Implementation of TMDL in Korea

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Ⅰ. *Overview of TMDL in Korea*

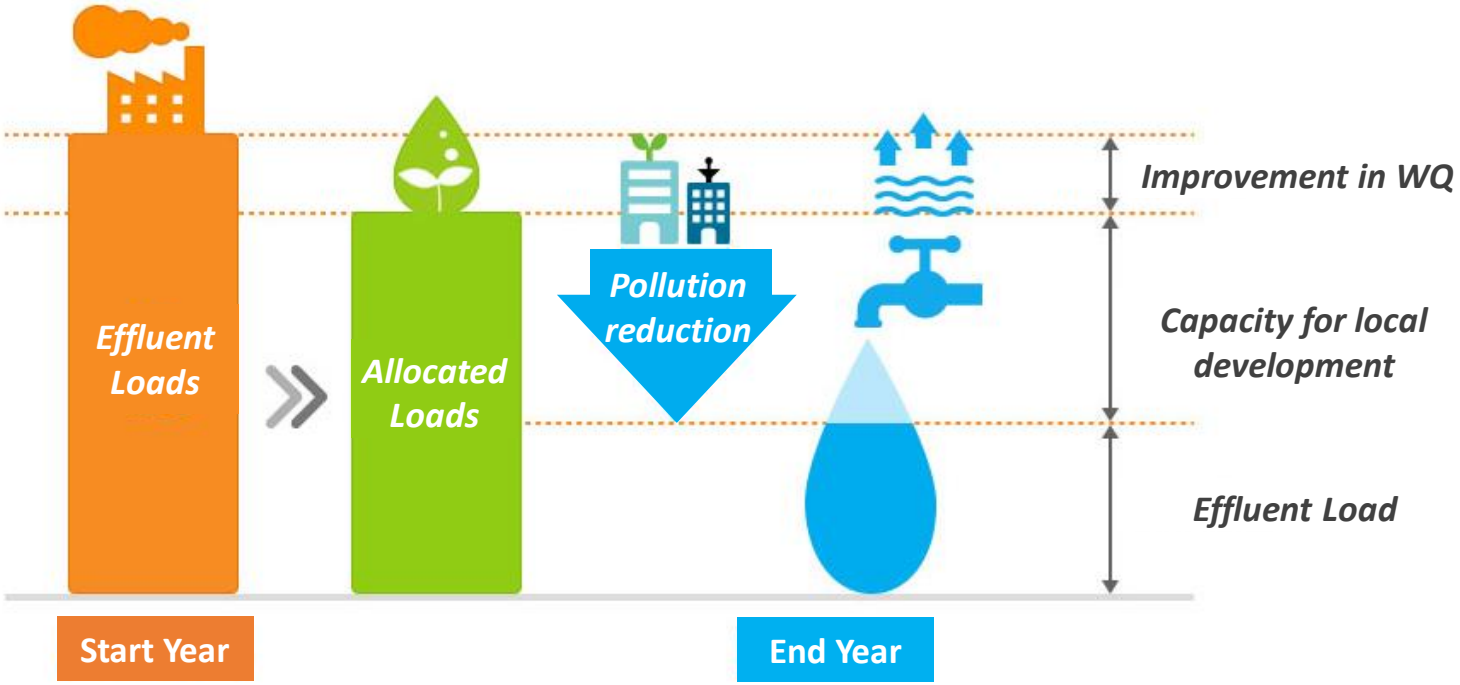
Background for implementing the TMDL

- **Water quality management system considering population density in the watershed.**
  - The densely populated human and industrial concentration along the downstream and midstream of rivers poses limitations in achieving environmental standards.
- **Limitations of regulation based on WQ conc.**
  - The concentration-based regulation focused on existing discharge permit standards has proven challenging in controlling the quantitative increase in pollution loads

"Requirement for an enhanced WQ management system that takes into account both WQ conc. & Loads "

What is a TMDL?

- **Total Maximum Daily Load**
  - A watershed management system that establishes achievable water quality goals at the downstream point of the watershed. It aims to reduce pollutants within the allowable total load (allocation) range.



