Current Status and Challenges of Advanced Wastewater Treatment

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History of Wastewater Service in Japan

- **1958 Amendment to the Sewerage Law**
  - Objective of the Sewerage Law amended to “Contribution to achievement of healthy cities and improvement in public hygiene by improving the urban environment.”
- **1960s Pollution throughout Japan in association with high levels of economic growth**
- **1970 “Pollution Diet”**
  - Addition of “Improvement of water quality in public water bodies” to the Sewage Law.
  - Establishment of water quality environmental standards and introduction of a Watershed Sewerage Master Plan.

Dokai Bay (Kitakyushu City) in the 1960s

Sumida River (Tokyo) in the early 1970s

An Outline of Shiga Prefecture and Lake Biwa

- Shiga Prefecture is located in the center of Japan.
- Lake Biwa is Japan's largest lake and occupies approximately 1/6th of the land area of Shiga Prefecture.

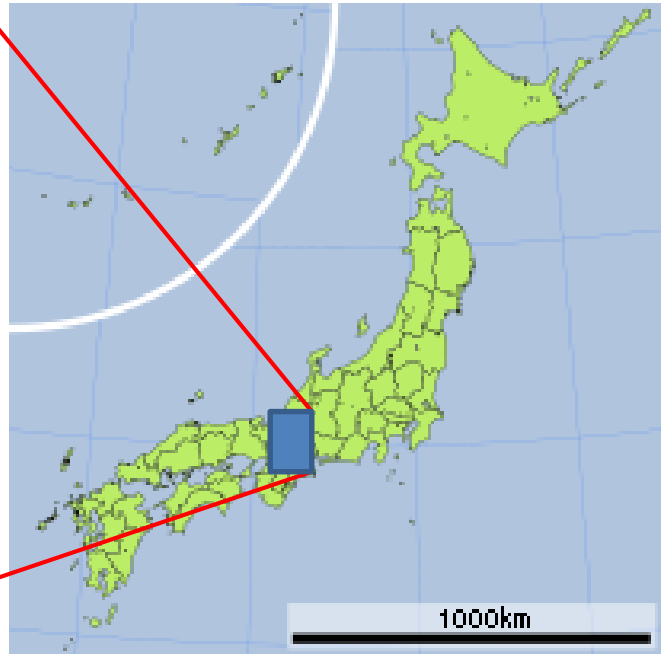
Shiga Prefecture

Population	1,420,000
Area	4,017 km^2

Lake Biwa

Area	670.25 km^2
Distance around lake	235 km
Capacity	27,500,000,000 m^3
North basin	27,300,000,000 m^3
South basin	200,000,000 m^3

Maximum depth	103.58 m
Average depth	41 m
North basin	43 m
South basin	4 m



Lake Biwa

Funa zushi

Koayu

Lake Biwa as a Drinking Water Resource

- The waters of Lake Biwa flow into Osaka Bay via the Setagawa, Ujigawa, and Yodogawa Rivers.
- The flow of water from Lake Biwa provides drinking water resources for a population of 14,500,000 in the cities of Osaka and Kyoto and environs.

	Catchment area	Proportion
Entire Yodogawa River	8,240km2	100.0%
Lake Biwa	3,848km2	46.7%

Prefecture	Population supplied with water from Lake Biwa (2008)
Shiga	1,148,702
Kyoto	1,811,645
Osaka	8,817,876
Hyogo	2,757,285
Total	**14,535,508**

Water Pollution in Lake Biwa

- While Lake Biwa is currently a drinking water resource and world-class tourism and leisure area, water pollution became a problem.
- Pollution increased during Japan's period of high economic growth. Freshwater red tide occurred on a large scale in 1977, and algal bloom in 1983.

Freshwater red tide on large scale in 1977

Algal bloom in 1983

New Ordinance to Prevent Eutrophication

- With the occurrence of freshwater red tide, a citizens' "Soap Movement" developed to avoid the use of phosphate detergent.
- This movement resulted in enactment in 1979 of an ordinance to prevent eutrophication.

A demonstration calling for use of washing powder

Phosphate detergents exchanged for washing powder

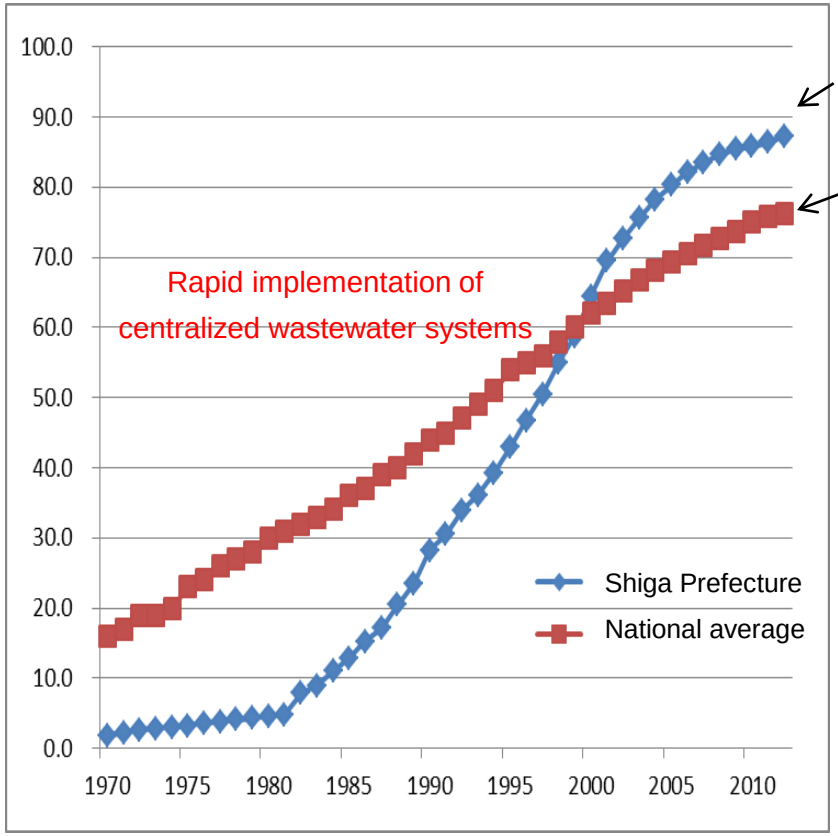
1979 Ordinance to prevent eutrophication

- Prohibited the use and retails of phosphate-based synthetic detergents in Shiga Prefecture.
- The first ordinance in Japan to regulate for nitrogen and phosphorus in industrial wastewater .

