National standard 60
Seoul's guideline 171
Total WQ items including CEC's 326



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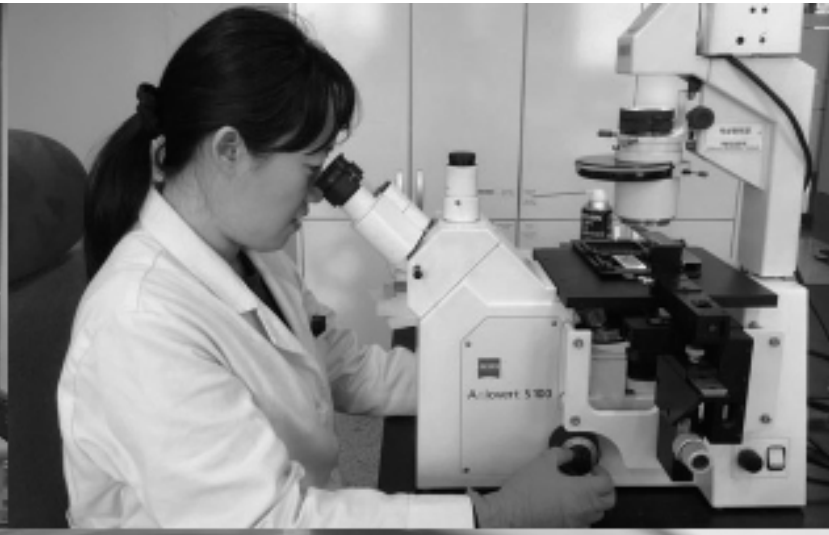

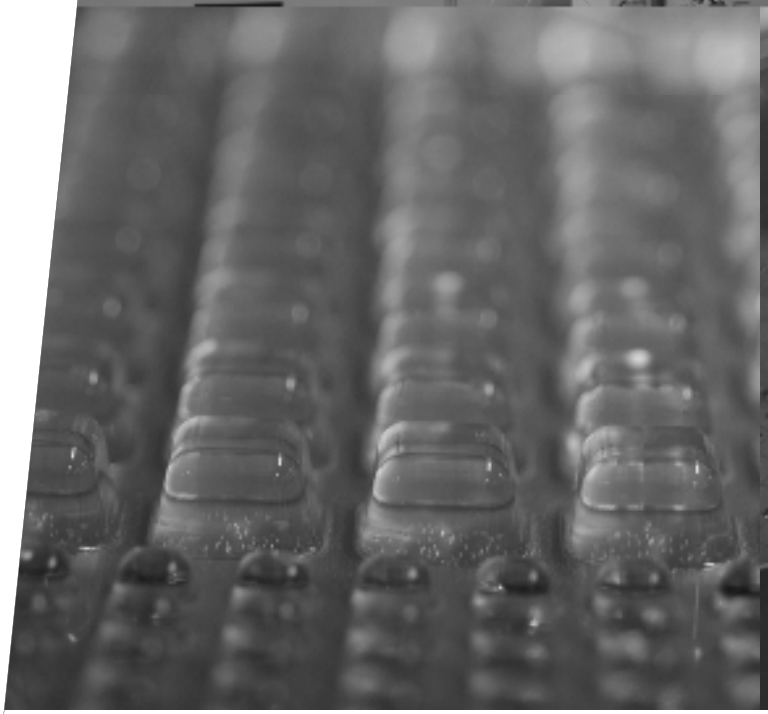

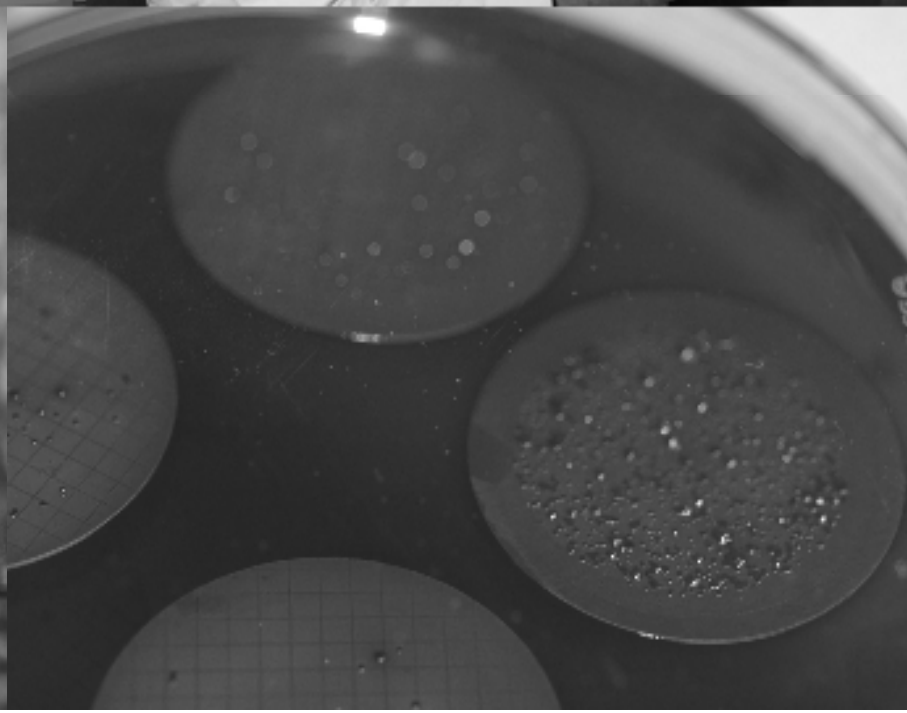

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Challengess

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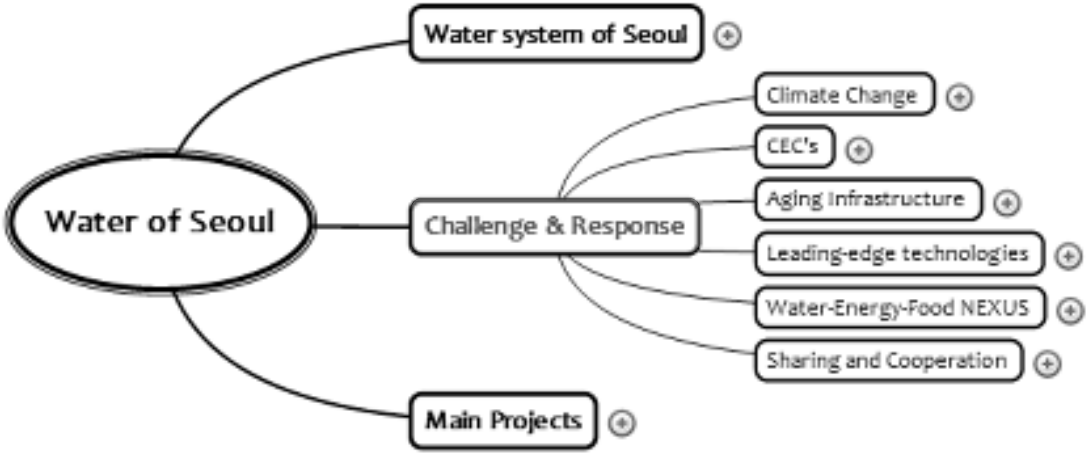
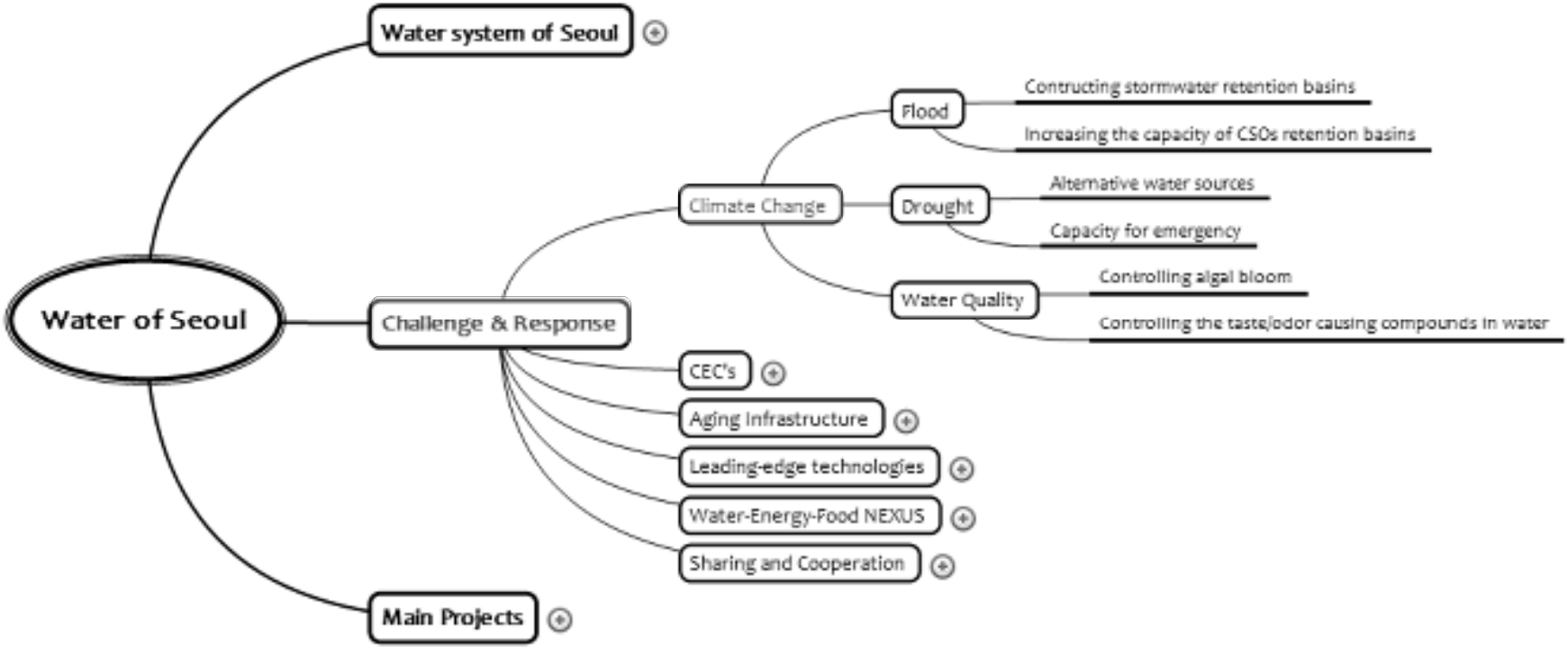


Challenge & Response

Arnold J. Toynbee

Civilizations arose in response to some set of challenges of extreme difficulty, when "creative minorities" devised solutions that reoriented their entire society.

