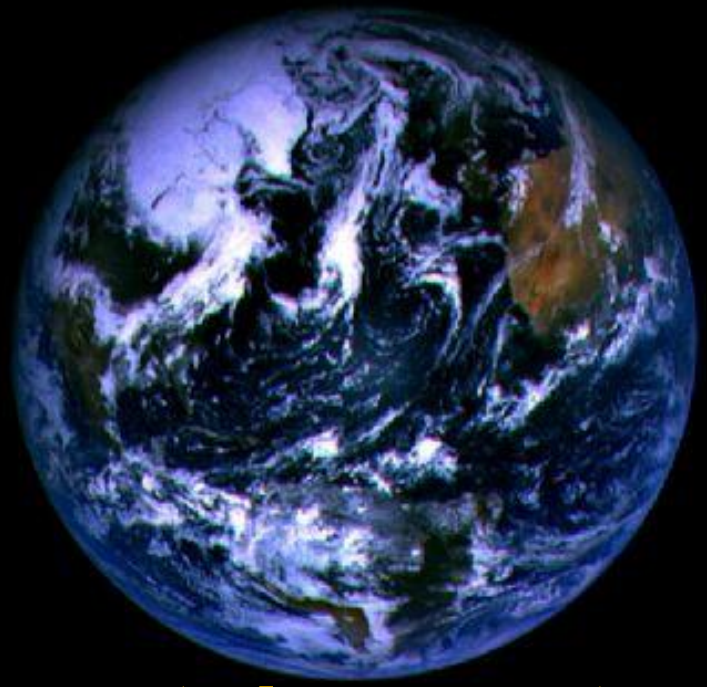
Enrironment and Ecology

Water Pollution

Water on Earth 1.39×10^9 km^3



Oceans (saline water) 97.5%

Freshwater 2.5%

Snow and ice 1.76%

Ground water 0.76%

Lake and river 0.01%

国土交通省水資源部「平成29年版 日本の水資源の現況」から

Environmental Quality Standards (EQS) for Water Pollution

under the Basic Environment Law

two major goals:

1. protection of human health

and

2. conservation of the living environment

Environmental Quality Standards for Human Health 1

Item	Standard values
Cadmium	≤ 0.003 mg/L
Total cyanide	not detectable
Lead	≤ 0.01 mg/L
Hexavalent chromium	≤ 0.02 mg/L
Arsenic	≤ 0.01 mg/L
Total mercury	≤ 0.0005 mg/L
Alkyl mercury	not detectable
PCBs	not detectable
Dichloromethane	≤ 0.02 mg/L
Carbon tetrachloride	≤ 0.002 mg/L
1, 2-dichloroethane	≤ 0.004 mg/L
1, 1-dichloroethylene	≤ 0.1 mg/L
Cis-1, 2-dichloroethylene	≤ 0.04 mg/L

Environmental Quality Standards for Human Health 2

Item	Standard values
1, 1, 1-trichloroethane	≤ 1 mg/L
1, 1, 2-trichloroethane	≤ 0.006 mg/L
Trichloroethylene	≤ 0.01mg/L
Tetrachloroethylene	≤ 0.01mg/L
1, 3-dichloropropene	≤ 0.002mg/L
Thiuram	≤ 0.006 mg/L
Simazine	≤ 0.003 mg/L
Thiobencarb	≤ 0.02 mg/L
Benzene	≤ 0.01 mg/L
Selenium	≤ 0.01 mg/L
Nitrate and nitrite N	≤ 10 mg/L
Fluoride	≤ 0.8 mg/L
Boron	≤ 1 mg/L
1,4-dioxane	≤ 0.05 mg/L

Environmental quality standards for conservation of the living environment

1. Rivers (excluding lakes)

A

Item / Class	Water use	Standard value				
		Hydrogen-ion concentration (pH)	BOD	Suspended solids (SS)	Dissolved oxygen (DO)	Total coliform
AA	Water supply class I, conservation of natural environment, and uses listed in A-E	6.5 ≤ pH ≤ 8.5	≤ 1 mg/L	≤ 25 mg/L	≥ 7.5 mg/L	≤ 20 CFU/ 100mL
A	Water supply class 2, fishery class 1, bathing and uses listed in B-E	6.5 ≤ pH ≤ 8.5	≤ 2 mg/L	≤ 25 mg/L	≥ 7.5 mg/L	≤ 300 CFU/ 100mL
B	Water supply class 3, fishery class 2, and uses listed in C-E	6.5 ≤ pH ≤ 8.5	≤ 3 mg/L	≤ 25 mg/L	≥ 5 mg/L	≤ 1,000 CFU/ 100mL
C	Fishery class 4, industrial water class 1, and uses listed in D-E	6.5 ≤ pH ≤ 8.5	≤ 5 mg/L	≤ 50 mg/L	≥ 5 mg/L	-
D	Industrial water class 2, agricultural water, and uses listed in E	6.0 ≤ pH ≤ 8.5	≤ 8 mg/L	≤ 100mg/L	≥ 2 mg/L	-
E	Industrial water class 3 and conservation of environment	6.0 ≤ pH ≤ 8.5	≤ 10 mg/L	Floating matter such as garbage should not be observed	≥ 2 mg/L	-