Implementation of Wastewater Systems in Shiga Prefecture

- A regional wastewater system started the service in 1982 in Shiga Prefecture.
- Wastewater service rapidly covered since 1982.
- 98.2% of the population is currently served by either centralized and on-site treatment system.

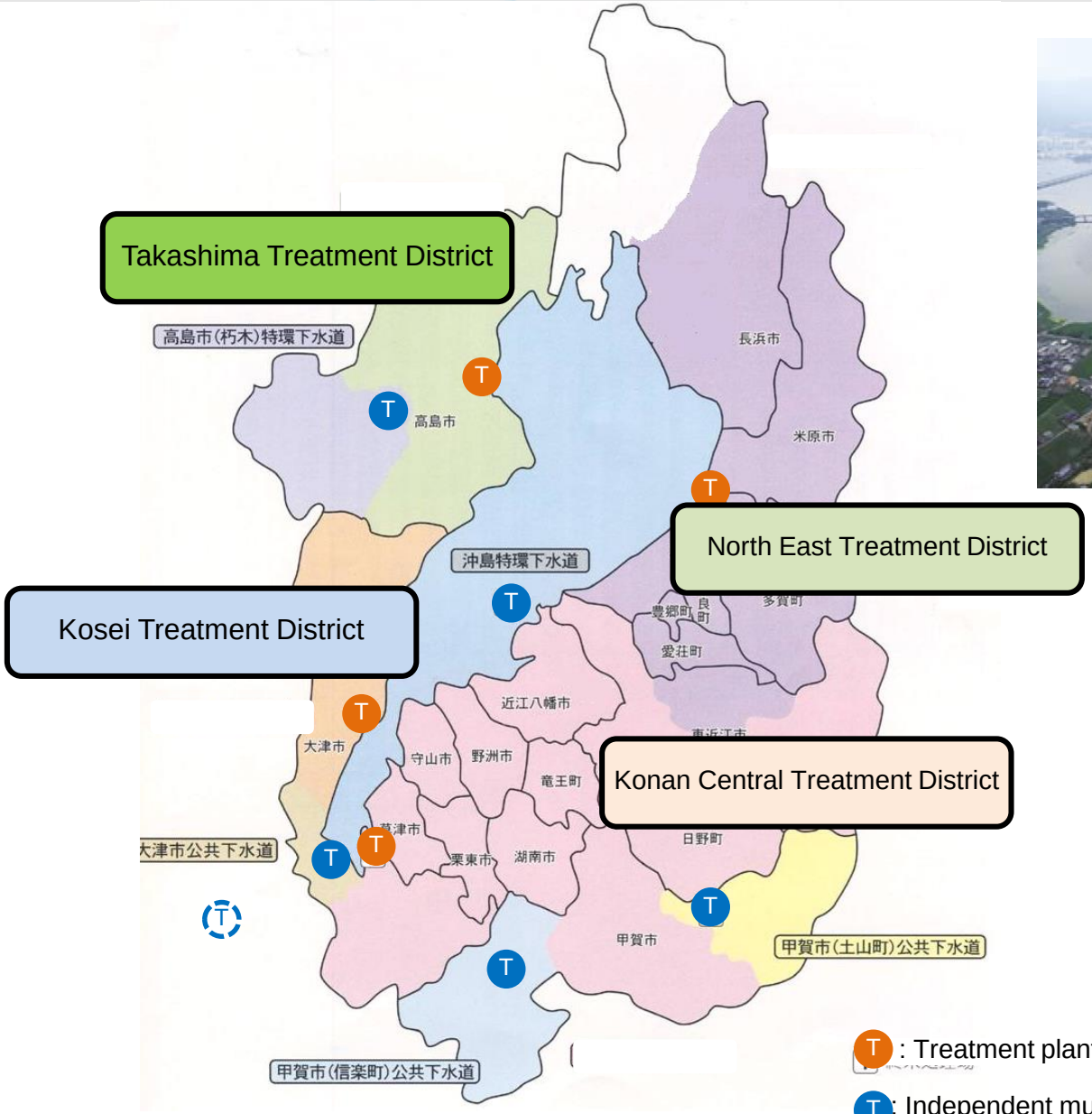
Trends in coverage of wastewater service



87.9% (as of late 2013)
(98.2% for wastewater treatment services including on-site systems)

77.0% (as of late 2013)