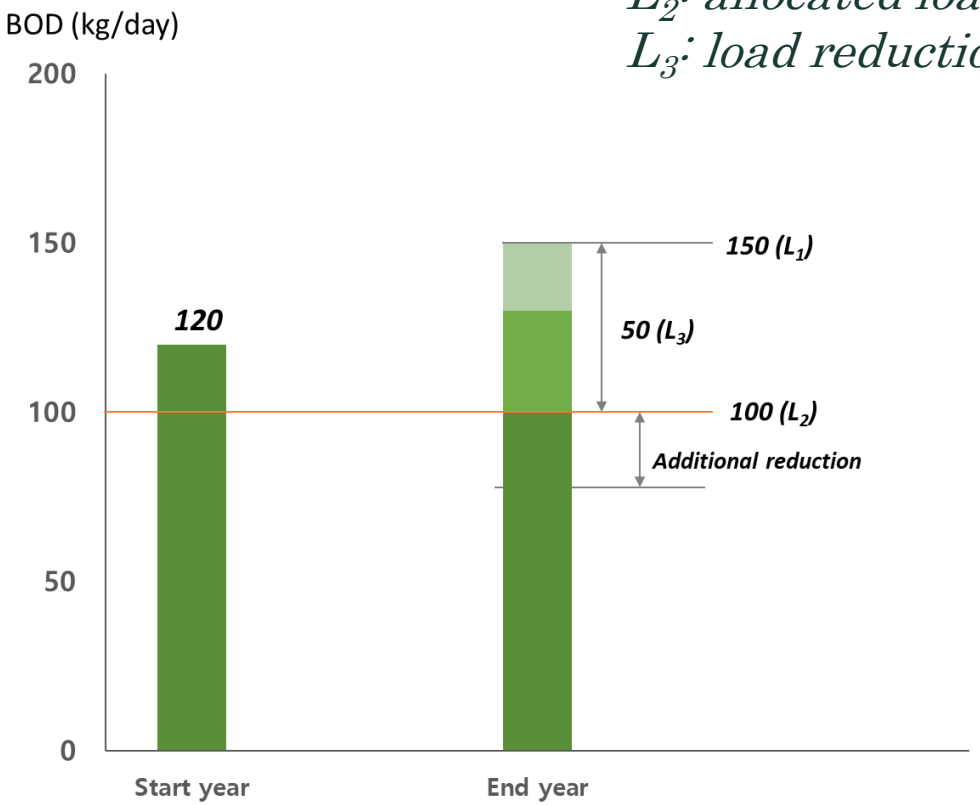
What is a TMDL?

- **Total Maximum Daily Load**

$$L_t = C_t \times Q_s$$

$$L_1 \leq L_2$$

L_t: pollutant load target (kg/day)
C_t: water quality target (mg/L)
Q_s: standard flow (m^3/s)
L_1: effluent load (kg/day)
L_2: allocated load (kg/day)
L_3: load reduction target (kg/day)



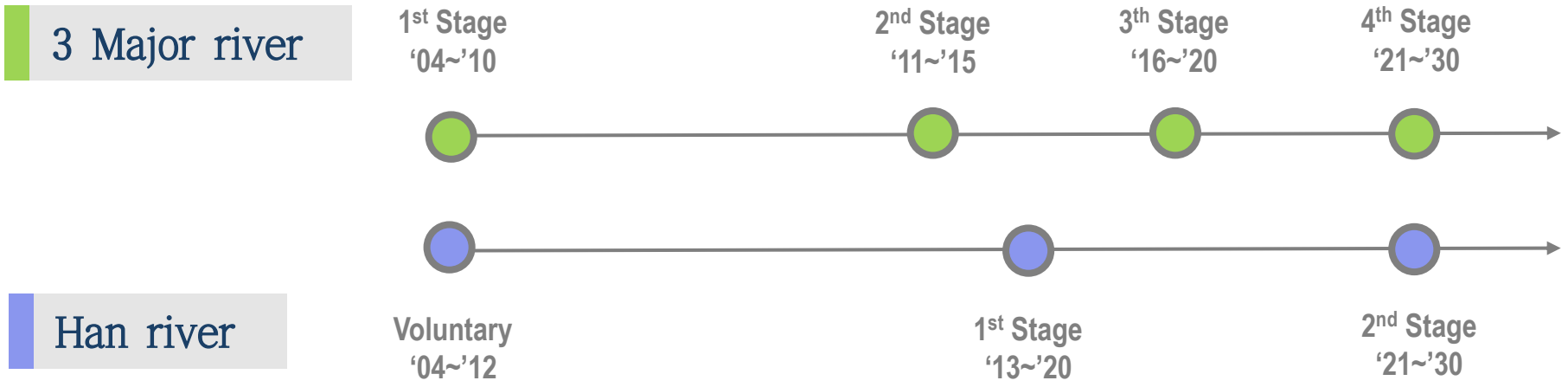
Implement Procedure of TMDL in Korea

Process for achieving consensus

"Communication & collaboration
between Central & Local governments"
⇒ *The process may be challenging and prolonge,*
yet both parties persist in reaching a consensus

Central gov.		Local gov.
• Decision	▸ **Selection of Target WQ parameters**	• Consultation
• Decision	▸ **Establishment of WQ target**	• Consultation
• Approval	▸ **Basic plan on TMDL management**	• Establishment
• Review	▸ **Implementation plan on TMDL management**	• Establishment, Approval
• Review	▸ **Performance assessment**	• Evaluation

Process since introduction of the TMDL



Han River		3 Major river (Nakdong, Geum, and Yeongsan river)	
Voluntary system	**(Period)** 2004~2012 **(Target WQ parameter)** BOD	1st stage	**(Period)** 2004~2010 **(Target WQ parameter)** BOD
1st stage	**(Period)** 2013~2020 **(Target WQ parameter)** BOD, T-P	2nd stage	**(Period)** 2011~2015 **(Target WQ parameter)** BOD, T-P
2nd stage	**(Period)** 2021~2030 **(Target WQ parameter)** BOD, T-P	3th stage	**(Period)** 2016~2020 **(Target WQ parameter)** BOD, T-P
		4th stage	**(Period)** 2021~2030 **(Target WQ parameter)** BOD, T-P

Current status of WQ goals in this stage

- **Status of WQ target establishment('21~'30)**

Classification	Total	Boundary between cities & provinces	Local government jurisdictional areas
Total	**149(5)**	**37(1)**	**112(4)**
Han river	49(1)	12	37(1)
Nakdong river	41	8	33
Geum river	31(2)	10	21(2)
Yeongsan river	24(2)	7(1)	17(1)
remaining river	4	-	4