B

Item Class	Adaptability to aquatic life habitat conditions	Standard value		
		Total zinc	Nonylphenol	LAS
Aquatic life A	Water bodies inhabited by aquatic organisms such as char, salmon, and trout, and their prey, which favour relatively low-temperature ranges.	≤ 0.03 mg/L	≤ 0.001 mg/L	≤ 0.03 mg/L
Special aquatic life A	Water bodies categorized in 'Aquatic life A' need to be conserved in particular in breeding or nursery grounds for the aquatic life categorized in in 'Aquatic life A'.	≤ 0.03 mg/L	≤ 0.0006 mg/L	≤ 0.02 mg/L
Aquatic life B	Water bodies inhabited by aquatic organisms such as carp, crucian, and also their prey, which favour relatively high-temperature ranges.	≤ 0.03 mg/L	≤ 0.002 mg/L	≤ 0.05 mg/L
Special aquatic life B	Water bodies categorized in 'Aquatic life B' ' need to be conserved in particular in breeding or nursery grounds for the aquatic life categorized in in 'Aquatic life B'.	≤ 0.03 mg/L	≤ 0.002 mg/L	≤ 0.04 mg/L

Remarks: Standard values are based on annual average values (including those for lakes and seas)

Environmental quality standards for conservation of the living environment

1. Rivers (excluding lakes)

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B	Water supply class 3, fishery class 2, and uses listed in C-E	6.5 ≤ pH ≤ 8.5	≤ 3 mg/L	≤ 25 mg/L	≥ 5 mg/L	≤ 1,000 CFU/ 100mL
C	Fishery class 4, industrial water class 1, and uses listed in D-E	6.5 ≤ pH ≤ 8.5	≤ 5 mg/L	≤ 50 mg/L	≥ 5 mg/L	-
D	Industrial water class 2, agricultural water, and uses listed in E	6.0 ≤ pH ≤ 8.5	≤ 8 mg/L	≤ 100mg/L	≥ 2 mg/L	-
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There are different standards for lake water and sea water.

Pollutants can be divided into three categories:

1. Organic contaminants
2. Nitrogen and phosphorus (eutrophication)
3. Toxic substances （heavy metals, POPs etc.）

1. Organic contaminants (Organic pollutants)

The organic pollution is caused by the contaminations of organic matter including foodstuffs and organic chemicals.

(In this explanation, highly toxic substances such as POPs are excluded.)

Japanese proverb:

三尺流れれば水清し

Sanjaku nagare re ba mizu kiyoshi

A flow of three feet makes the water clean.

BOD & COD

BOD Biochemical Oxygen Demand

生物化学的酸素要求量

The amount of dissolved oxygen demanded by aerobic microorganisms to break down organic matter present in water (20℃, 5 days incubation).