Current Wastewater Systems in Shiga Prefecture



Konan Central Treatment Plant

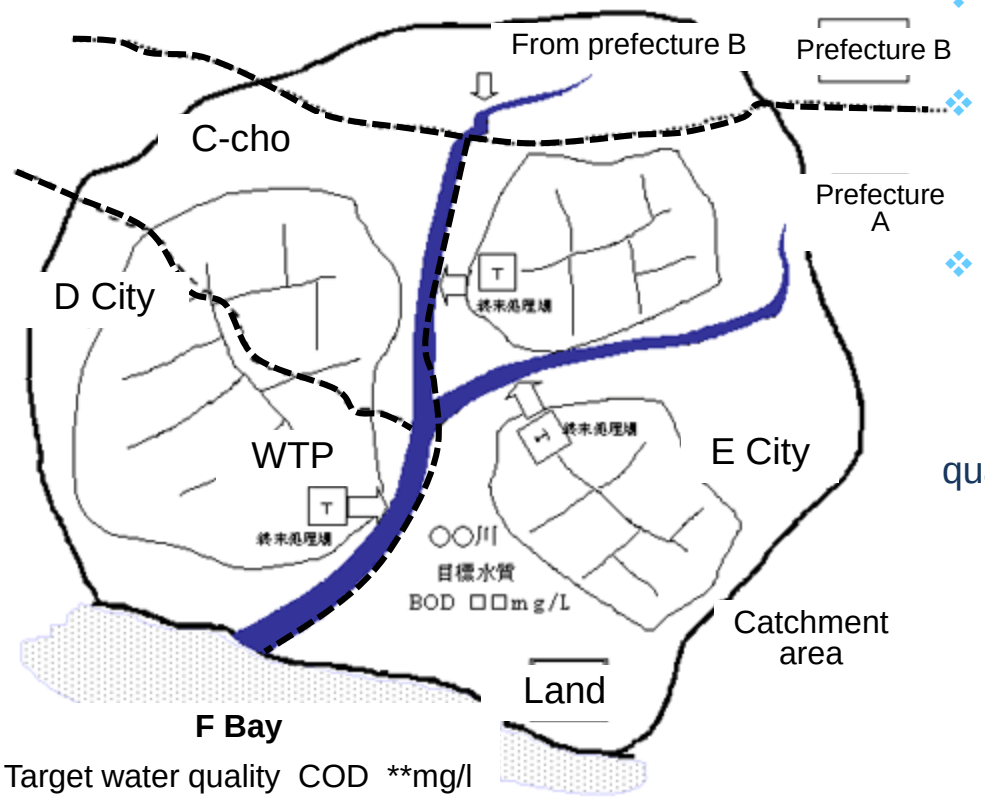
Lake Biwa Regional Wastewater System
Four treatment district
Independent municipal wastewater systems
Five sites

Current Regional Wastewater Systems in Shiga Prefecture

- Service starting in 1982 in Shiga Prefecture.
- The Konan Central treatment district covers half the sewered population of the prefecture.
- Total population of 1,100,000 (80% of the population) is served by 4 treatment plants.

	Konan Central	Kosei	North East	Takashima
Service start	1982.4	1984.11	1991.4	1997.4
Treatment sector area (ha)	17,340	2,179	9,307	1,834
Population covered (persons)	707,108	114,788	262,732	40,384
Treatment capacity (m^3/day)	268,500	52,500	120,750	16,400

Achieving Environmental Standards



- Wastewater services are under the responsibility of local government.
- Measures to conserve of public water quality lies within the wider administrative offices, and must be implemented efficiently.
- A basic overall plan for the most rational implementation of wastewater systems is established as the Watershed Sewerage Master Plan, intending to achieve public water quality standard.

Watershed Sewerage Master Plan

Outline of the Watershed Sewerage Master Plan

Duration of implementation plans

- Established for 20–30 years.

Water quality targets

- Target is generally the maintenance and achievement of water quality standards.

Targets for implementation of wastewater systems

- Wastewater system implementation plan necessary for maintenance and achievement of water quality standards.
- Measures additional to those for wastewater systems implementation such as on-site systems are also considered.

Drawing Up a Watershed Sewerage Master Plan

START

Basic survey

- Natural conditions
- Current and future population and industry
- Current and future wastewater volume and pollution load

Pollution analysis and pollution load reduction plan

- Pollution analysis using models etc.
- Establish reduction targets and reduction policy

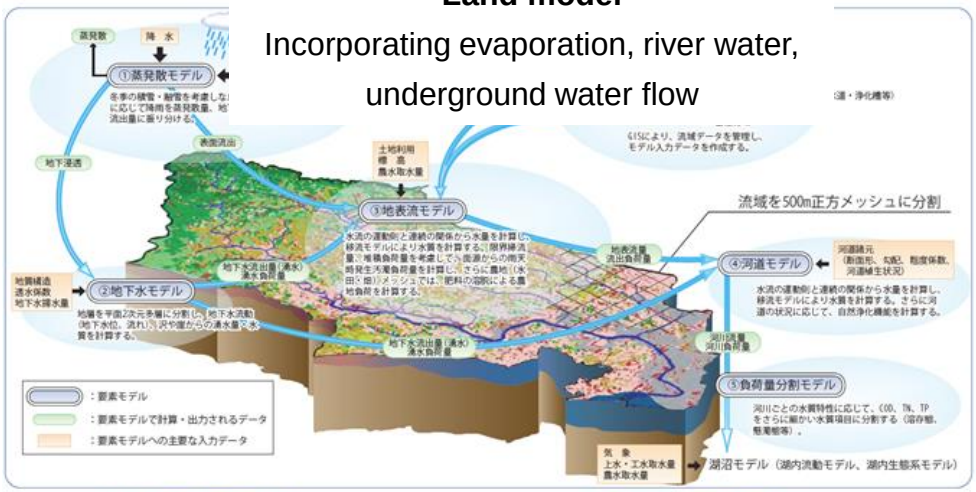
Wastewater systems implementation plan

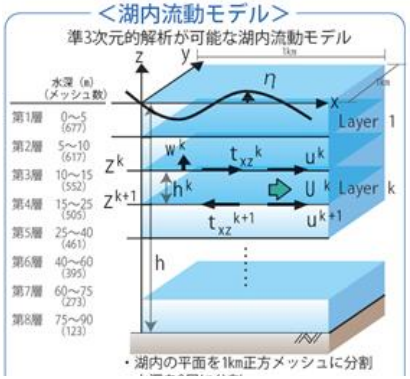
- Establish planned treated water quality
- Establish wastewater treatment method