** The numbers in parentheses represent the points within the seawater distribution section where water quality goals have not been set*

Current status of WQ goals in this stage

- **WQ goals on boundary between cities & provinces('30)**

Geum River(mg/L)		
Watershed	BOD	T-P
Geumbon C	1.0	0.014
Geumbon D	1.0	0.019
Geumbon F	1.0	0.016
Yoodeung A	1.2	0.032
Gabcheon A	4.1	0.118
Geumbon G	2.2	0.062
Byeongcheon A	2.3	0.105
Miho B	4.0	0.089
Geumbon H	2.9	0.083
Geumbon K	3.0	0.078

Yeongsan·Seomjin River(mg/L)		
Watershed	BOD	T-P
Yeongbon A	2.4	0.082
Hwangryong A	2.2	0.060
Yeongbon C	4.6	0.145
Seombon C	1.4	0.038
Yocheon B	1.5	0.054
Seombon E	1.1	0.030

Han River(mg/L)		
Watershed	BOD	T-P
Hangang A	1.1	0.028
Hangang D	1.0	0.034
Seomgang B	1.7	0.070
Bukhan C	1.4	0.020
Hongcheon A	1.0	0.020
Hangang G	1.7	0.039
Joongrang A	4.0	0.220
Tancheon A	4.0	0.314
Anyang A	6.2	0.320
Hangang I	3.8	0.214
Gulpo A	3.9	0.486
Hantan A	1.4	0.056

Nakdong River(mg/L)		
Watershed	BOD	T-P
Nakbon A	1.4	0.044
Nakbon F	1.9	0.040
Geumho B	3.0	0.072
Geumho C	3.4	0.098
Nakbon G	2.6	0.056
Hoicheon A	1.2	0.038
Milyang A	1.3	0.031
Nakbon L	2.6	0.049

TMDL systems in the Unite states

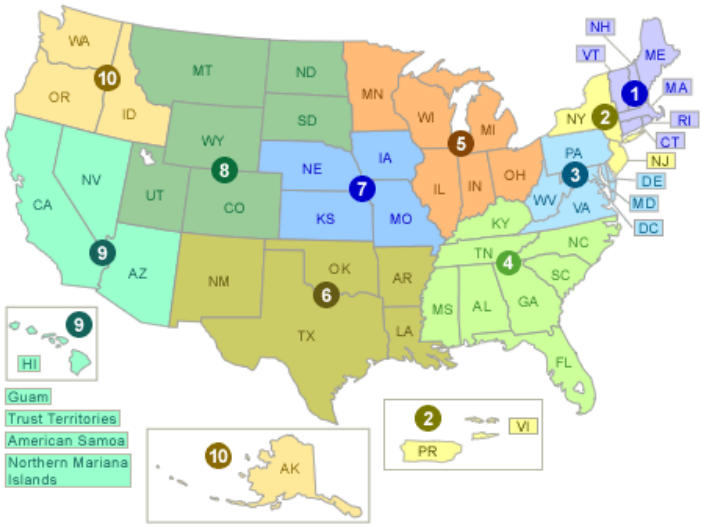
- **Background & Overview**
  - **National Pollutant Discharge Elimination System(1972)**
    - NPDES permit program by regulating point sources
  - **In the early 1990s, TMDL was officially implemented.**
  - **TMDL development required by Clean Water Act for streams impaired by a pollutant**

TMDL systems in the Unite states

- **TMDL is the calculation of the maximum amount of a pollutant that a water body can receive and still meet WQ standards, and an allocation of that amount to the pollutant's sources.**

$$TMDL = \sum WLA + \sum LA + MOS$$

- ∑ WLA: Sum of waste load allocations (point sources)
  - ❖ Need NPEDS permit
- ∑LA: Sum of load allocations (nonpoint sources)
  - ❖ No permit required
- MOS: margin of safety