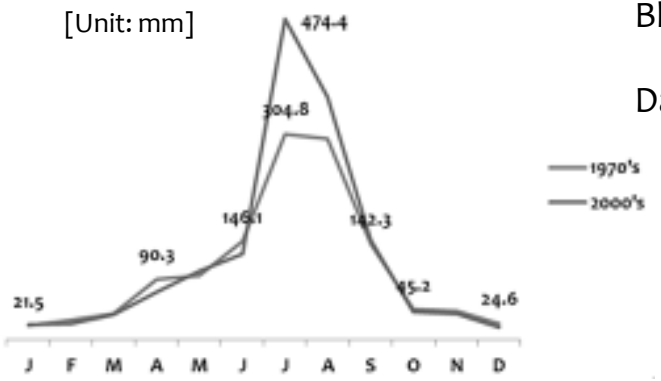
- Climate Change
- CEC's
- Aging Infrastructure
- New Technologies
- Water-Energy-Food NEXUS
- Knowledge Sharing and Cooperation



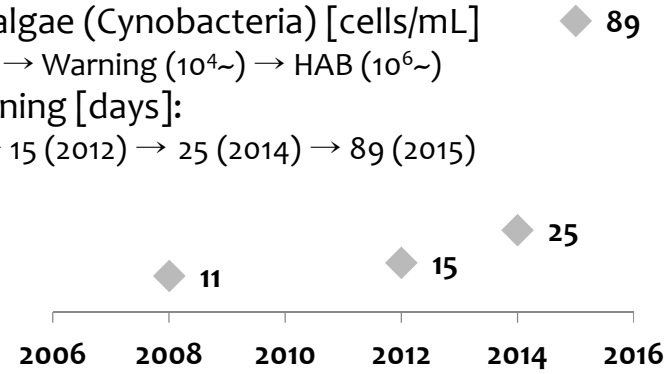
Climate Change

Adaptation/Mitigation

Flood
Drought
Water quality change



Blue green algae (Cynobacteria) [cells/mL]
Alert (10^3~) → Warning (10^4~) → HAB (10^6~)
Days of warning [days]:
11 (2008) → 15 (2012) → 25 (2014) → 89 (2015)



Flood

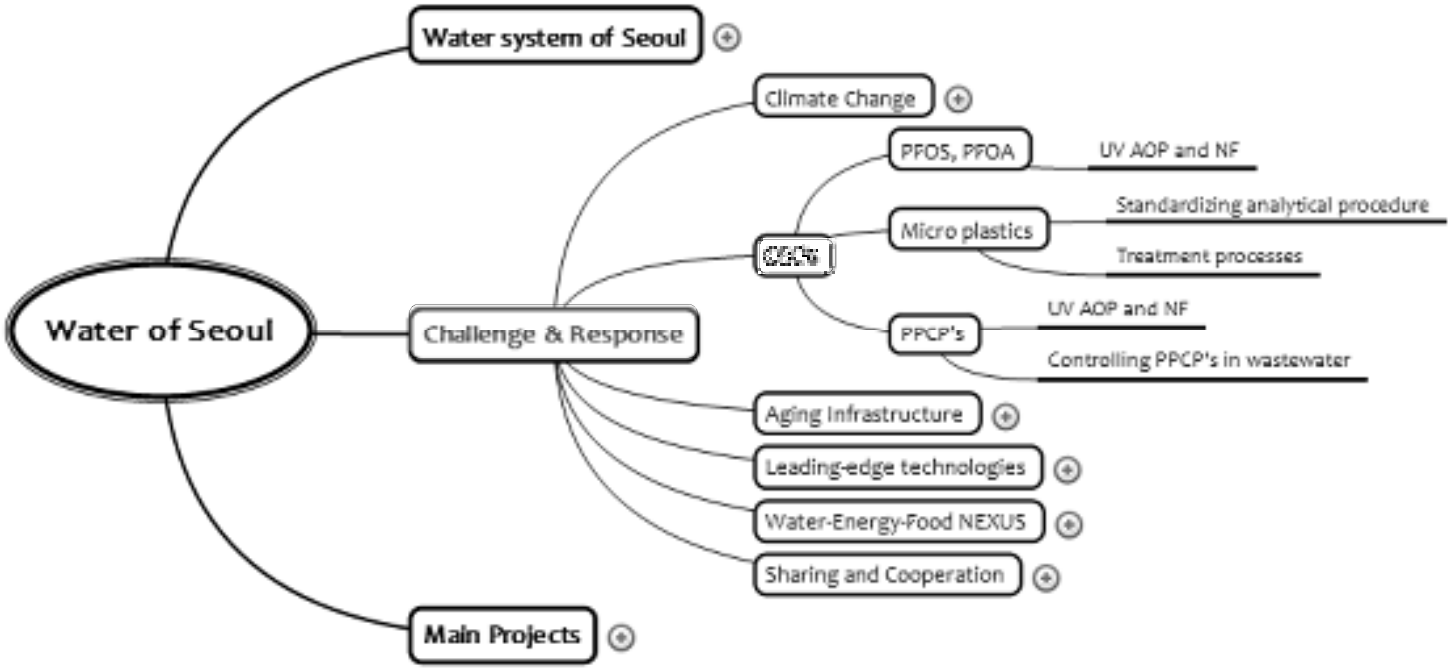
- Stormwater retention basin: 17 (103,564 m^3) → 26 basins
- CSOs retention basin: 2 (11,000 m^3) → 11 basins (361,000 m^3)

Drought

- Alternative water sources
- Water supply capacity for emergency

Water Quality Changes

- Algal bloom
- Taste/odor causing compounds (2-MIB and Geosmin) control



Compounds of Emerging Concern

CEC's

PFC
Microplastics
PPCP's

Perfluorinated Chemicals (PFOA, PFOS)

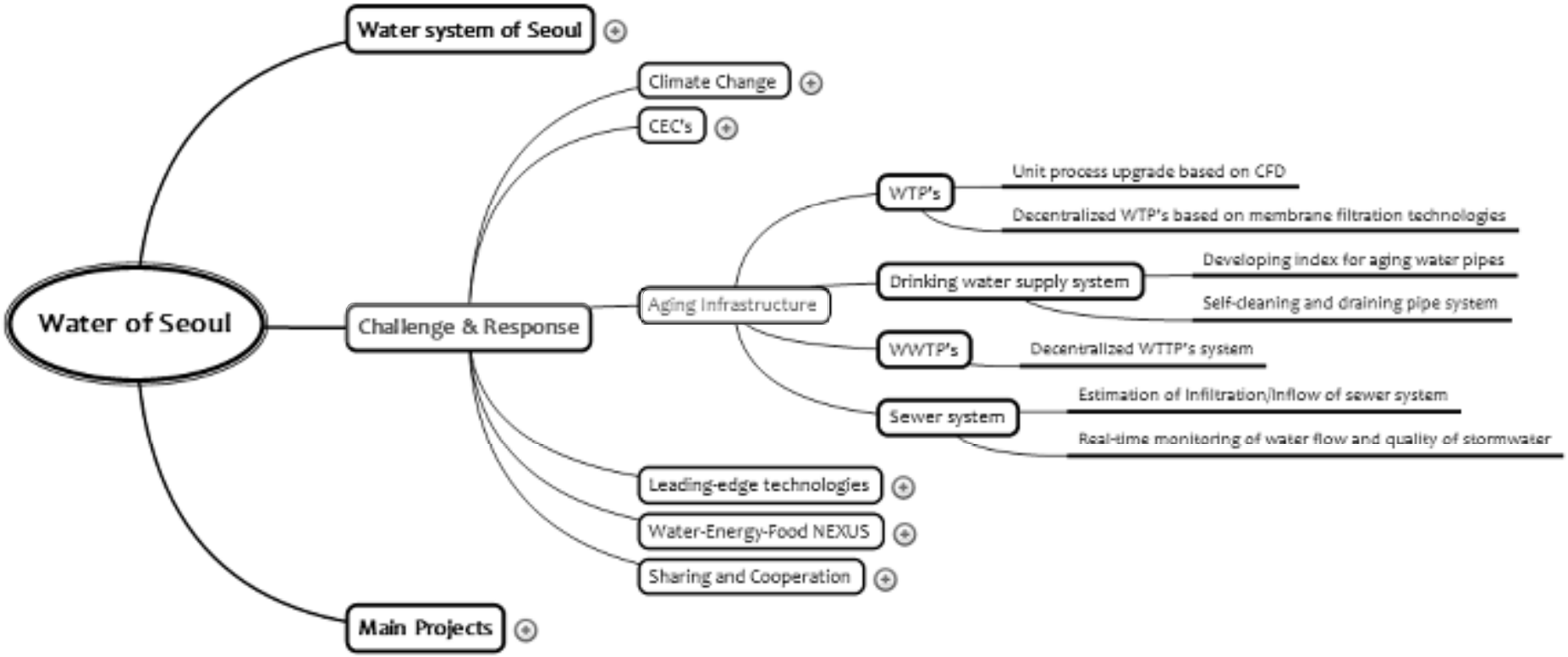
- UV AOP and NF

Microplastics

- Standard analytical methods
- Treatment processes

PPCP's

- UV AOP and NF
- Control PPCP's in wastewater



Aging Infrastructure

Renovation

31.4% of 185,709 km of water pipes and 58.8% of the 486 WTP's in Korea are older than 20 years.