Lake Biwa pollution load analysis example

Land model

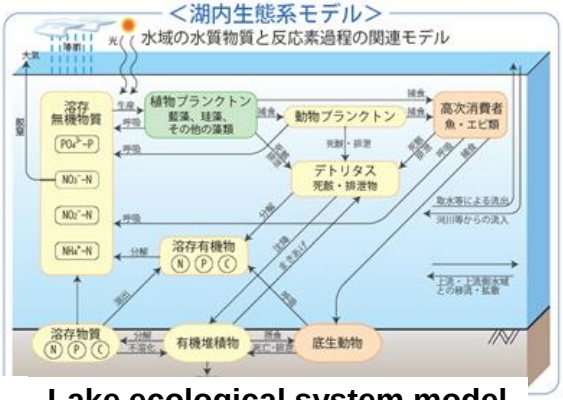
Incorporating evaporation, river water, underground water flow





Lake model

Incorporating diffusion in vertical and horizontal directions in Lake Biwa



Lake ecological system model

Incorporating analysis and yield with ecological system

Treatment Water Quality Targets Based on the Watershed Sewerage Master Plan

- Water quality of effluent target of WWTP based on the Watershed Sewerage Master Plan are shown below.
- Advanced treatment (ozone treatment and activated carbon absorption levels) is required to achieve the environmental standards.
- Tentative targets for water quality were therefore set in the Watershed Sewerage Master Plan (2025 target period).
- Wastewater effluent standards under the Sewerage Law are currently based on actual results.

	Watershed Sewerage Master Plan target water quality (daily average)	Tentative target water quality (daily average)	Sewerage Law (maximum)
BOD（mg/l）		4.8 *	4.8
COD（mg/l）	3.0	6.0	20
SS（mg/l）			40
T-N（mg/l）	2.2	3.0	10 or 5
T-P（mg/l）	0.02	0.04	0.25

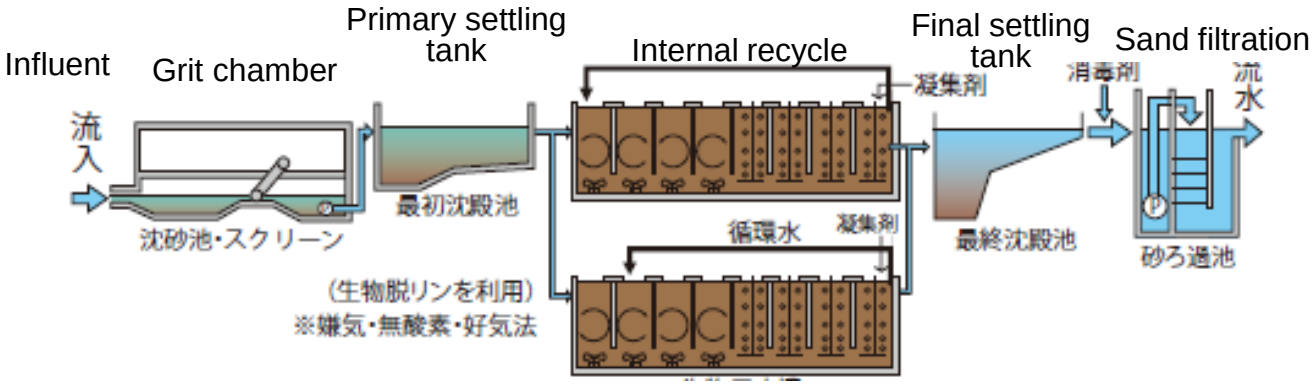
*** Daily maximum for BOD only.**

Treatment Methods Employed in Shiga Prefecture

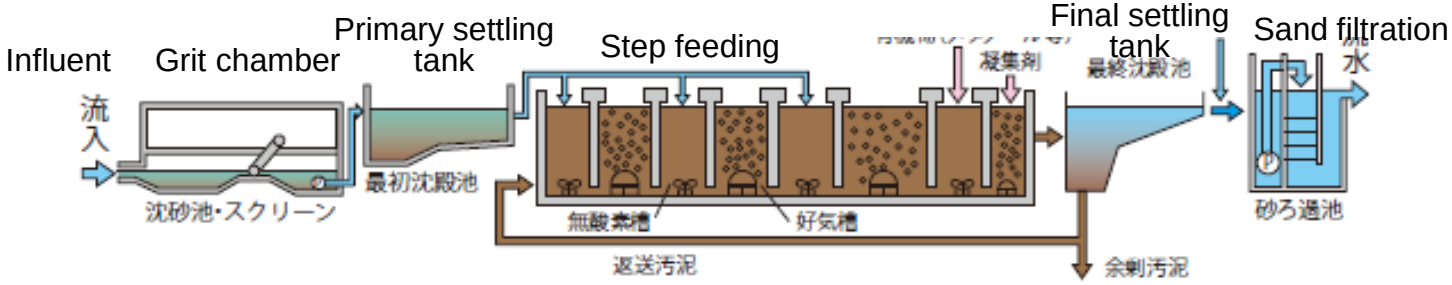
- The following treatment methods were used to achieve the tentative targets under the Watershed Sewerage Master Plan.
- (1) Flocculent-additive pre-denitrification + sand filtration
- (2) Flocculent-additive multi-stage nitrification/denitrification + sand filtration

  T-N water quality targets differ for (1) and (2) (10mg/L for (1), 5mg/L for (2)).
- (1) are upgrading to (2) until 2025.

(1)