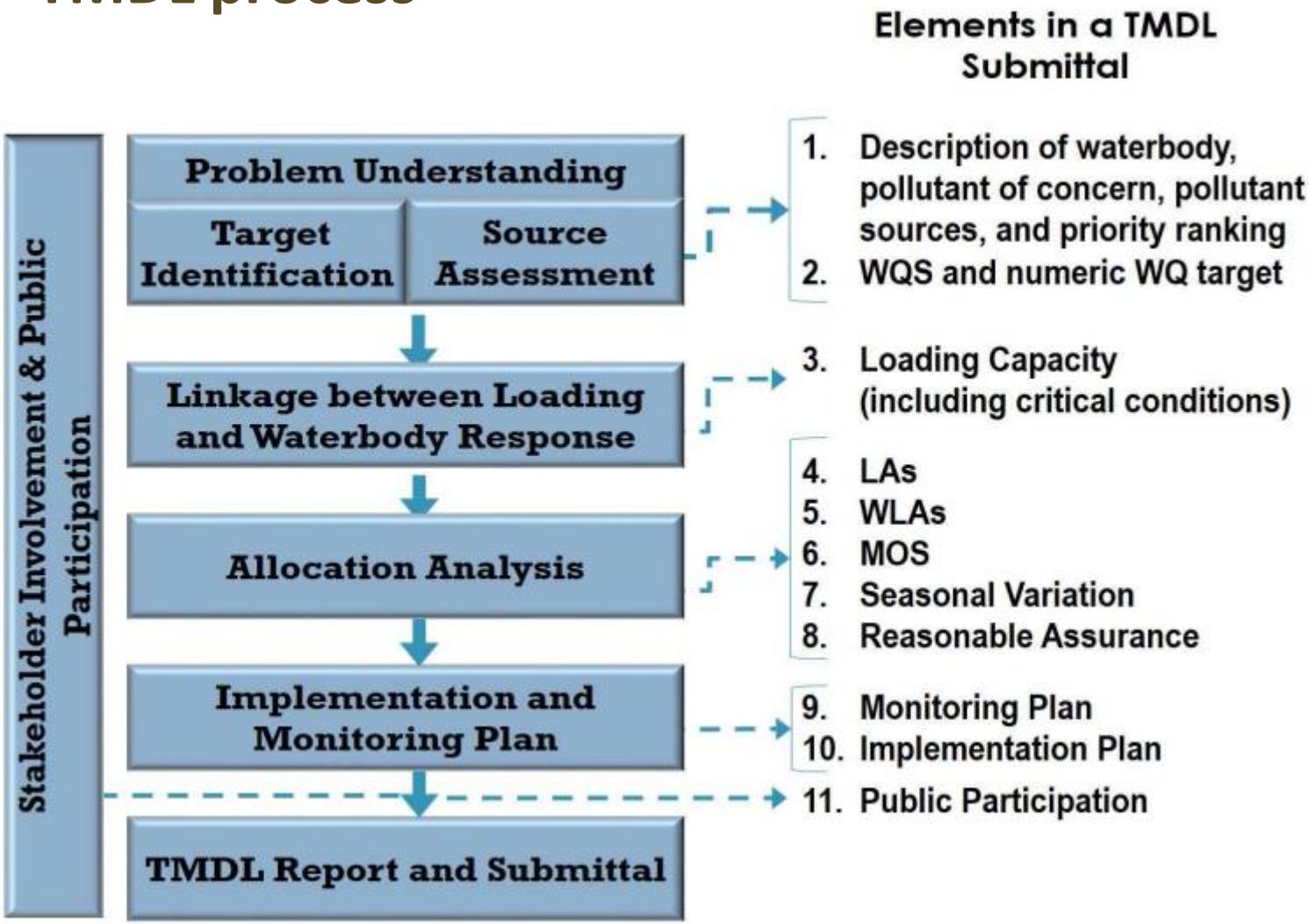
As of 2021, a total of 74,001 TMDL have been approved in US.