WTP's

- Unit process renovation
- Decentralized WTP's using membrane filtration

Drinking Water Supply System

- Index for aging water pipes replacement
- Self-cleaning and draining system

WWTP's

- Unit process renovation
- Decentralized WWTP's

Sewer System

- Infiltration/Inflow of sewer system
- Water flow and quality monitoring

Membrane Filtration System

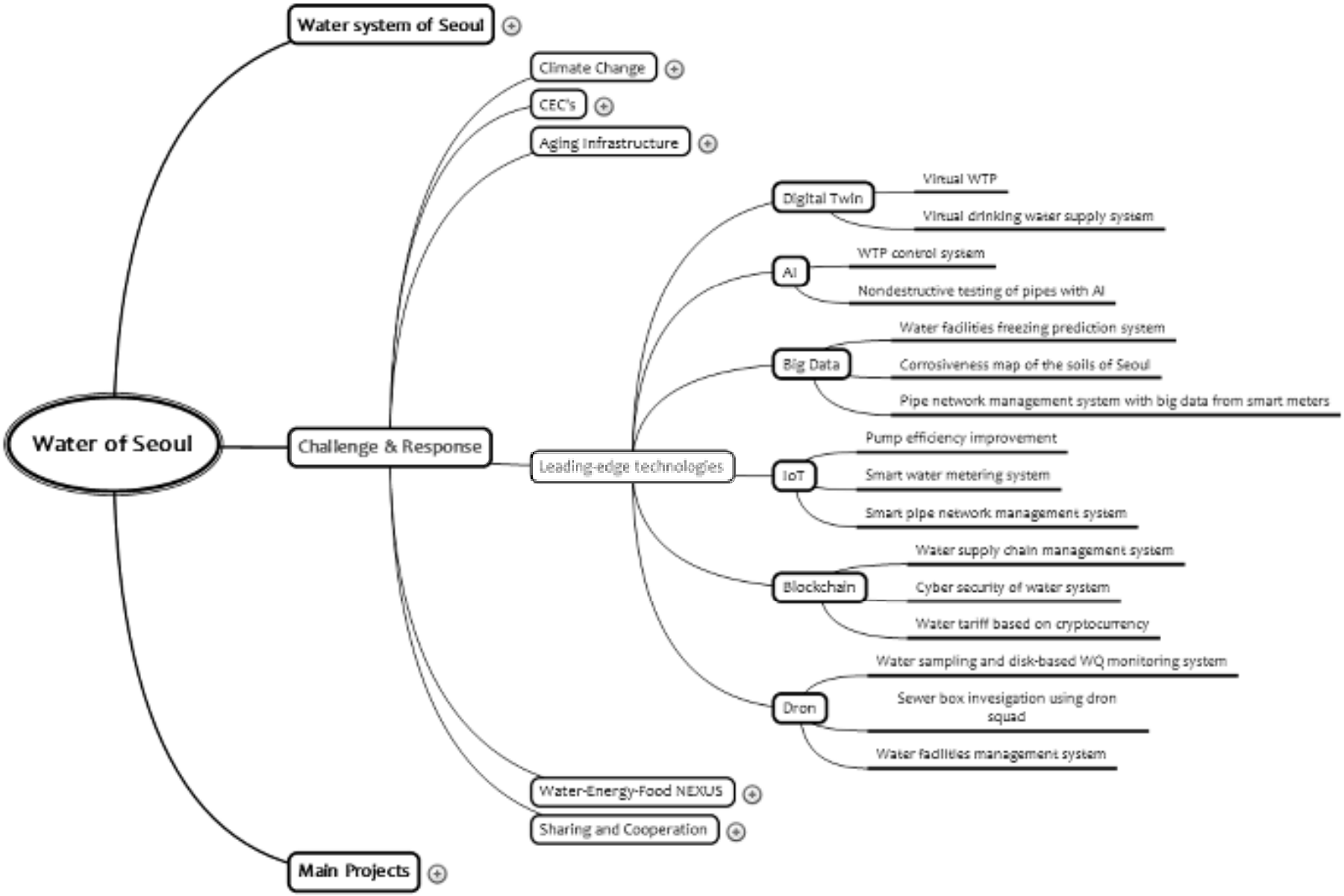
Membrane system for Seoul

Membrane system optimized for Seoul

Membrane Filtration System

Membrane system for Seoul

Membrane system optimized for Seoul



Leading-edge Technologies

The 4th IR Technologies

Digital Twin
AI
Big Data
IoT
Blockchain
Dron

Digital Twin

- Virtual WTP and drinking water supply system

Artificial Intelligence

- WTP control system
- Nondestructive testing of pipes with AI

Big Data

- Accident prediction system
- Soil corrosiveness map of Seoul

IoT

- Pump efficiency improvement
- Smart water metering system

Blockchain (in planning)

- Water supply chain management
- Cyber security of water system, i.e., tariff, asset management

UAV (in planning)

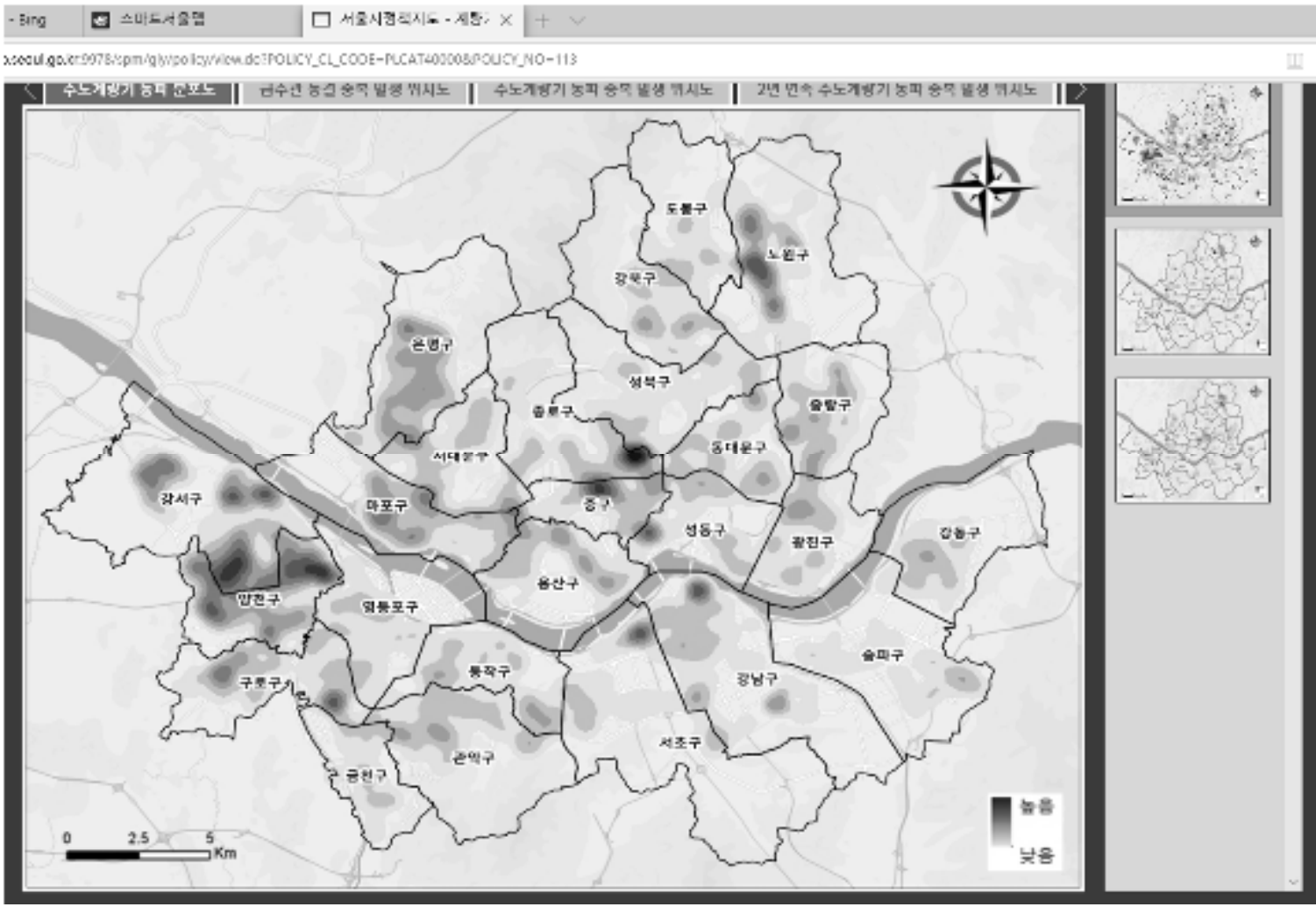
- Water sampling
- Sewer box investigation