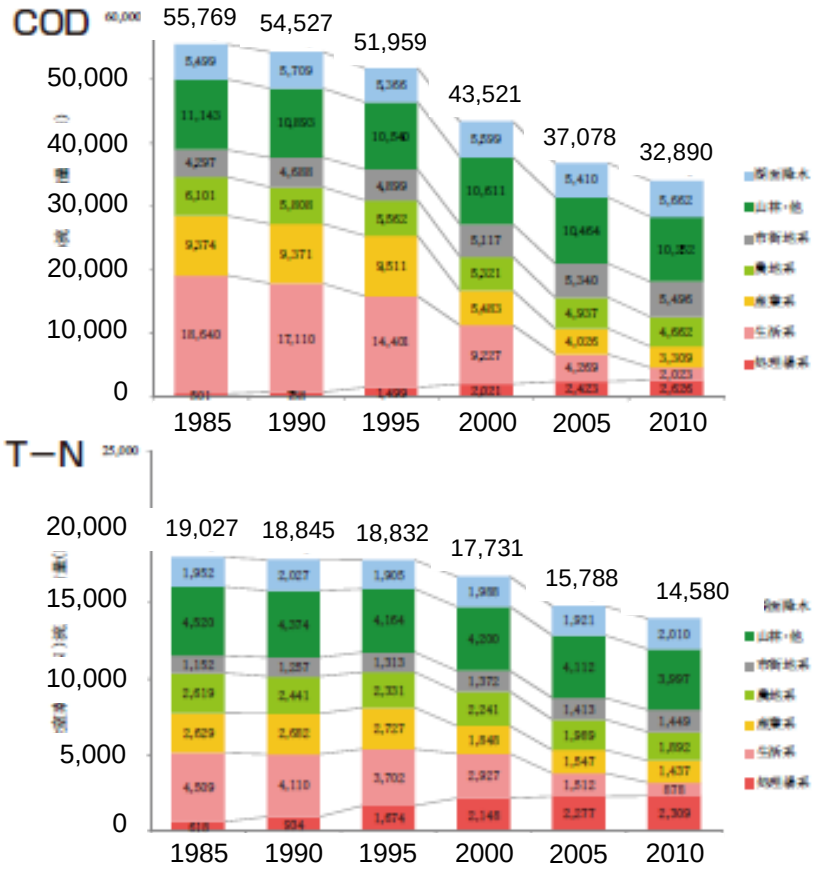
(2)

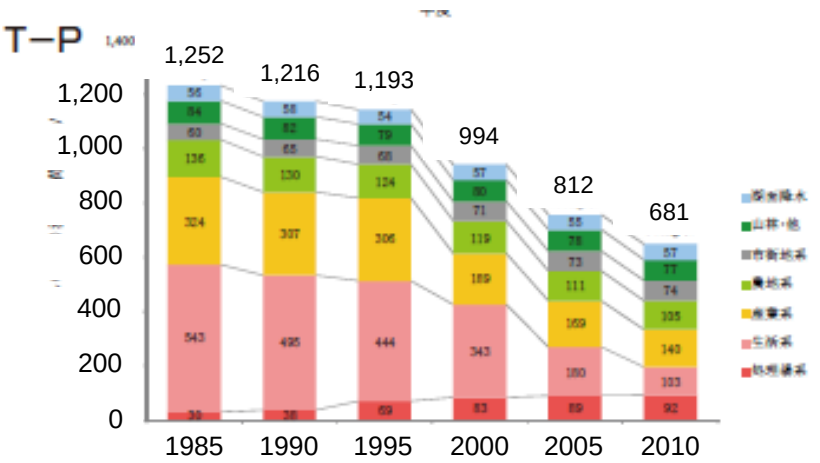


Pollution Load Reduction with Wastewater Systems

- Pollution load from domestic wastewater was considerable in 1985, however it has reduced with implementation of wastewater systems.
- Pollution load from domestic wastewater has reduced firmly, thus it is under discussion for the necessity of further implementation of advanced treatment.

Changes in load of inflow into Lake Biwa (kg/day)



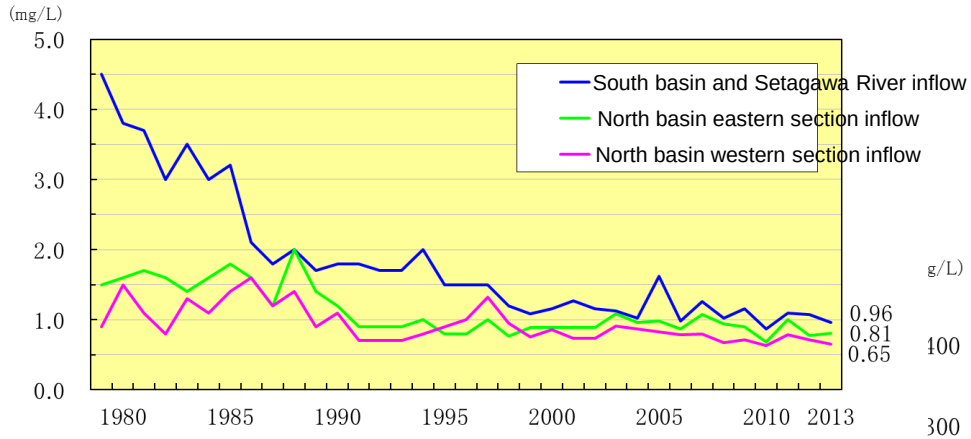


Rainfall
Mountains and forests etc.
Urban
Agricultural
Industrial
Domestic
Treatment plants

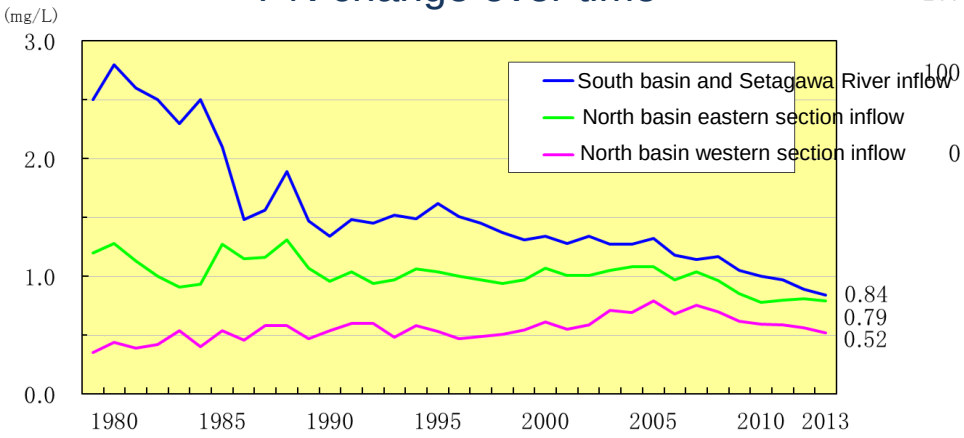
Effects of the Implementation of Wastewater Systems (river water quality)

- Dramatic recovery in river water quality through implementation of wastewater systems.