COD Chemical Oxygen Demand

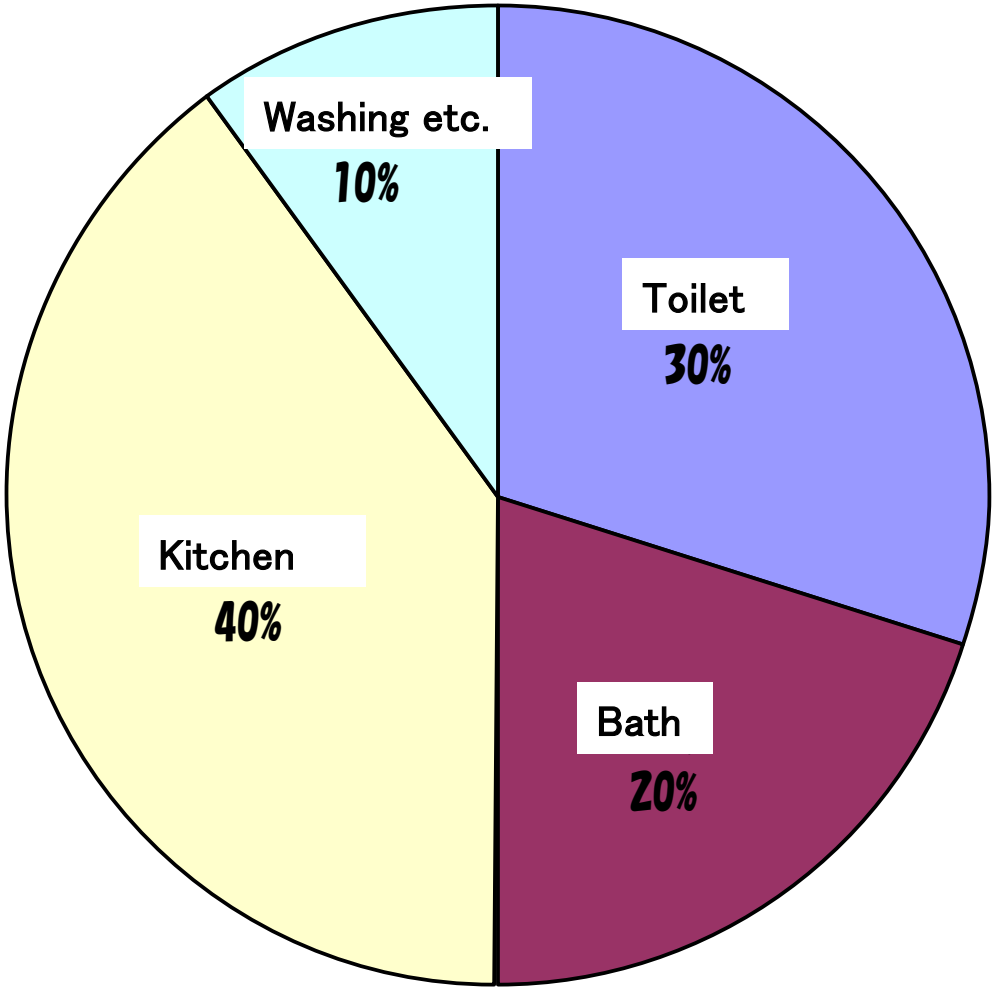
化学的酸素要求量

The amount of oxygen required for organic matter in water to be completely oxidized by a strong oxidizing agent (e.g. $KMnO_4$, $K_2Cr_2O_7$).

Environmental quality standards

River water: BOD

Lake, Sea water: COD

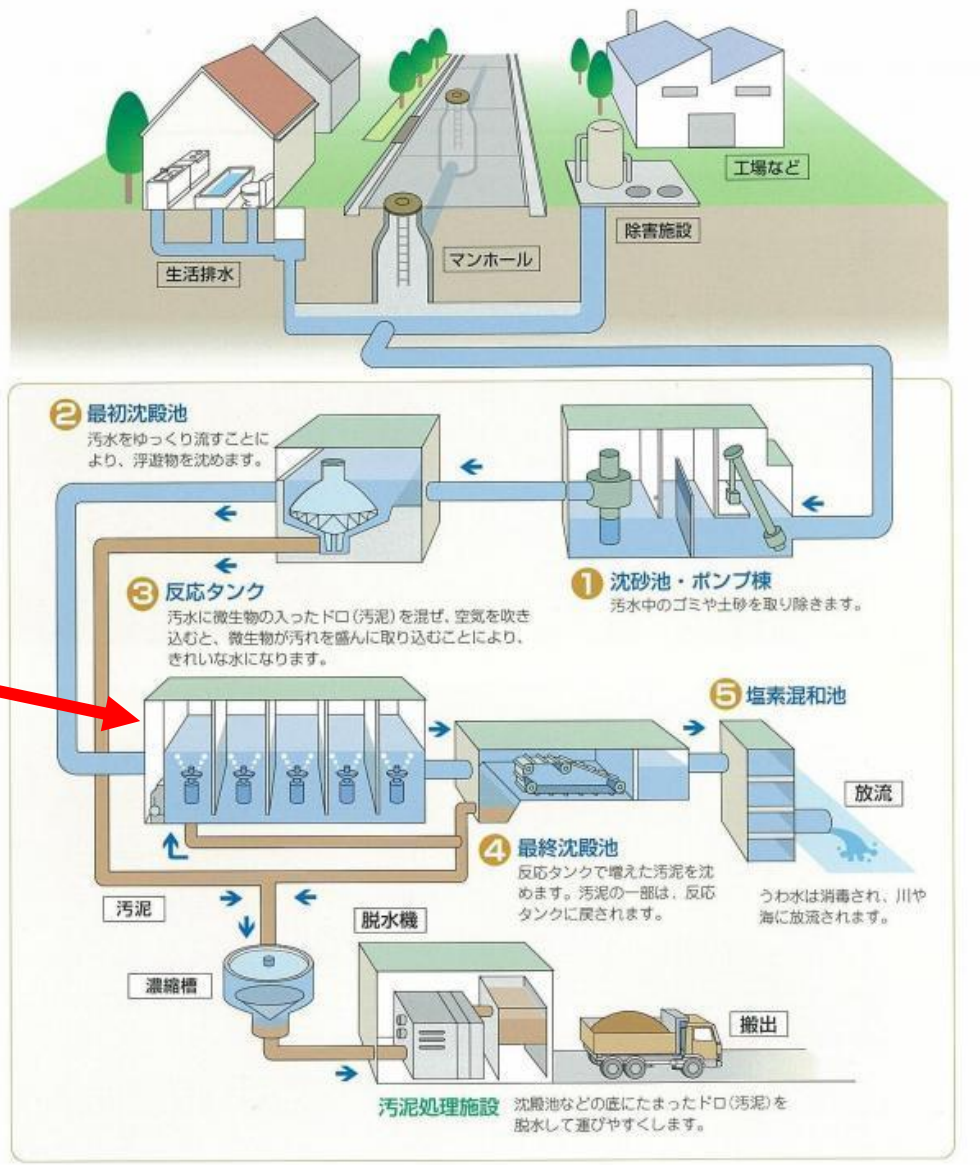


Water pollution（BOD）from daily life drainage

Ministry of the Environment (2003)

Organic pollutants in sewage are removed through several processes in sewage treatment plants.