Smart Seoul Map : Water meter free from freezing

Big data based map

The mapping system is an accident prediction system

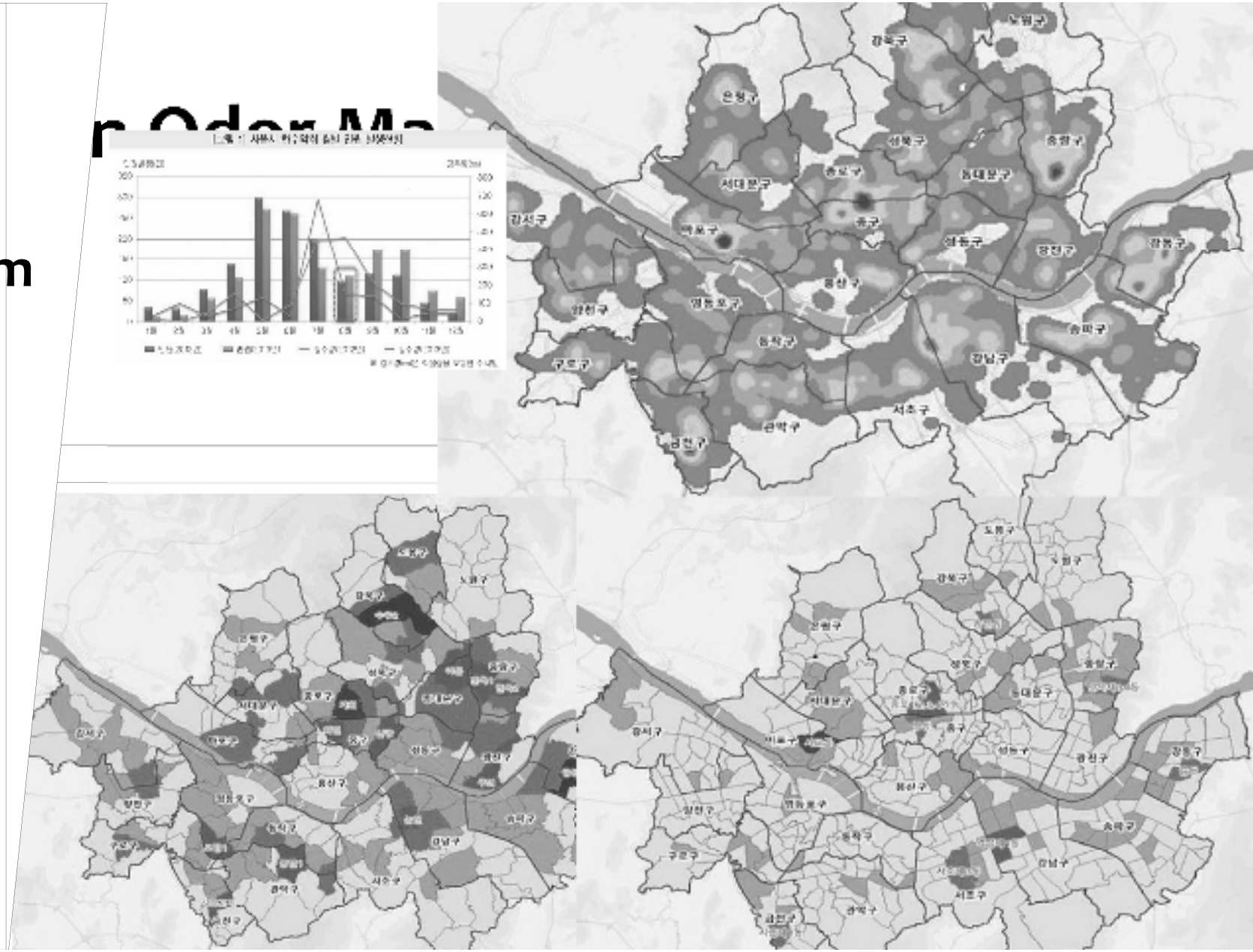
http://map.seoul.go.kr/smgis/webs/main/main.do



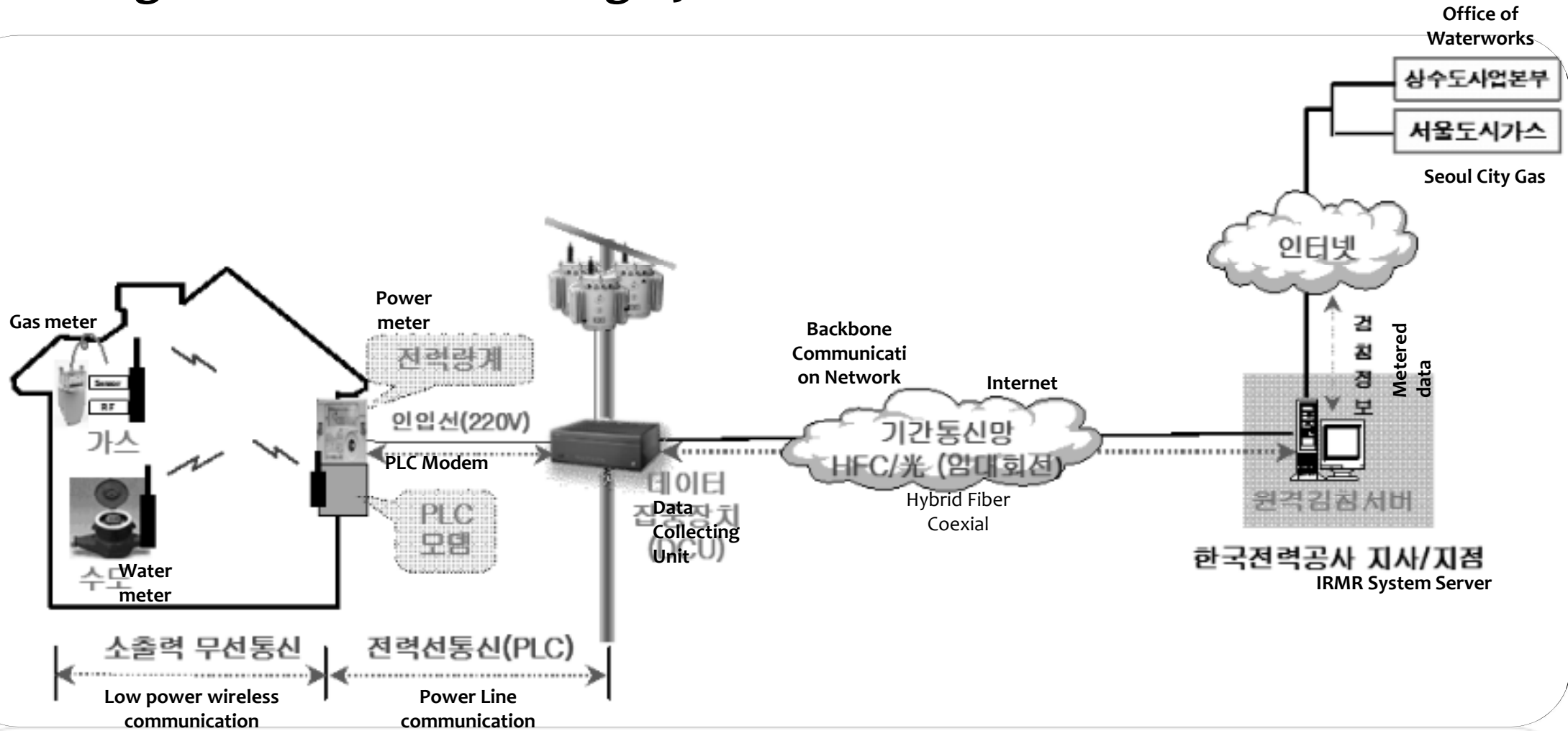
Urban Odor Mapping System

Urban odor control

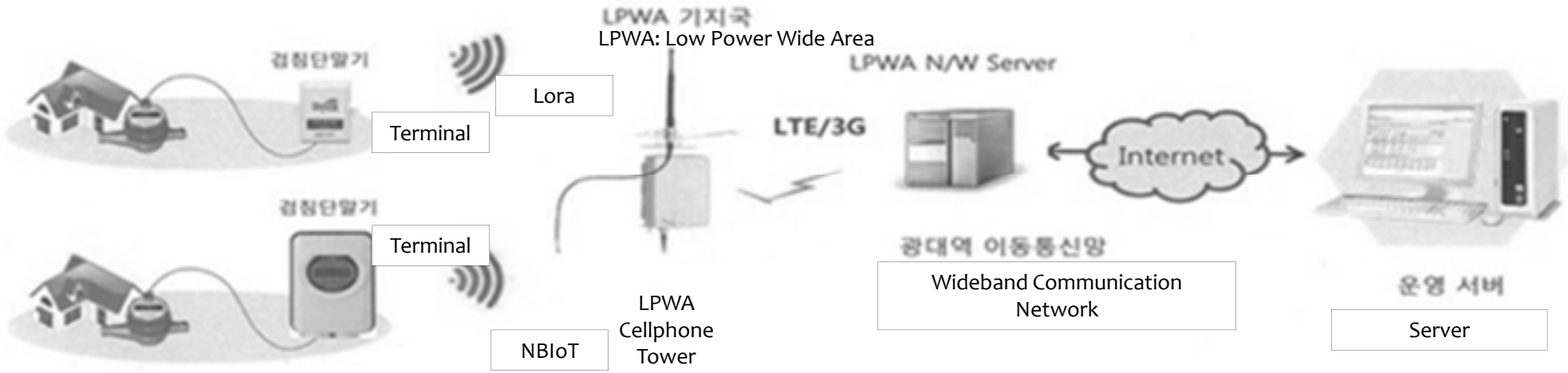
The air temperature of Seoul in winter time goes down to – 20 degree Celsius.