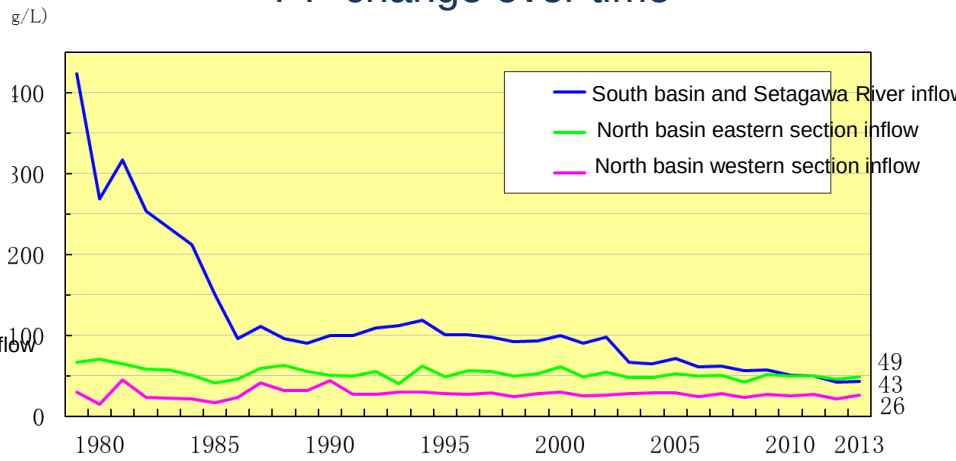
BOD change over time



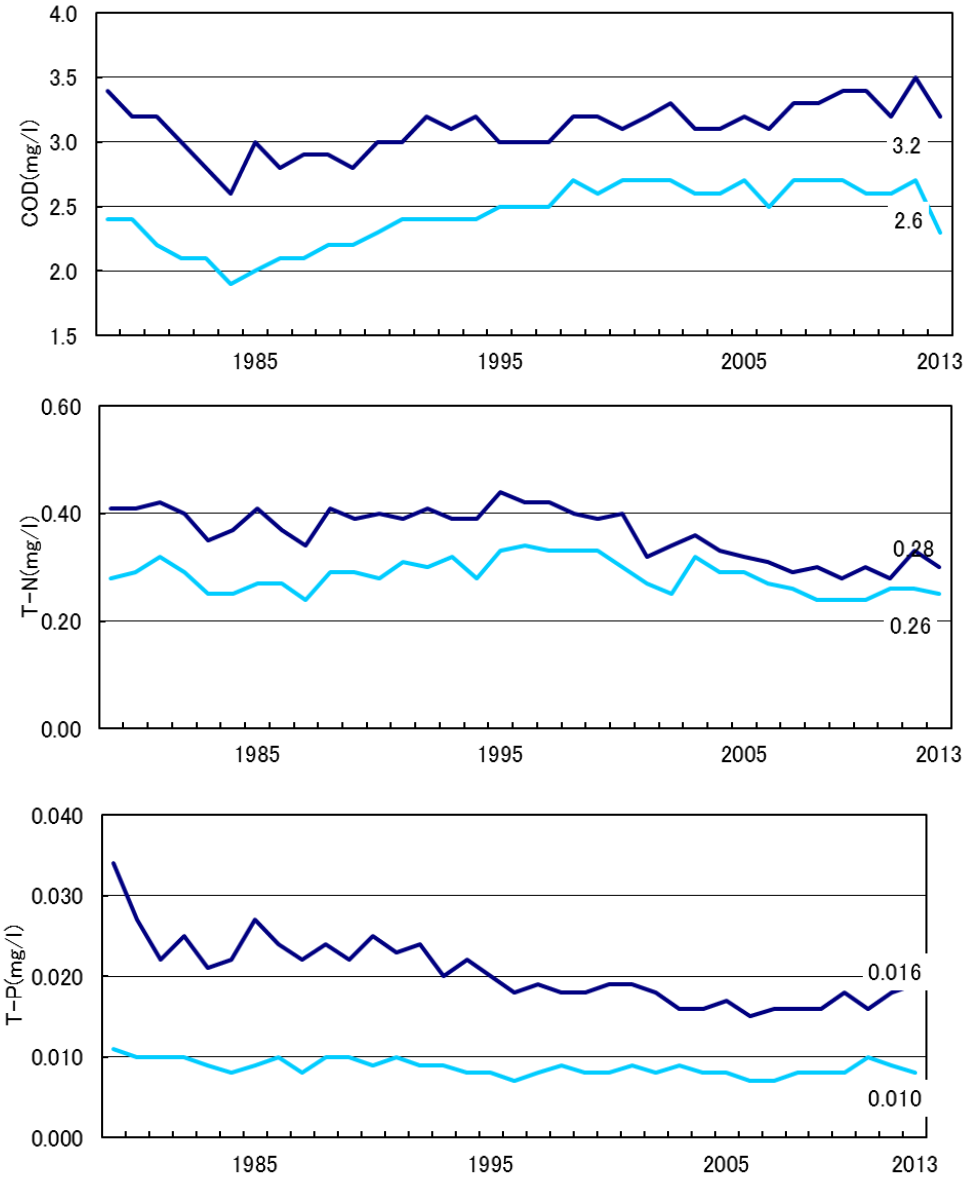
T-N change over time



T-P change over time



Changes in Water Quality of Lake Biwa Over Time



- T-N and T-P show gradual improvement.
- COD shows no improvement.