Aeration tank



http://www.city.higashihiroshima.lg.jp/kurashi/sumai/3/6343.html

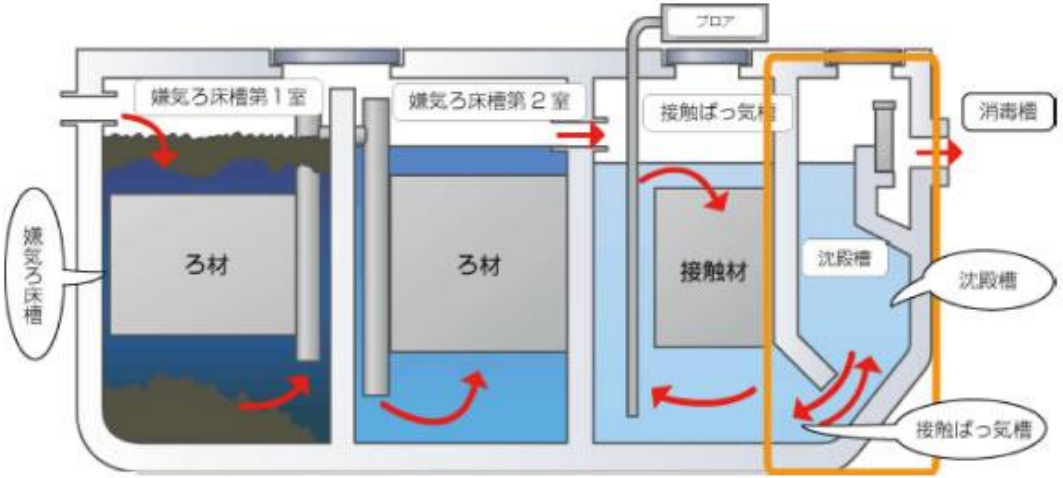
Microorganisms in aeration tanks (activated sludge) break down organic matter present in sewage.

Microorganisms settle down in water.

Centralized sewage systems can not be made in rural areas where population density is low.