Integrated Smart Metering System



IoT based Smart Metering System



The National R&D Project

Dec. 2017~ Feb. 2019
120 Water posts
A mid-size block

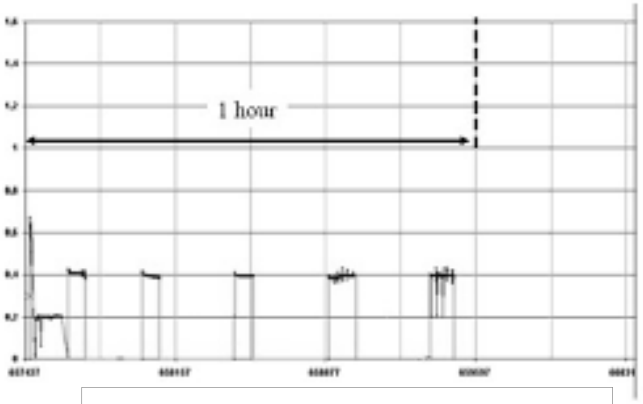
The Model Project

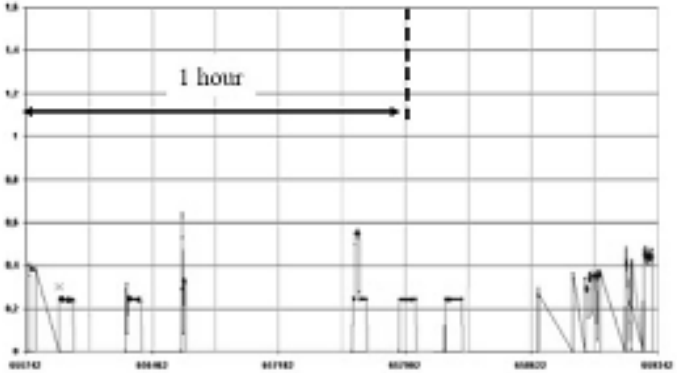
Jan. 2018~Dec. 2018
1,900 Water posts (15~150 mm)
Metering and communication performance
Water consumption pattern

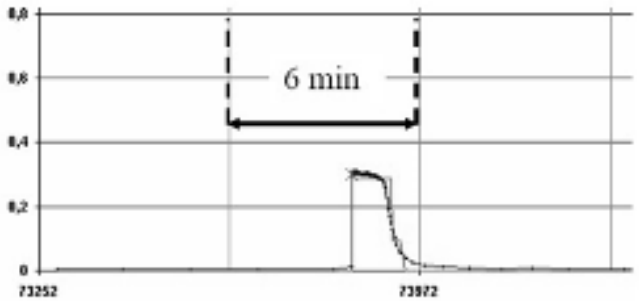
Unexpected Problem

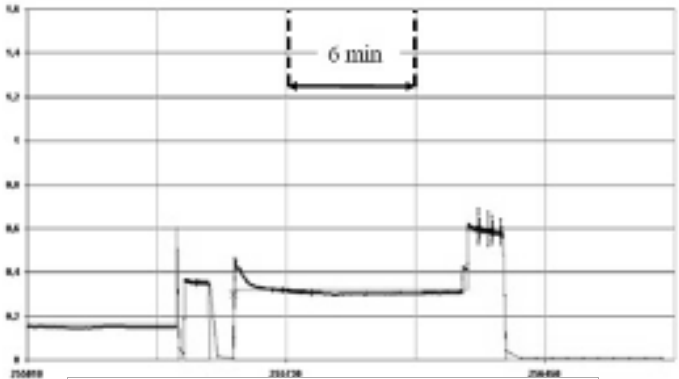
Big data & Privacy Violation

Just with the data on water consumption, I know what you are doing









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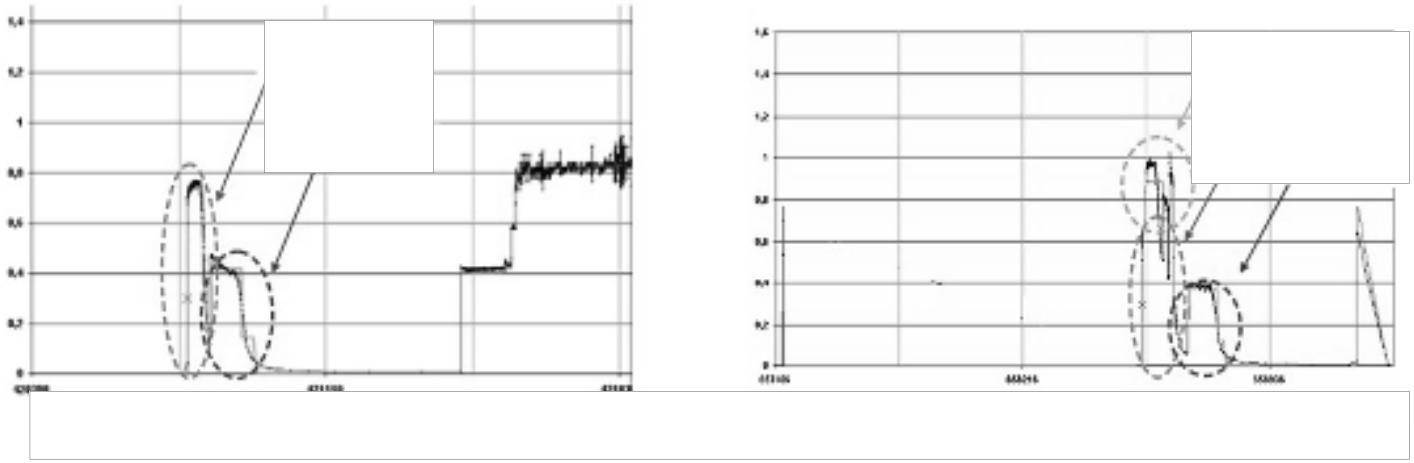
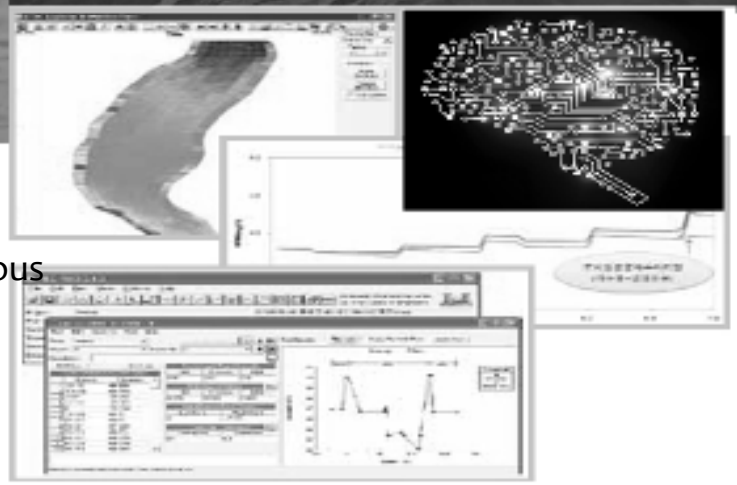


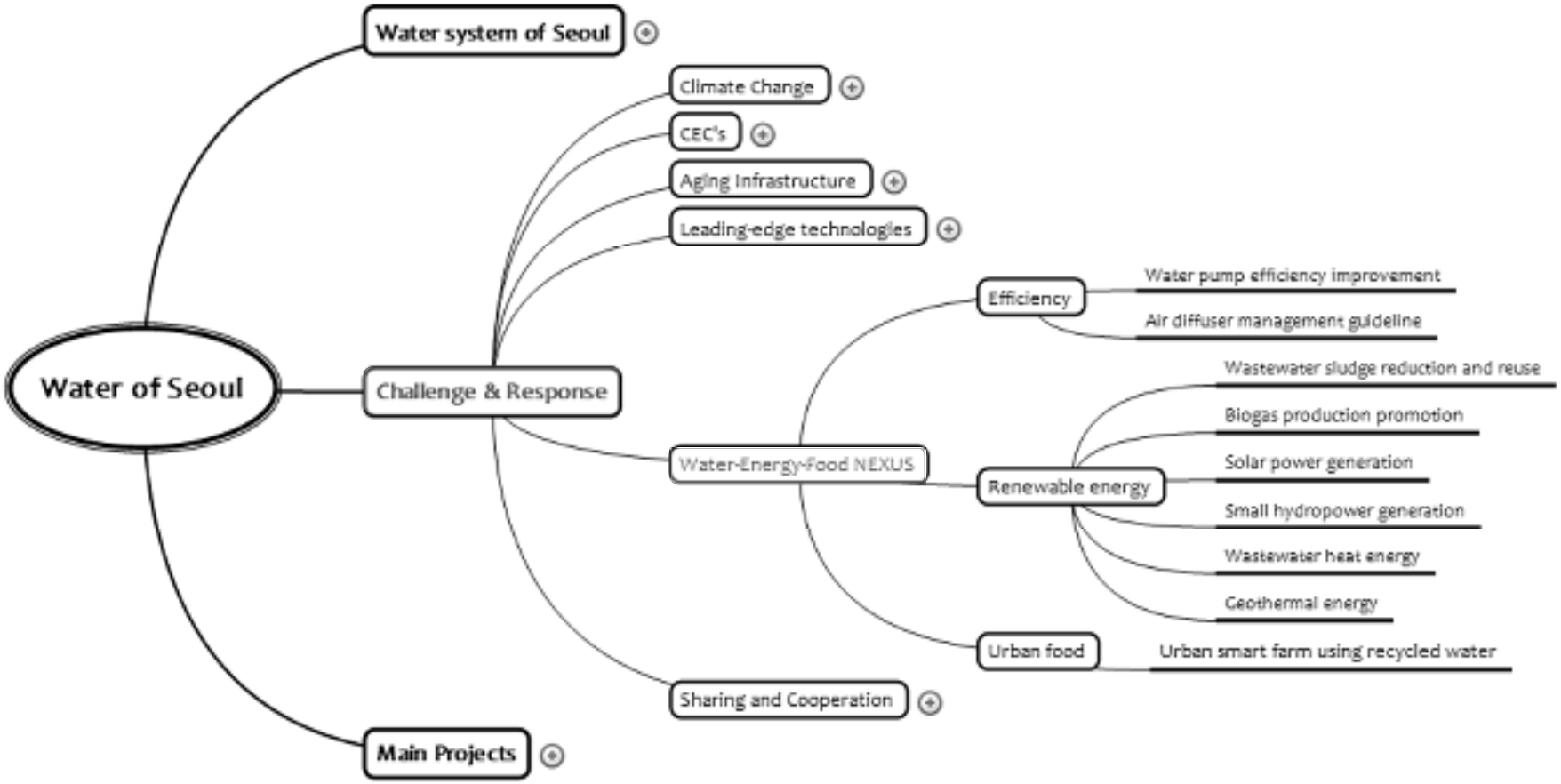
WQ Monitoring with UAV

Sampling & Monitoring

UAV (Draon)
Analytic Disk Technology
AI based WQ prediction system



- WQ Monitoring using Drons
  - WQ monitoring where access is dangerous
  - Algae monitoring
  - Accident monitoring
- WQ Prediction System
  - Ultra High Frequency Wave
  - Systematic analysis on WQ Big Data and environmental information
  - Prediction and correspondence on/to WQ change