National Institute of Environmental Research

<source: www.epa.gov>

TMDL systems in the Unite states

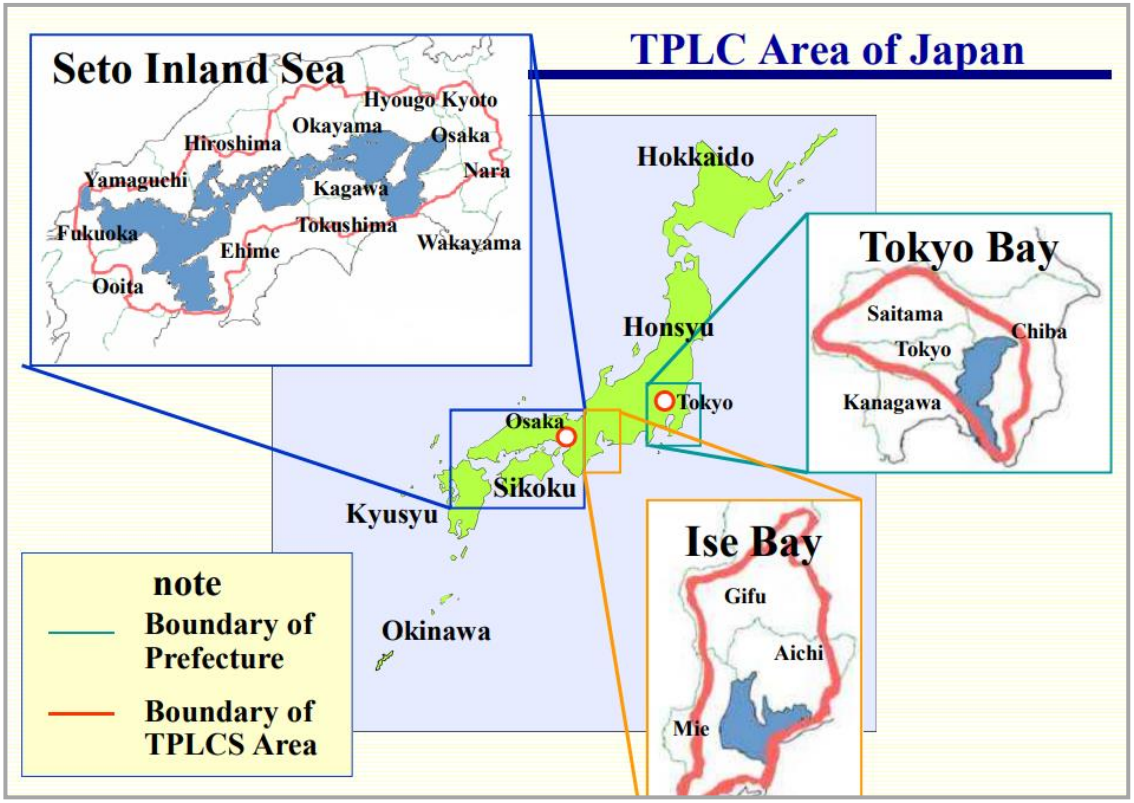
- **TMDL process**



<source: '23 National Training Workshop on WQ data, Assessment, and Plans>

TPLCS in Japan

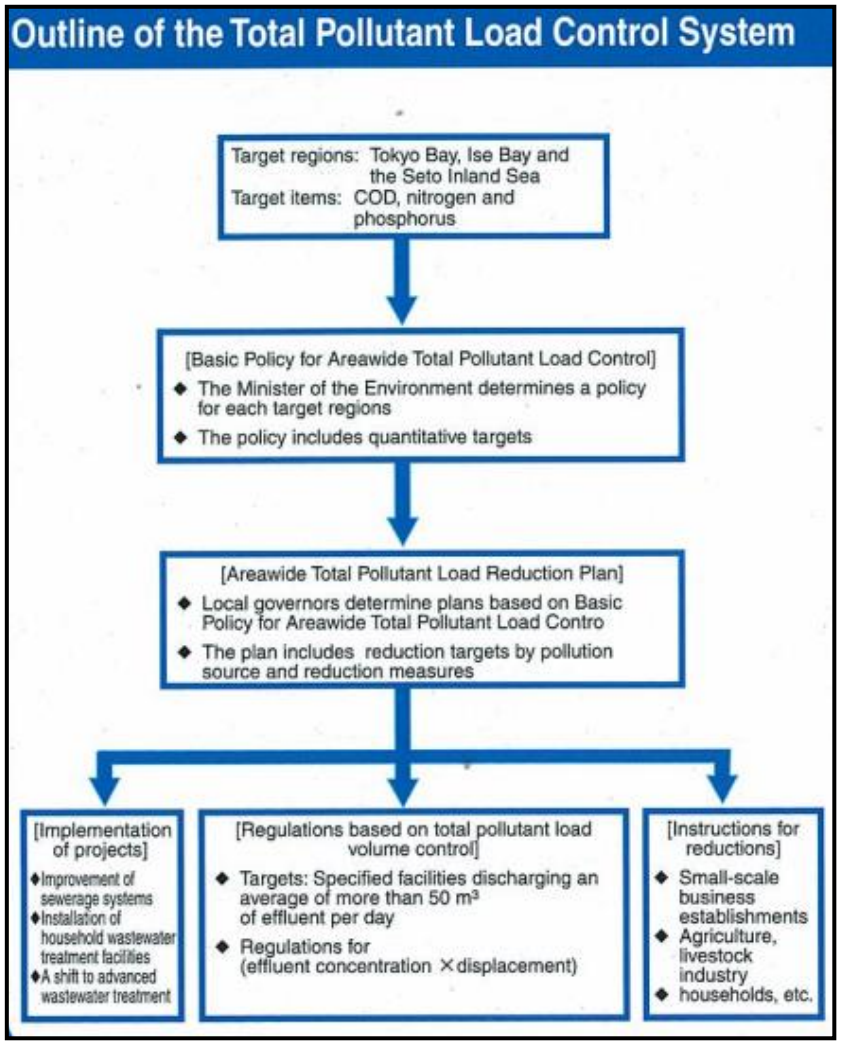
- **Total Pollutant Load Control & its System(TPLCS)**
  - since 1979(COD) in enclosed 3 water areas
    - ❖ All the drainage basin to the specified estuaries(20)
  - From 2001(5th stage), TPLS(N, P) started



<source: www.env.go.jp>

TPLCS in Japan

- **Scheme & methods of TPLCS**



◆ **Methods of Pollutant Reduction**

+ Promote the implementation of various waste water treatment facilities/equipments.

+ Ensure the compliance of the regulated point sources with standard of total pollutant load.

+ Develop the waste water guidance for unregulated small-scale facilities, agriculture, the livestock waste and feedings.

+ Promote the dissemination and the communication on the TPLCS.

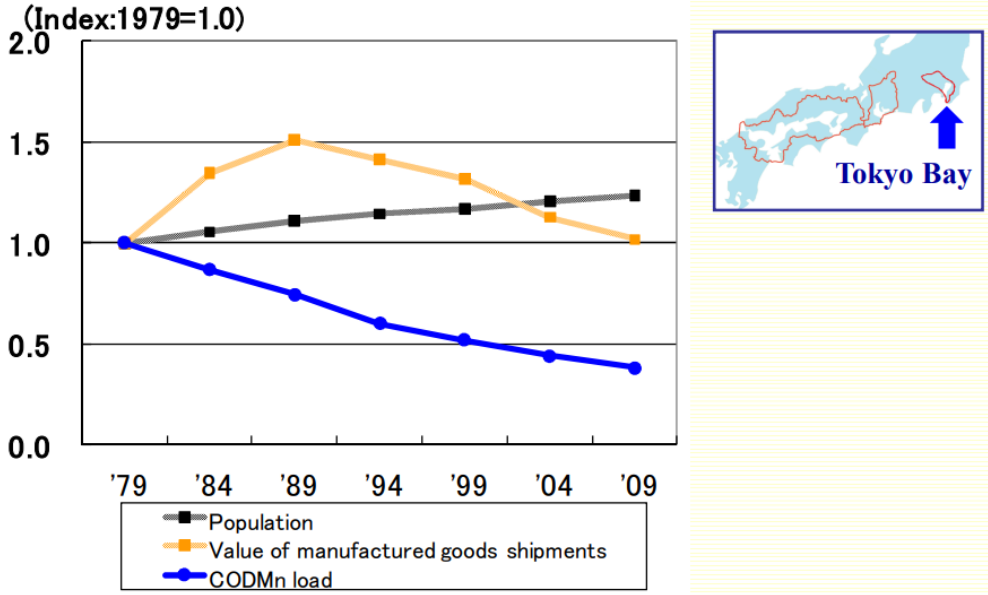
+ Reinforce the self-purification capability of water by constructing artificial flat, etc.