Drainage of waste water without proper treatment

Septic tanks



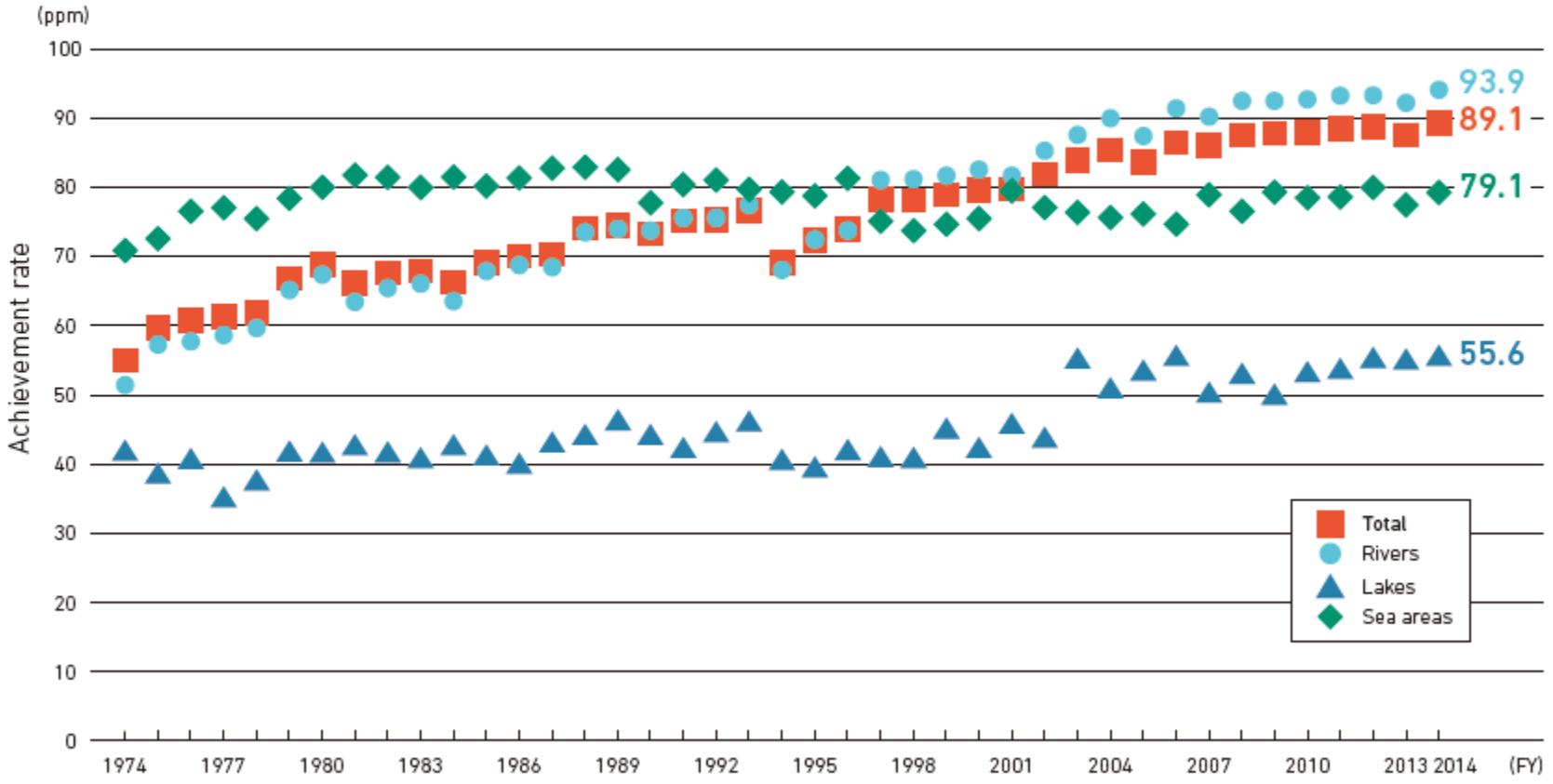
Combined treatment septic tank

Single treatment septic tank

https://www.town.tatsugo.lg.jp/seikatsu/kurashi/kankyo/gappeshori.html

The spread of sewage systems and combined septic tanks has improved the water quality of rivers in Japan.

An overall level of 89.1% has been achieved for the biochemical oxygen demand (BOD) and chemical oxygen demand (COD) environmental standards relating to the maintenance of living environments. BOD