Water-Energy-Food NEXUS

WoE, Water of Everything

Efficiency of system
Renewable energy production
Urban food supply system

Efficiency of System

- Water pump efficiency improvement
- Air diffuser management guideline

Renewable Energy Production

- Wastewater sludge reduction and reuse
- Biogas production, solar power generation, small hydropower generation, Wastewater heat energy, Geothermal energy

Urban Food Supply System (in planning)

- Urban smart farm building using recycled water


http://alsanidamsm.com/uploads/gallery/67aa5a0e3878969473627fb2766519a.jpg

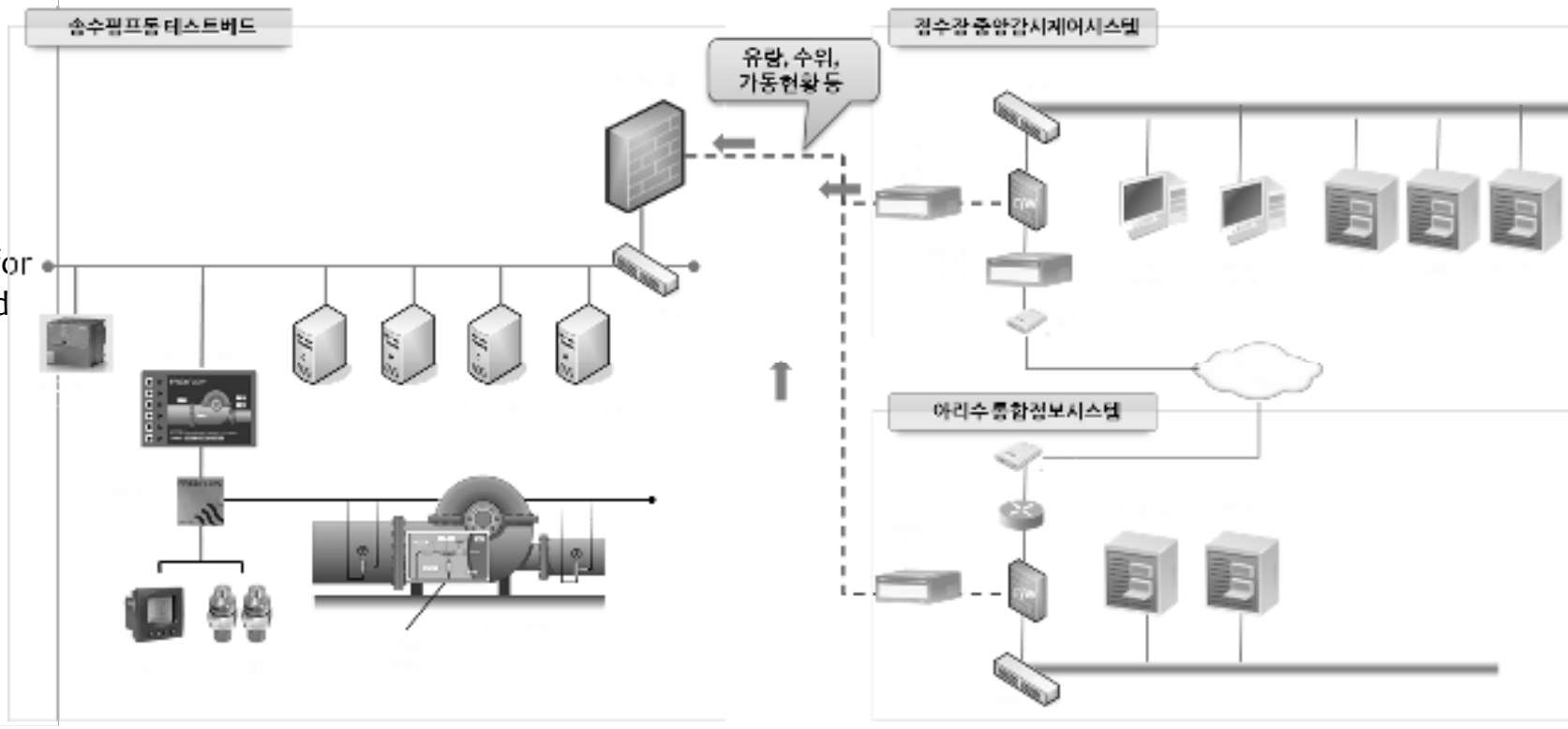
IoT and Pump Efficiency Improvement

IoT, Big Data, AI

According to the calculation, about 5% of the total energy for pumping system can be saved with the IoT based optimized pumping system