<source: www.env.go.jp>

Improved WQ by TPLCS

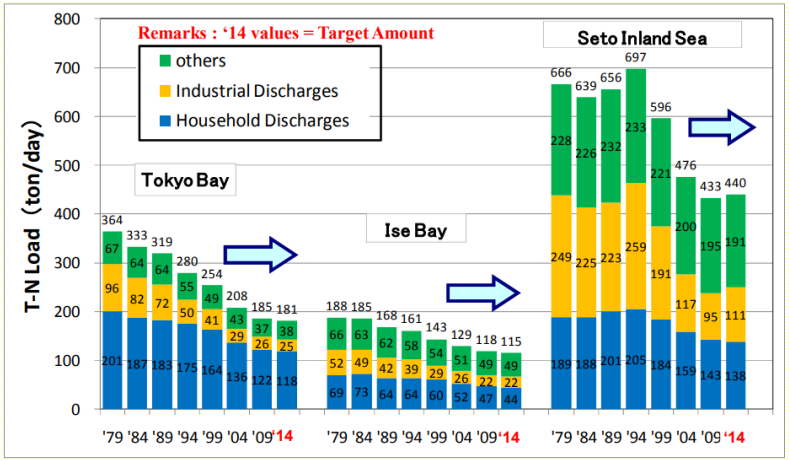
- a clear tendency of decreasing pollutant loads.

Change of Industry, Population and COD_{Mn} Load

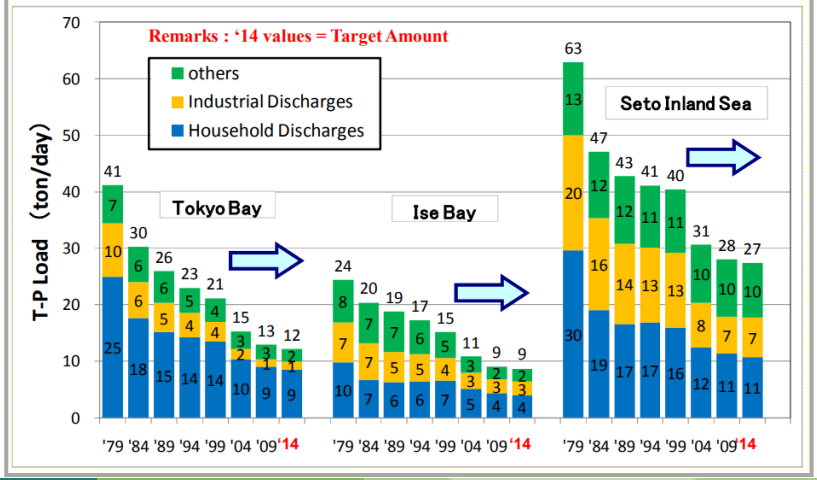


Transition of population, industry and pollutant load after starting the TPLCS (Tokyo Bay)

Pollutant Load (T-N)



Pollutant Load (T-P)



<source: www.env.go.jp>

Comparison of TMDL
in Korea, the Unite States, and Japan

- **Similarity:** Limitations of concentration based WQ management
  ☞ Introduction of a pollutant load-oriented WQ management
- **Summary**

Classification	Korea	US	Japan
Strat year	2002	1992	1979
Objective	Harmony between development and environmental protection	WQ standard attainment	WQ pollution prevention
Target region	4 major river	Impaired Waterbody	Closed water area - Tokyo bay, Ise bay, The Seto inland sea
Target parameter	BOD, T-P	Parameters exceeding WQ standards such as metals, pathogens, Nutrients, DO, etc	COD, TN, T-P
Entity in charge of formulating pollution load reduction plans	Local government	State government	Local government

//. Performance of TMDL in Korea

WQ attainment rate of 3th stage

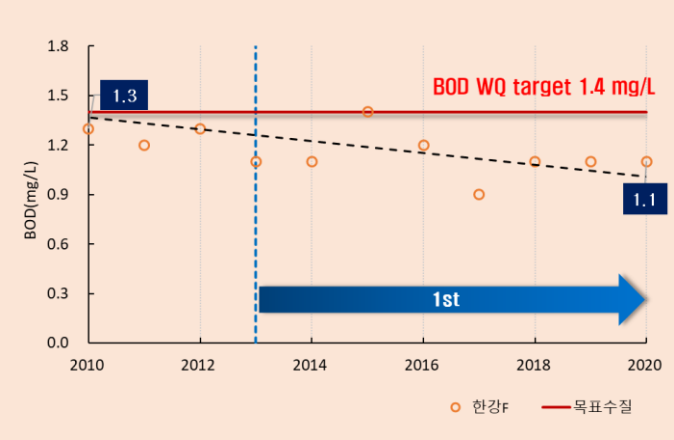
- As of the year 2020*, the attainment rate for water quality targets at the designated locations is 77% for BOD and 69% for T-P