and COD are leading indicators of water quality in respect of organic pollution.



Source: "Measurement Results of Water Quality in Public Waters FY 2014" Ministry of the Environment

Annual Report on the Environment,
the Sound Material-Cycle Society and Biodiversity
in Japan 2016

Published by Ministry of the Environment

2. Nitrogen and phosphorus

These are nutrients essential for the growth of plants including phytoplankton.

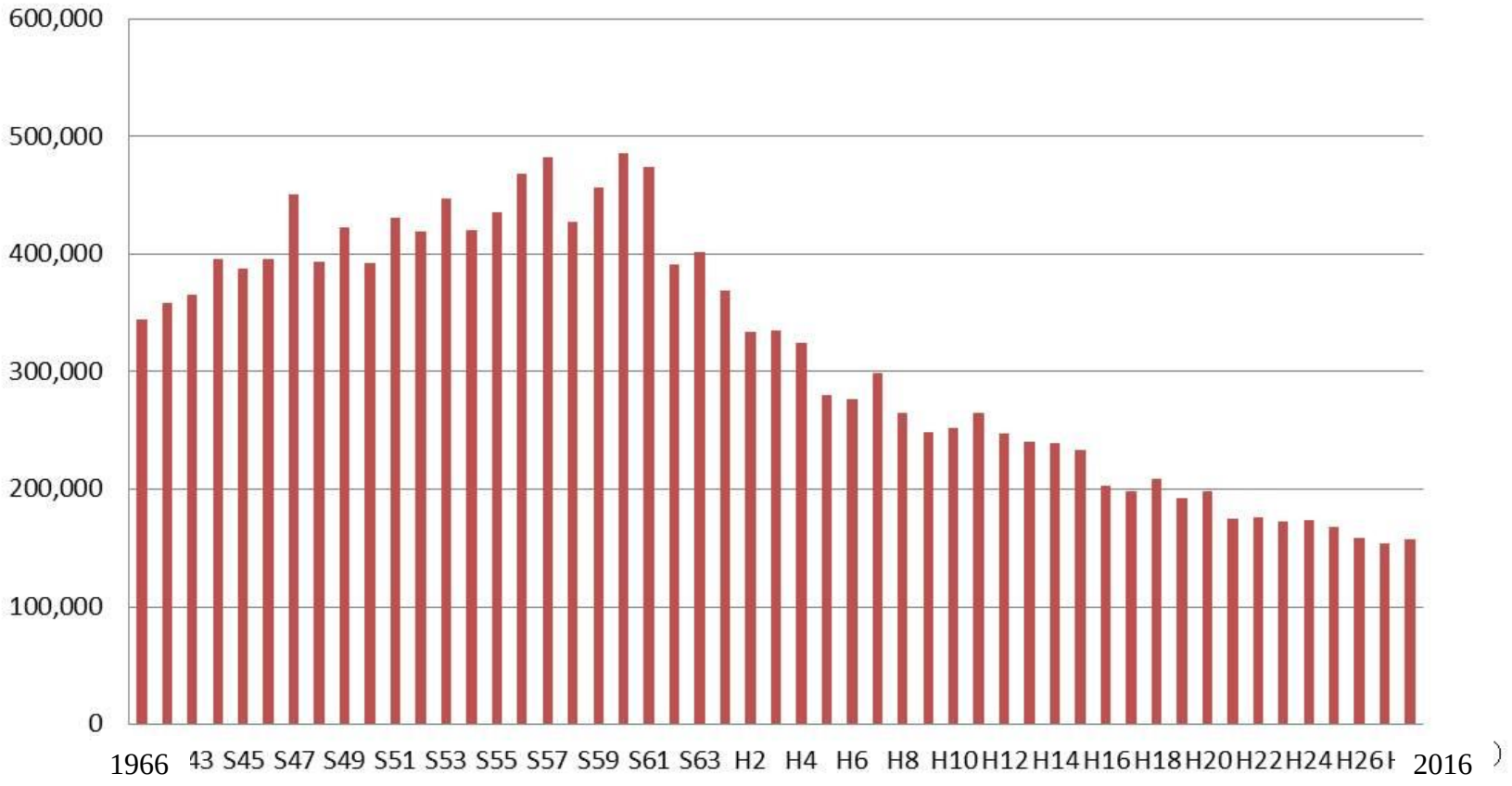
High loads of these nutrients cause red tide and water-bloom.