Optimized Pumping System

based on IoT technology

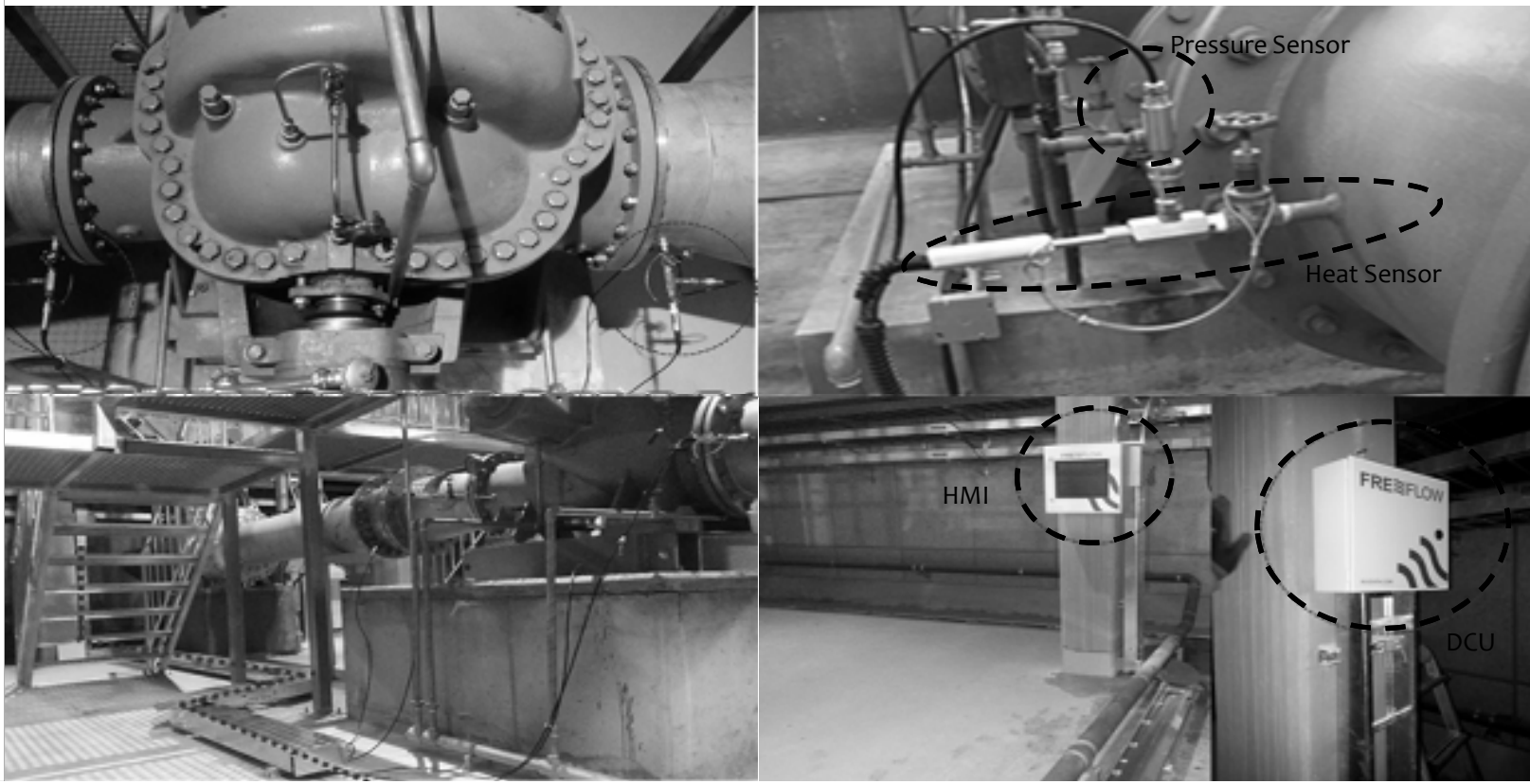


IoT and Pump Efficiency Improvement

Sensor network

Temperature
Pressure
Vibration

Temperature and Pressure Sensors

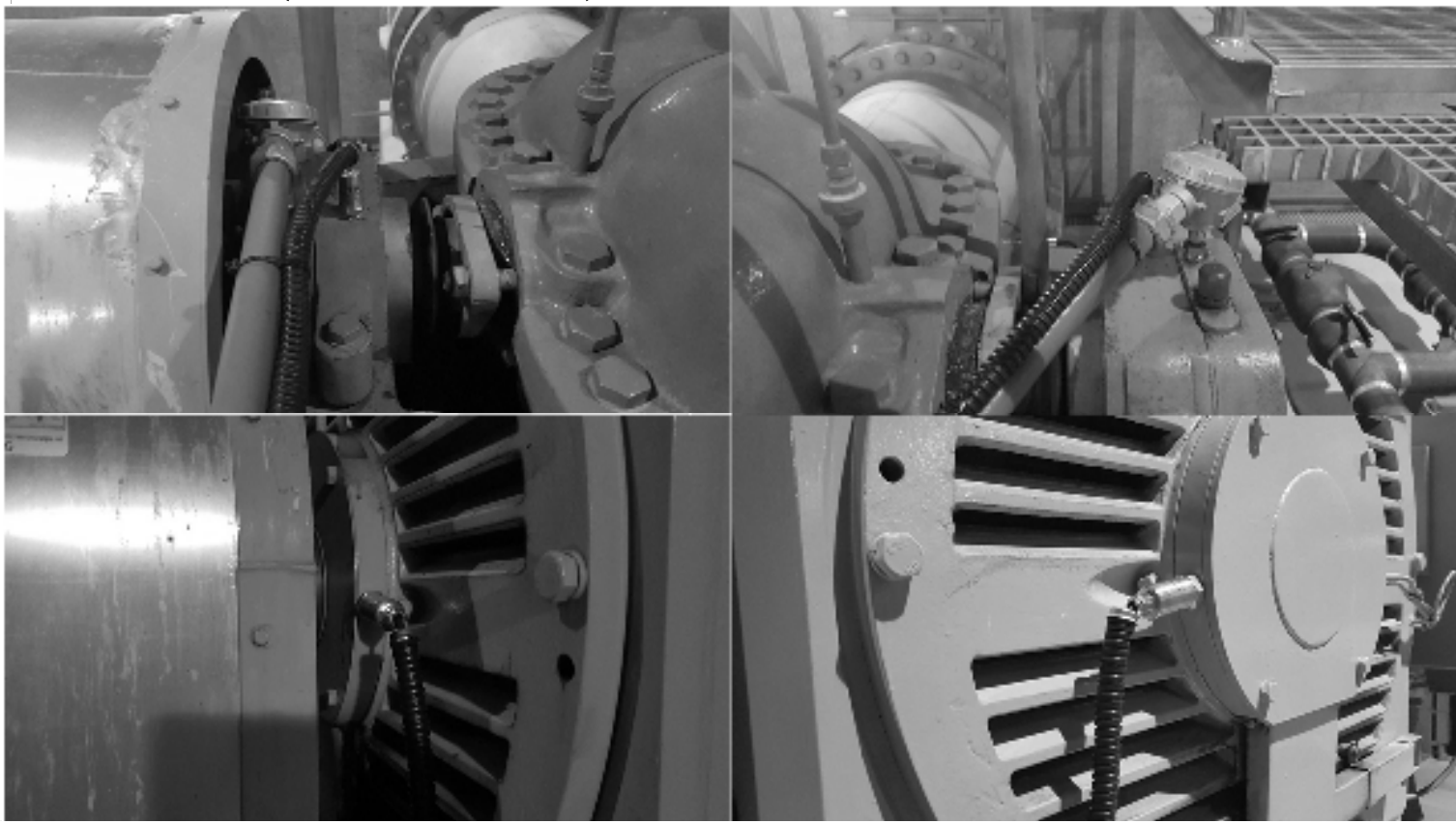


IoT and Pump Efficiency Improvement

Sensor network

Temperature
Pressure
Vibration

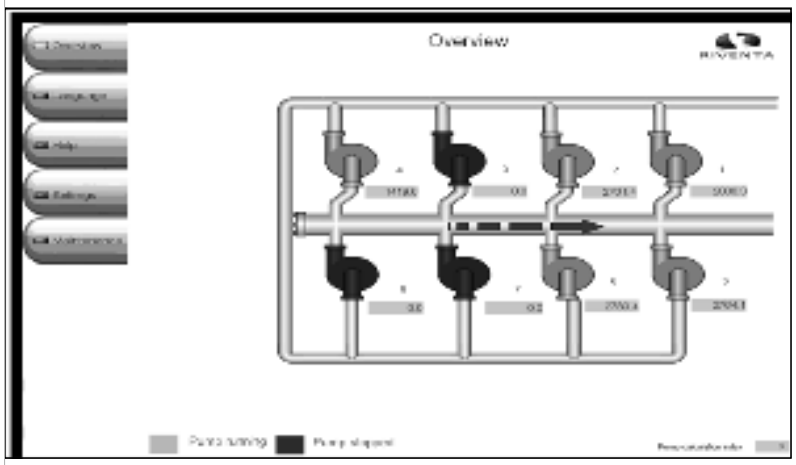
Motion (Vibration) Sensor



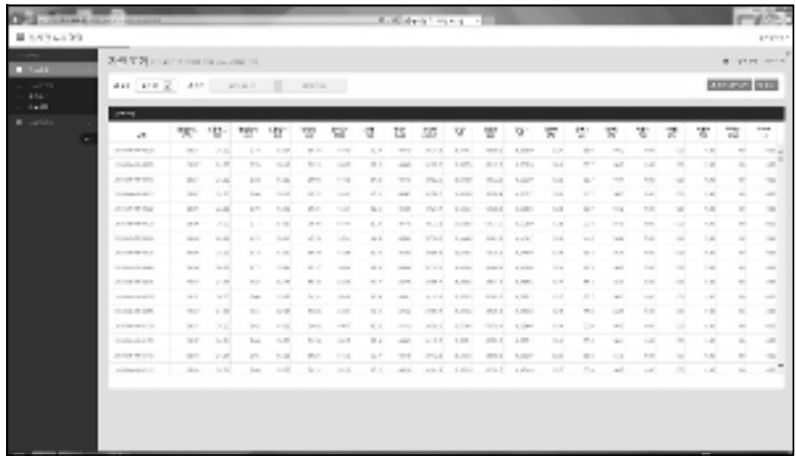
IoT and Pump Efficiency Improvement

Analytic System

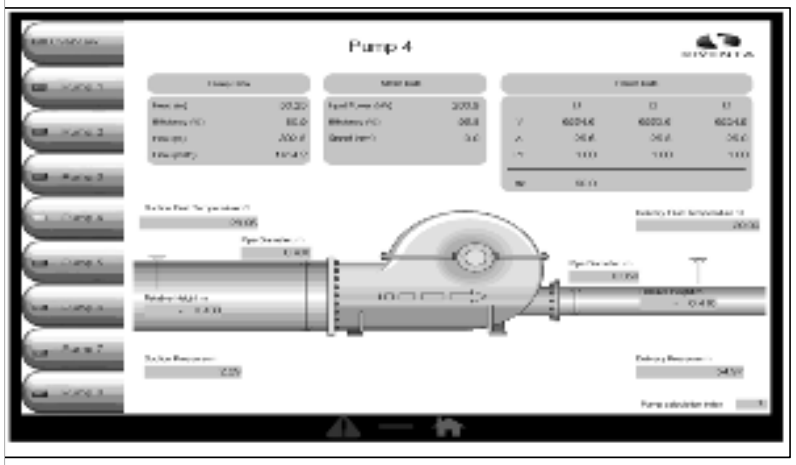
Water level at reservoir
Combination of pumps



Pumps in Operation



Real-time Data Monitoring



Pump and Sensor Monitoring

Statistics and Analytics

Photovoltaic Power Generation

Solar panels

Water/wastewater treatment plant has huge space, which is perfect condition for urban solar power generation

tion @Sunam WWTP

http://image.fnnews.com/resource/media/image/2013/07/31/201307310320077671_l.jpg

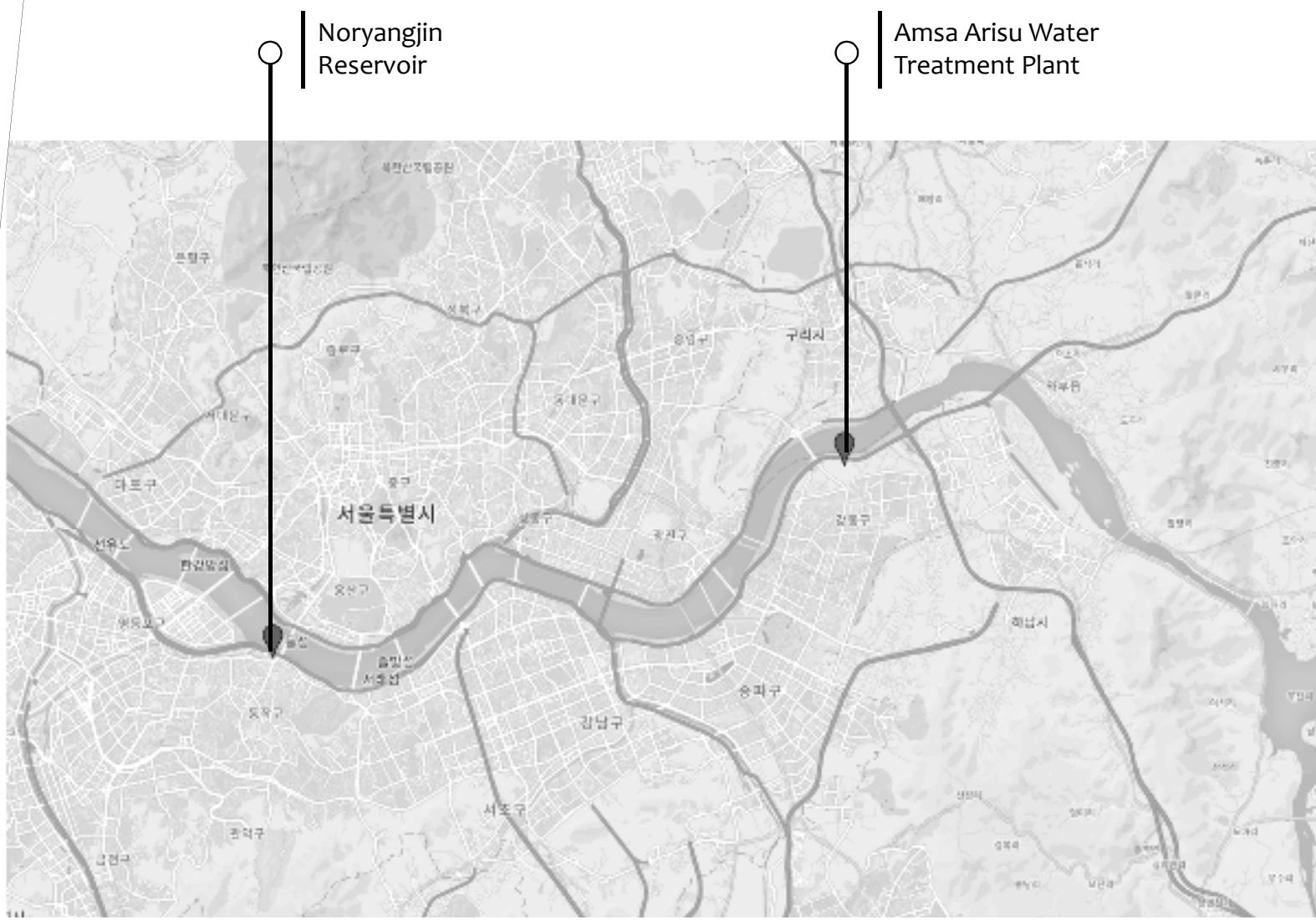
http://dimg.donga.com/wps/NEWS/IMAGE/2013/07/31/56757407-1.jpg

https://nkview.files.wordpress.com/2014/03/00.jpg

Small Hydropower Plant

Elevation is energy

The city of Seoul has many hills and mountains, which means we have lots of energy everywhere.