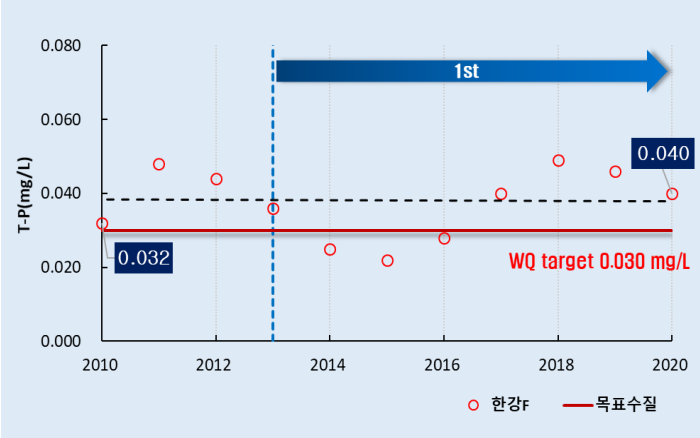
Target parameter	Water system	Target area				
		Total	Attainment	Non-attinment	Attainment Rate	Attainment rate in previous stage
BOD	Han	26	19	7	73.1%	-
	Nakdong	41	36	5	87.8%	75.6%
	Geum	30	16	14	53.3%	86.7%
	Yeongsan·Seomjin	22	20	2	90.9%	90.5%
	Total	119	91	28	76.5%	82.6%
T-P	Han	26	17	9	65.4%	-
	Nakdong	41	30	11	73.2%	97.6%
	Geum	30	19	11	63.3%	87.5%
	Yeongsan·Seomjin	22	16	6	72.7%	81.0%
		119	82	37	68.9%	91.4%

In 2020, the three major rivers marked the conclusion of the third stage, while the Han River concluded only the first stage.

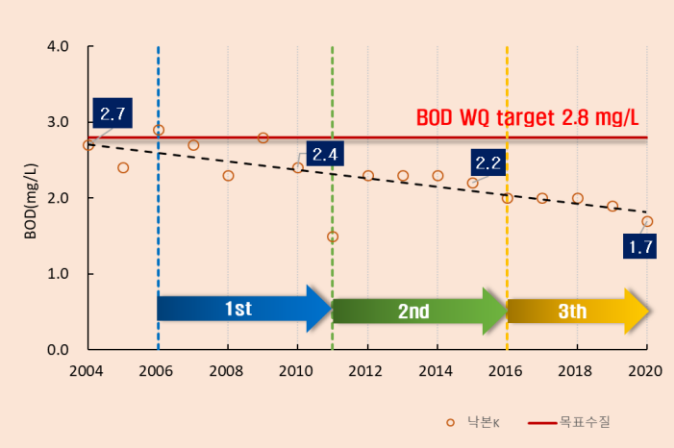
Improvement of Water quality

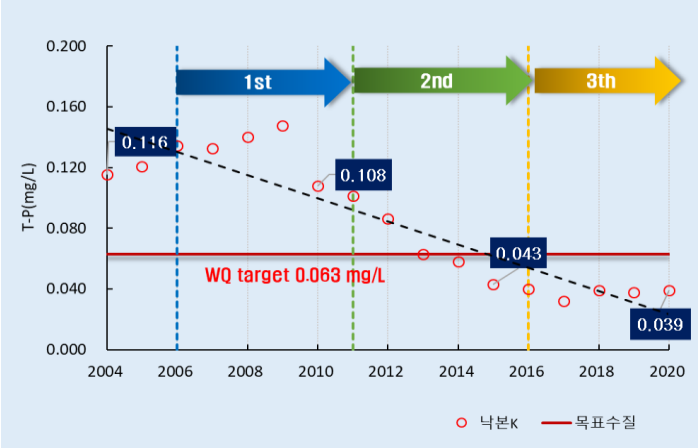
- Hangang F (Han river)





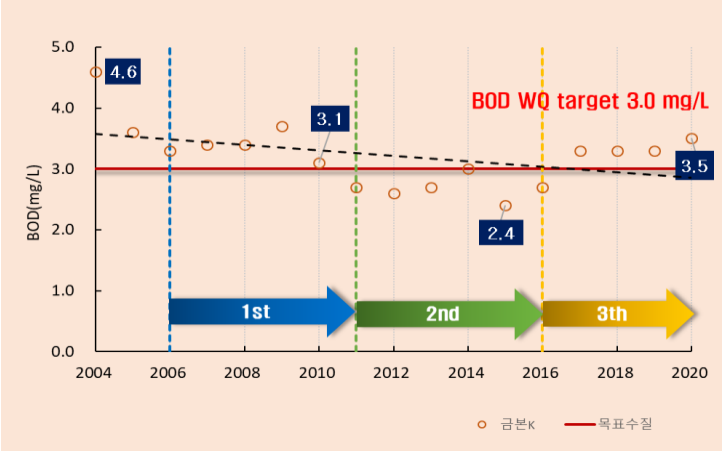
- Nakbon K (Nakdong river)