High concentrations of Nitrate (NO^{3-}) and nitrite (NO^{2-}) N in water are harmful to human health. They are listed in the Environmental Quality Standards for Human Health.

瀬戸内海区／海面漁業漁獲量の推移

Fish catch in the Seto Inland Sea

(Unit: ton)



出典:「漁業・養殖業生産統計年報」(農林水産省)
※「瀬戸内海区」の範囲は「漁業・養殖業生産統計年報」の大海区区分。

http://www.jfa.maff.go.jp/setouti/tokei/seisansuii.html

The Seto Inland Sea Environmental Protection Special Law (Seto Inland Law, enacted in 1973)

瀬戸内海環境保全特別措置法（瀬戸内法）

was amended in 2021

Establishment of a management system for controlling the nutritional balance of the Inland Sea's waters by regulating the amount of water discharged from water treatment plants etc.

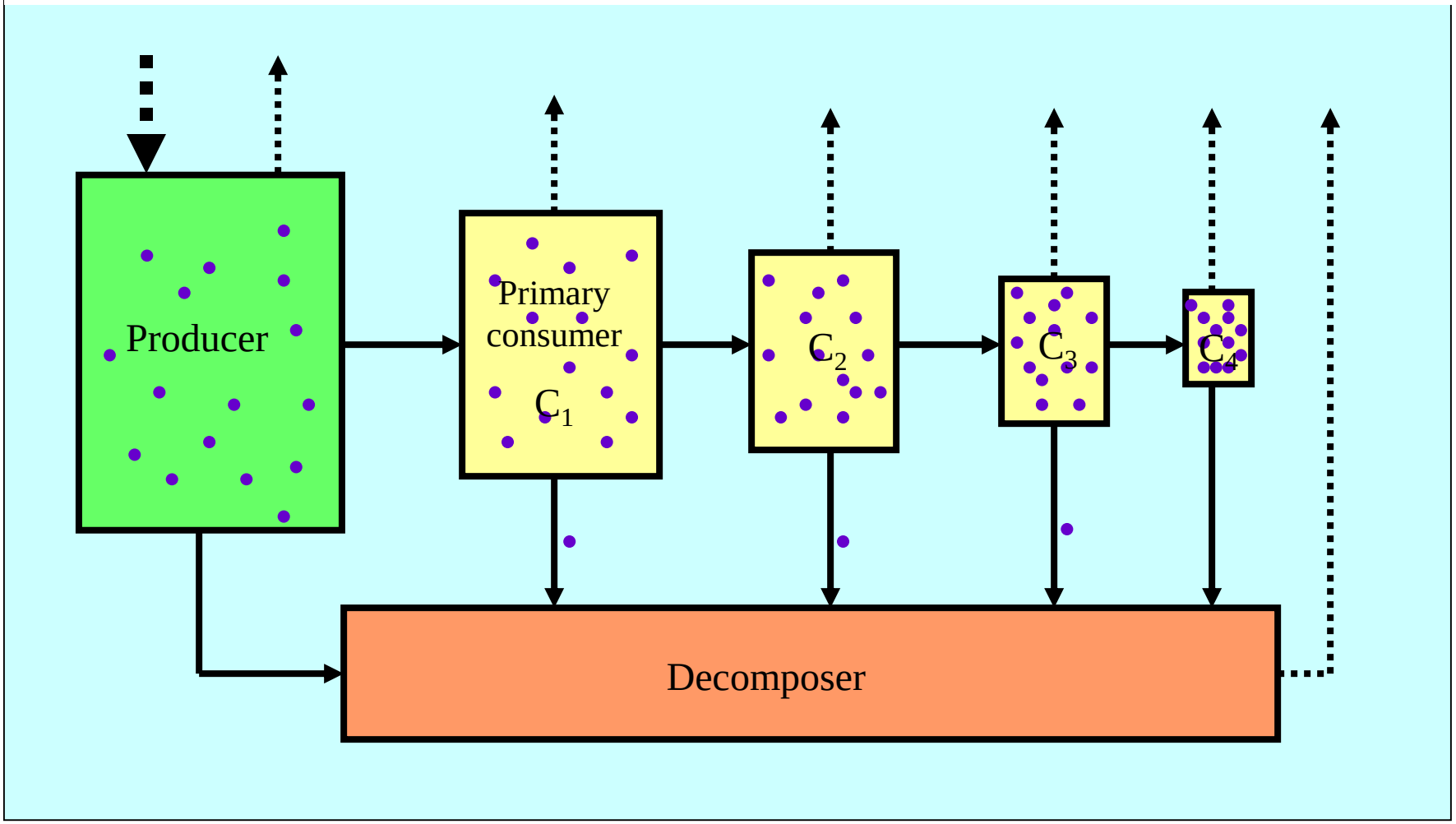
3. Toxic substances

There are a number of toxic substances.

Some of them are easily decomposed in natural water but others are not.

Some substances are remain intact for exceptionally long periods of time and often accumulated in organisms' bodies.

Substances that accumulate in the fatty tissue of living organisms are found at higher concentrations at higher levels in the food chain



Bioaccumulation
生物濃縮

Bioaccumulation

Increase in the concentration of a substance in certain tissues of organisms' bodies due to absorption from food and the environment