Small Hydropower Plant

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1 아리수 소수력발전소 위치도 2 3 4 소수력발전소 내부 모습 5 노량진 배수지 전경 6 공사진행 현황

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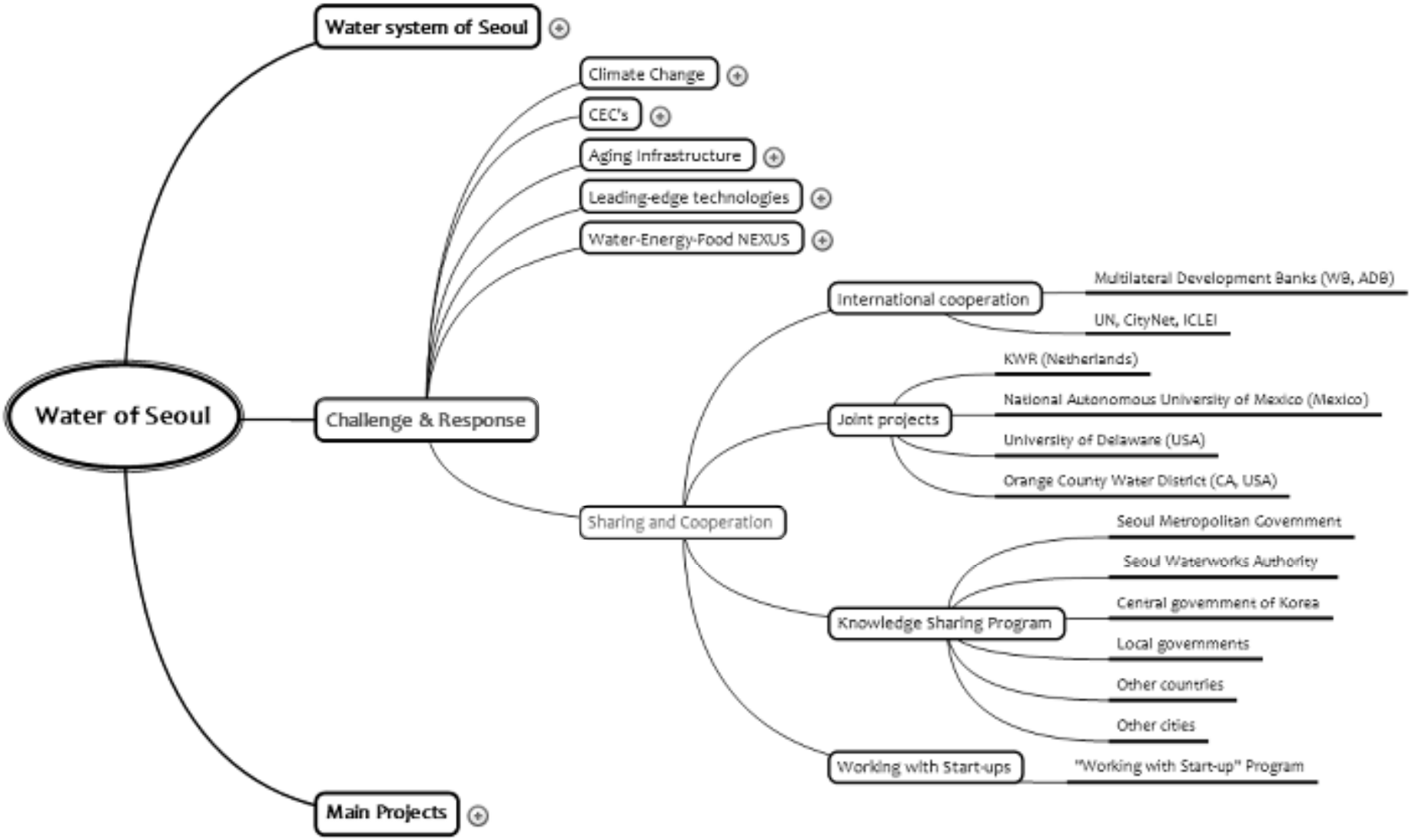
https://seoulsolution.kr/sites/default/files/images/image00003(8).jpg



Knowledge Sharing and Cooperation

W4A, Water for All

International cooperation
Joint projects
Knowledge sharing programs
Working with Start-ups

International Cooperation

- Multilateral Development Banks: World Bank, ADB, AIIB
- UN, ICLEI, CityNet, WeGo

Joint Projects

- KWR (Netherlands), UNAM (Mexico), U of Delaware (USA), Orange County Water District (USA), Tokyo (Japan)

Knowledge Sharing Programs

- SMG, SWA, the central and local governments of Korea, UOS, HRDC of Seoul, other countries and cities

"Working with Start-ups" Program

- Technical consulting
- Joint feasibility study at the test bed

Knowledge Sharing and Cooperation

W4A, Water for All

International cooperation
Joint projects
Knowledge sharing programs
Working with Start-ups

Policies & Strategies

Center for Future Strategies

Study on policies & strategies

Current Projects

_*Publication and Symposium*

: 4 symposiums on water technologies and policies
: Seoul-Tokyo Forum – every year at Seoul and Tokyo
: Association of Water Research Institute of Korea
: Quarterly news letter, ***Seoul Water***
: White paper on 'Water research 30 years'

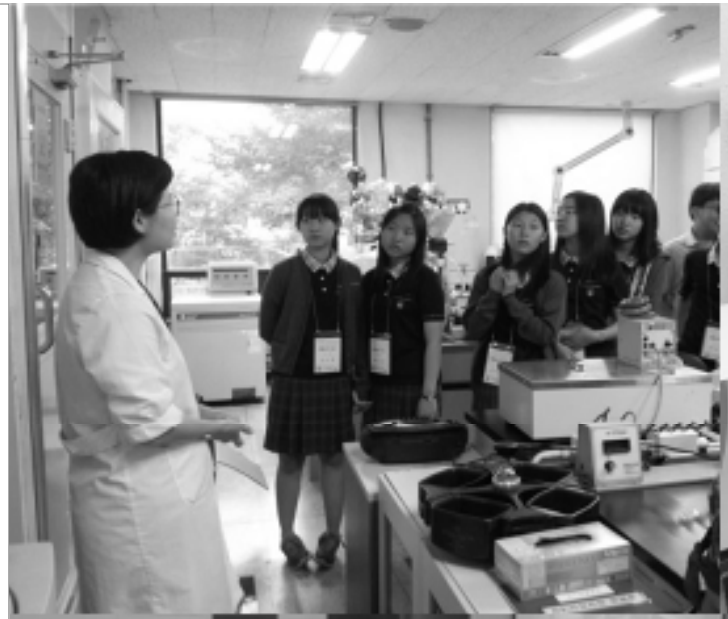
_*Research Project*

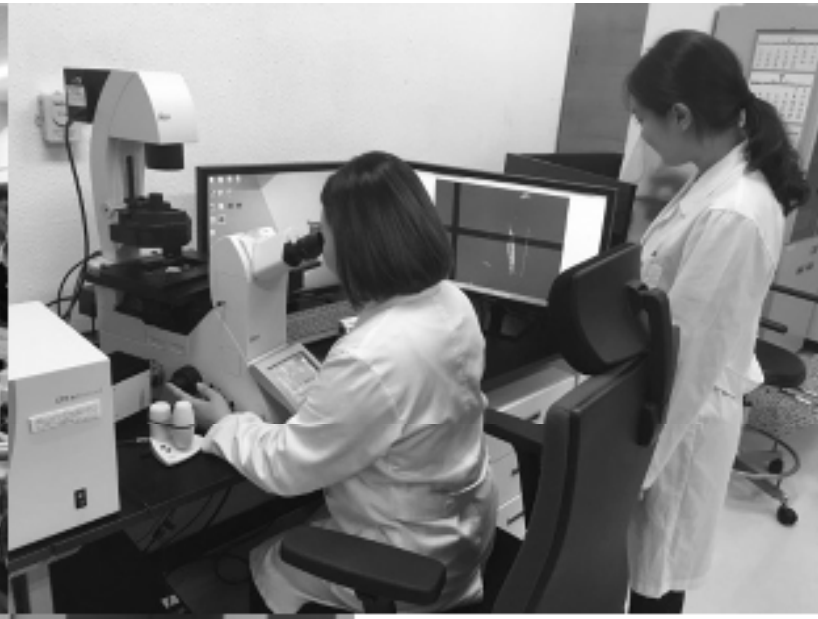
: Model development for asset management
: Risk assessment on the waterworks system of Seoul
: App development for tap water fountains (location and WQ)
: Evaluation method for algal toxin
: Optimization of human resources in the Call Center
: 'Knowledge partner' at the portal of internet, Naver
: Water tariff for water as human right

Open Lab Program

Open lab for students

Kids
College students





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