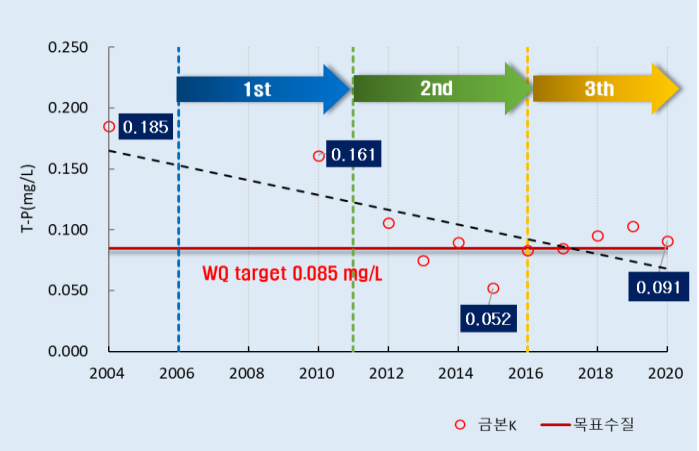




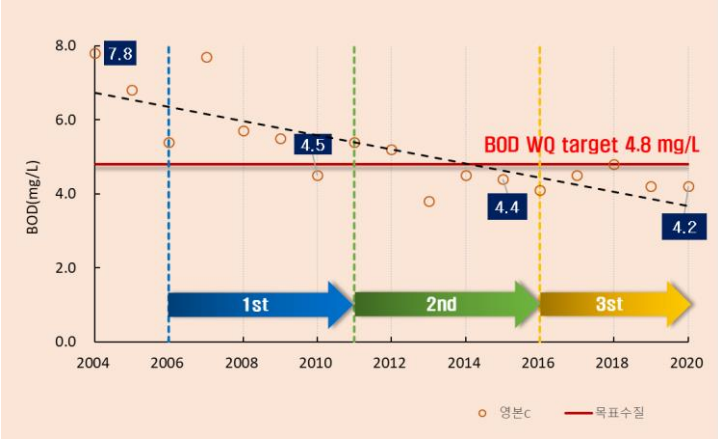
Improvement of Water quality

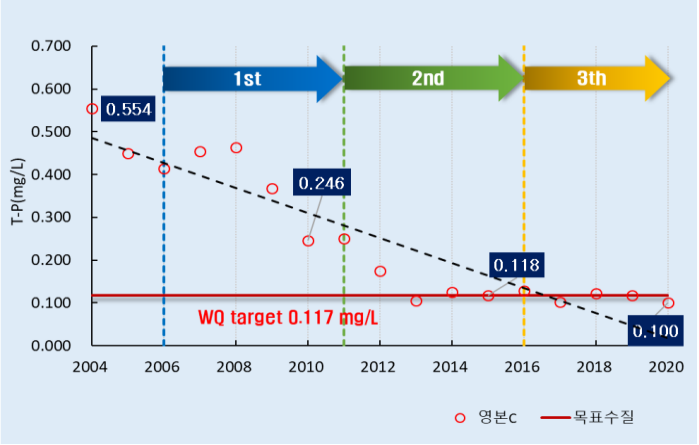
- Geumbon K (Geum river)





- Yeongbon C (Yeongsan river)





Decrease of discharge load

- According to the stage assessment, there is a decreasing trend in pollutant discharge loads across watersheds

(kg/day)

Target parameter	Water system	Before 2004	2010	2015	2020
BOD	Han	-	-	152,336	84,827
	Nakdong	176,080	105,711	68,944	64,747
	Geum	126,163	74,272	55,074	53,568
	Yeongsan·Seomjin	51,105	33,339	31,140	30,653
	Total	353,348	213,322	307,494	233,795
T-P	Han	-	-	19,296	5,762
	Nakdong	-	11,121	6,147	4,346
	Geum	-	1,360	956	530
	Yeongsan·Seomjin	-	3,933	1,849	2,181
	Total	-	16,414	28,248	12,819

Ⅲ. *Current issues of TMDL in Korea*

Recent criticisms regarding TMDL

- Planning and evaluation based on overly complex formulas
  - Approximately 200 formulas are used in the pollutant load calculation process (source → generated load → discharge load)
- A Reduction plan concentrated on point sources
  - Establishment of allocation and reduction plans focusing on easily manageable public wastewater treatment plants
- Lack of incentives vs. Absence of substantial restriction
  - No rewards for areas that have achieved target water quality; no sanctions for areas that have not met the target

Efforts to improve the TMDL *(Future initiative)*

- **Simplification** of TMDL implementation
  - Complex equations alone may not be sufficient to calculate everything that occurs in actual watershed. ⇒ Planning and rapid evaluation based on the latest monitoring data through pilot projects.
- Expansion of **recognized reduction** activities
  - Expansion of the recognized scope of reduction efforts for nonpoint source pollution through activities such as agricultural BMPs and canal cleaning, rather than relying on facilities like wastewater treatment plants

Thank you for your attentive listening!

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