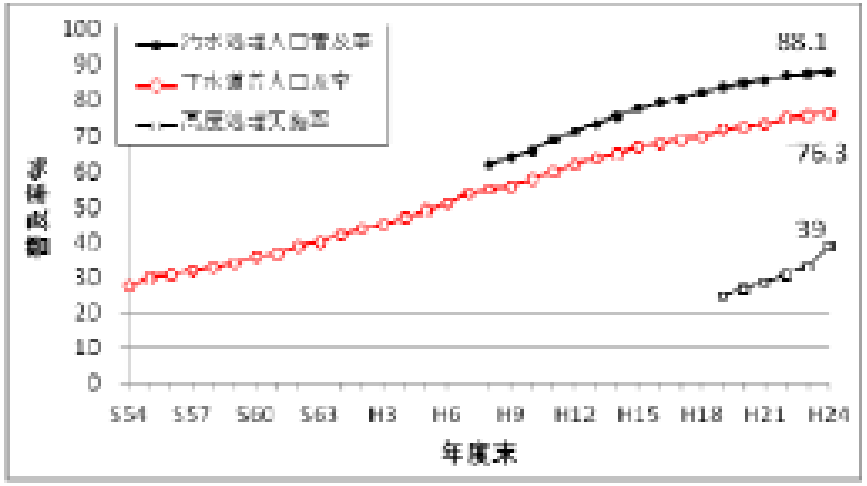
South basin

North basin

	Environmental standards
COD	1
T-N	0.2
T-P	0.01

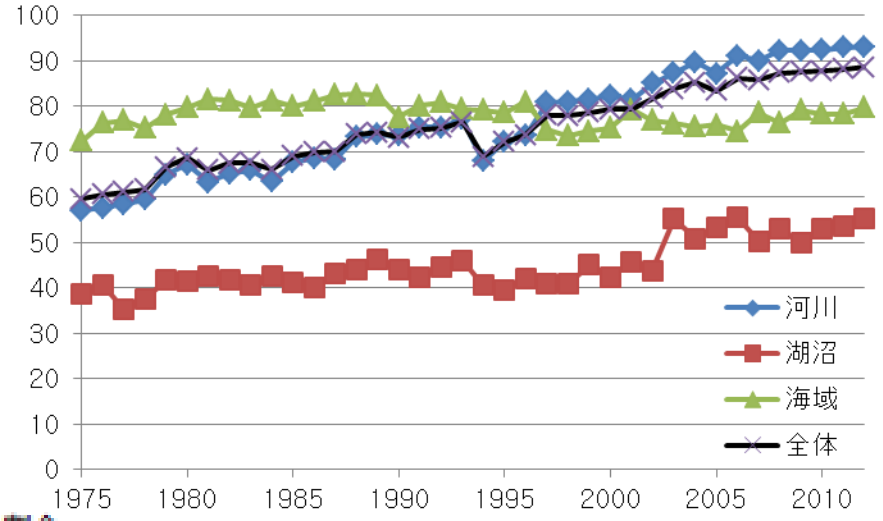
Achievement of National Environmental Standards

- Wastewater systems have proliferated since 1970.
- River and ocean environments have improved in association with the proliferation of wastewater systems.
- Implementation of advanced water treatment is gradually increasing, however the achievement of environmental standards for lakes and marshes remains low.



注)高度処理実施率とは高度処理対象処理区における現況人口に対する割合

Proliferation of wastewater systems and implementation of advanced wastewater treatment



Achievement of environmental water quality standards

Improvement of The Watershed Sewerage Master Plan

Point (1) Setting diverse targets for other than water quality environmental standards

Active

- Wastewater systems managers are able to take into consideration the situation and characteristics of the region in addition to achievement and maintenance of environmental water quality standards, and to set targets for other than water quality standards (e.g. seasonal water quality targets, targets related to energy).

Point (2) Use of resources and energy and promotion of energy-saving

Active

- Calculation of current consumption of energy, water, resources, and energy potential.
- Target load by source and planned treated water quality are also set in consideration of energy consumption.

Point (3) Promotion of an optimized plan for reorganization

Active

- Re-planning of the main facilities for wastewater systems include unification and abolishment from the existing plans with considering the total cost, energy consumption, implementing office work force and so on.

Point (4) Setting mid-term implementation targets

Dynamic

- Set details to be implemented with priority (implementation policy, advanced water treatment introduction policy, response at maximum water inflow) for approximately ten years
- Investigate staged advanced water treatment methods for treatment plants at which advanced water treatment is required.
- Mid-term implementation targets are updated periodically every ten years or so, after the Watershed Sewerage Master Plan is established, and adaptive management implemented.

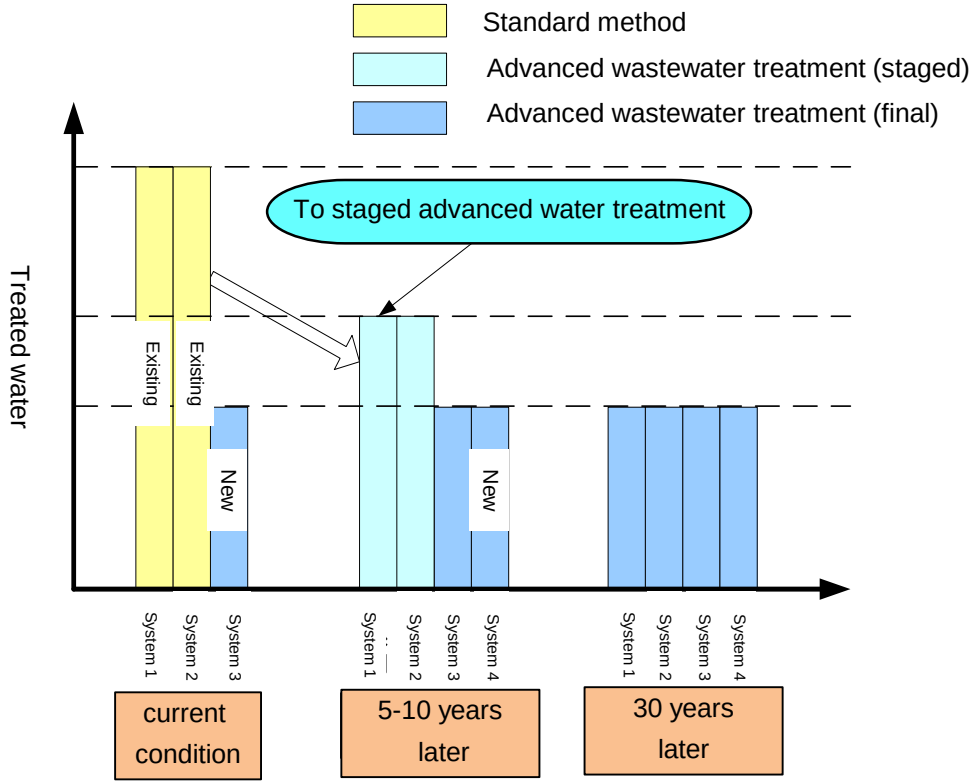
Point (5) Work simplification

Dynamic

- When the effects of current and future wastewater volumes and pollution load are small, existing statistical data can be employed to form Watershed Sewerage Master Plan for simplification of the re-planning works.
- Employment of GIS for the distribution map making of population, industrial plants, domestic animals.
- Based on the future decrease in population, if the assumed conditions of the Watershed Sewerage Master Plan are forecast to be similar for approximately five years before and after the anticipated year for the future population, no changes are required in the Plan.

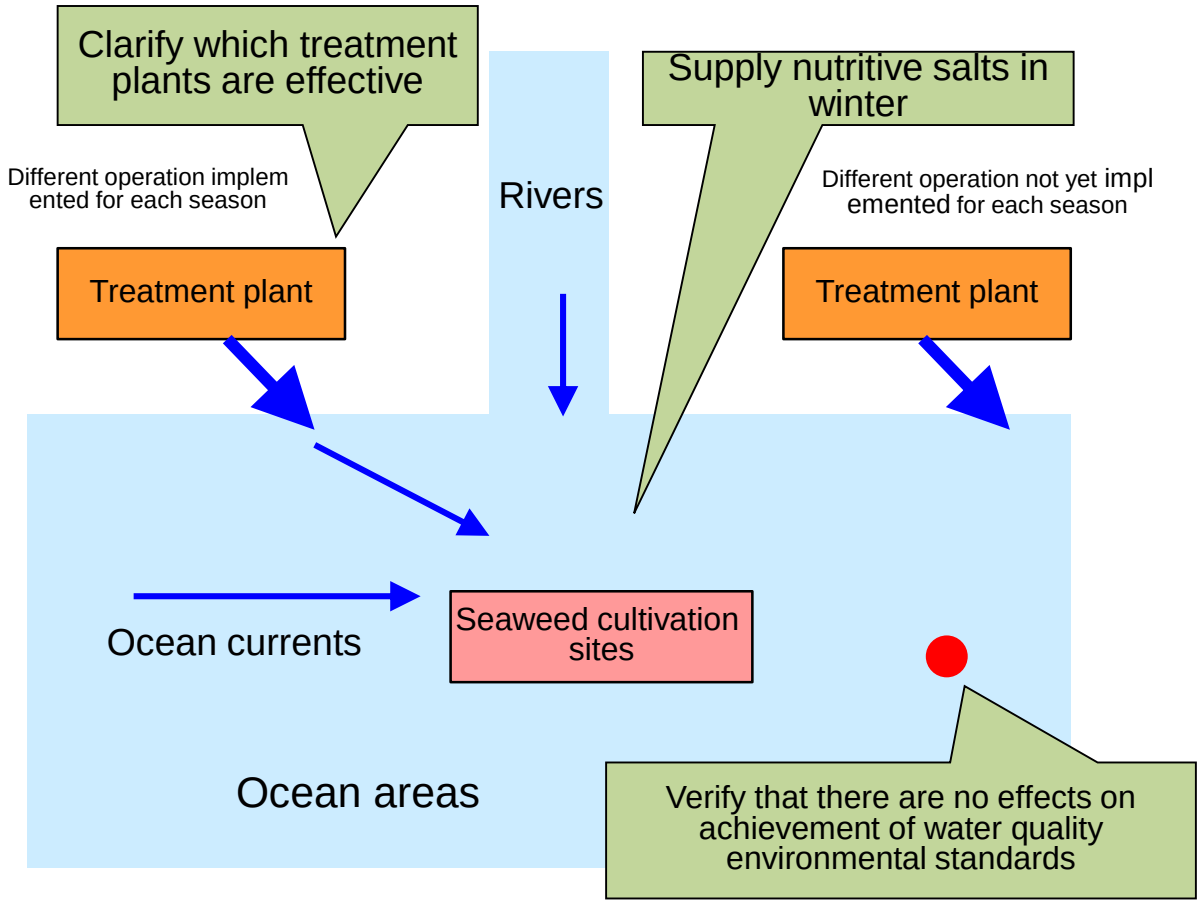
Achievement of National Environmental Standards

- Attempt to promote reductions in pollution load by positioning staged advanced wastewater treatment methods etc. as mid-term implementation items.
  - Set details to be implemented with priority for approximately ten years as mid-term implementation pl ans.
  - Investigate staged advanced wastewater treatment methods for treatment plants at which advanced wastewater treatment is required.



Achievement of National Environmental Standards

- Enabling additional target setting based on the local condition, other than existing environmental water quality standards.
  - Forcusing on the water usage condition, in some cases more stringent target might be implimented, or loose target might be considered.



- Establishing the Watershed Sewerage Master Plan is simplified.

Summary

- Japanese pollution problems of the 1960s led to progress in implementation of wastewater systems, primarily from the 1970s.
- Advanced wastewater treatments were implemented based on the Watershed Sewerage Master Plans.
- However, advanced wastewater treatments have not been constructed sufficient for achieving of the environmental water quality standards.
- This situation has brought major changes to the scheme of the Watershed Sewerage Master Plans which promote advanced treatment.

Thank you for listening