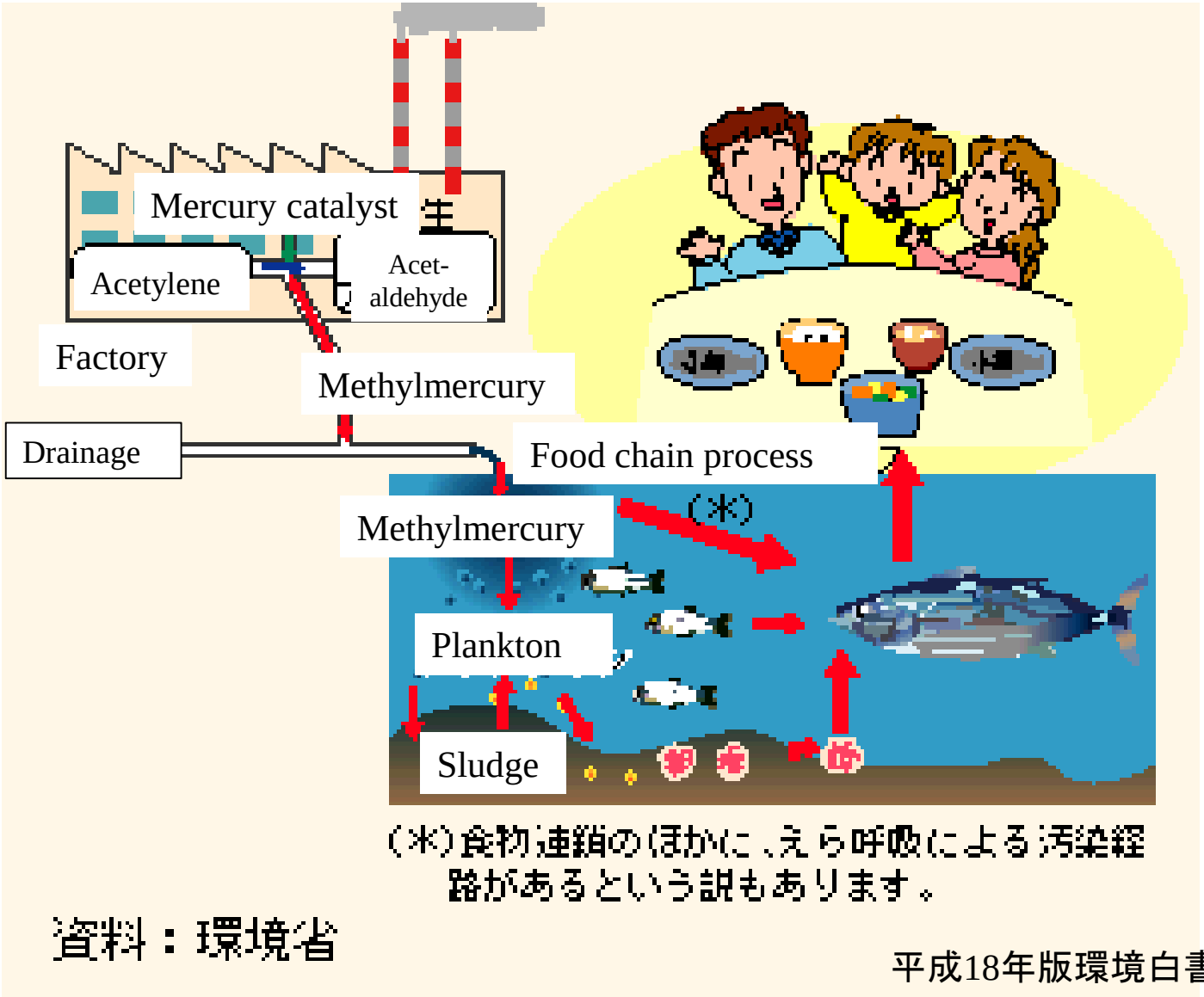
Bioconcentration

Uptake and accumulation of a substance from water

Biomagnification

Magnification of a substance with increasing trophic level

Methylmercury discharged from the factory was bioaccumulated in shellfish and resulted in Minamata Disease: a neurological syndrome caused by severe mercury poisoning.



平成18年版環境白書より

水銀に関する水俣条約

Minamata Convention on Mercury

目的：The Minamata Convention on Mercury is an international treaty that was designed to protect human health and the environment from anthropogenic emissions and releases of mercury and mercury compounds.

2013年10月10日採択

The Convention was adopted and opened for signature on 10 October 2013

DDT dichloro-diphenyl-trichloroethane

A strong insecticide. Effective to control malaria and typhus.

Its insecticidal action was discovered by P. H. Müller, who was awarded the Nobel Prize in Physiology or Medicine in 1949.

Nearly insoluble in water but has good solubility in fats and oils → bioaccumulation

DDT and BHC were taken off from Japanese market in 1971.

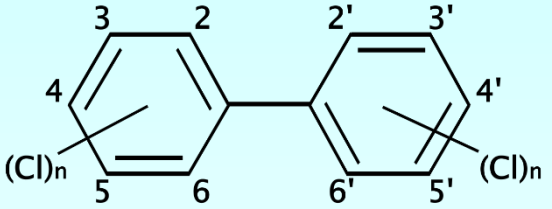
Biological concentration of DDT
（Long Island, N. Y., USA）

Sample	DDT residues（ppm）	Relative conc.
Water (estimated value)	0.00005	1
Plankton, mostly zooplankton	0.040	800
Shrimp	0.16	3,200
Atlantic needlefish	2.07	41,400
Double-crested cormorant	26.4	528,000
Ring-billed gull	75.5	1,510,000

Data from Woodell et al. (1967)

PCB Polychlorinated biphenyl

An organic chlorine compound with the formula C12H10−xClx. There are 209 different chemical compounds



- stable at high temperatures

Applications: insulating fluids, plasticizer, carbonless copy paper etc.

- domestically manufactured from 1929

- concentrated in the fatty tissue of organisms

→ bioaccumulation

cf. Yushō disease: a mass poisoning by PCBs in northern Kyūshū, Japan (1968)

Stockholm Convention on Persistent Organic Pollutants

an international environmental treaty that aims to eliminate or restrict the production and use of persistent organic pollutants (POPs).

Persistent Organic Pollutants (POPs) are organic chemical substances, that is, they are carbon-based. They possess a particular combination of physical and chemical properties such that, once released into the environment, they:

•remain intact for exceptionally long periods of time (many years);

•become widely distributed throughout the environment as a result of natural processes involving soil, water and, most notably, air;

•accumulate in the fatty tissue of living organisms including humans, and are found at higher concentrations at higher levels in the food chain; and

•are toxic to both humans and wildlife.

http://chm.pops.int/TheConvention/ThePOPs/tabid/673/Default.aspx

The 12 initial POPs under the Stockholm Convention

Initially, twelve POPs have been recognized as causing adverse effects on humans and the ecosystem and these can be placed in 3 categories:

Pesticides: aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, hexachlorobenzene, mirex, toxaphene;

Industrial chemicals: hexachlorobenzene, polychlorinated biphenyls (PCBs); and

By-products: hexachlorobenzene; polychlorinated dibenzo-*p*-dioxins and polychlorinated dibenzofurans (PCDD/PCDF), and PCBs.

The Conference of the Parties adopted amendments of the new POPs (16 chemicals)

http://chm.pops.int/TheConvention/ThePOPs/tabid/673/Default.aspx

Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS)

Per- and polyfluoroalkyl substances (PFAS) are a large, complex group of synthetic chemicals that have been used in consumer products around the world since about the 1950s.

They are ingredients in various everyday products. For example, PFAS are used to keep food from sticking to packaging or cookware, make clothes and carpets resistant to stains, and create firefighting foam that is more effective.

PFAS molecules have a chain of linked carbon and fluorine atoms. Because the carbon-fluorine bond is one of the strongest, these chemicals do not degrade easily in the environment.

NIH website https://www.niehs.nih.gov/health/topics/agents/pfc

Why Be Concerned About PFAS?

Multiple health effects associated with PFAS exposure have been identified and are supported by different scientific studies. Concerns about the public health impact of PFAS have arisen for the following reasons:

Widespread occurrence

Numerous exposures

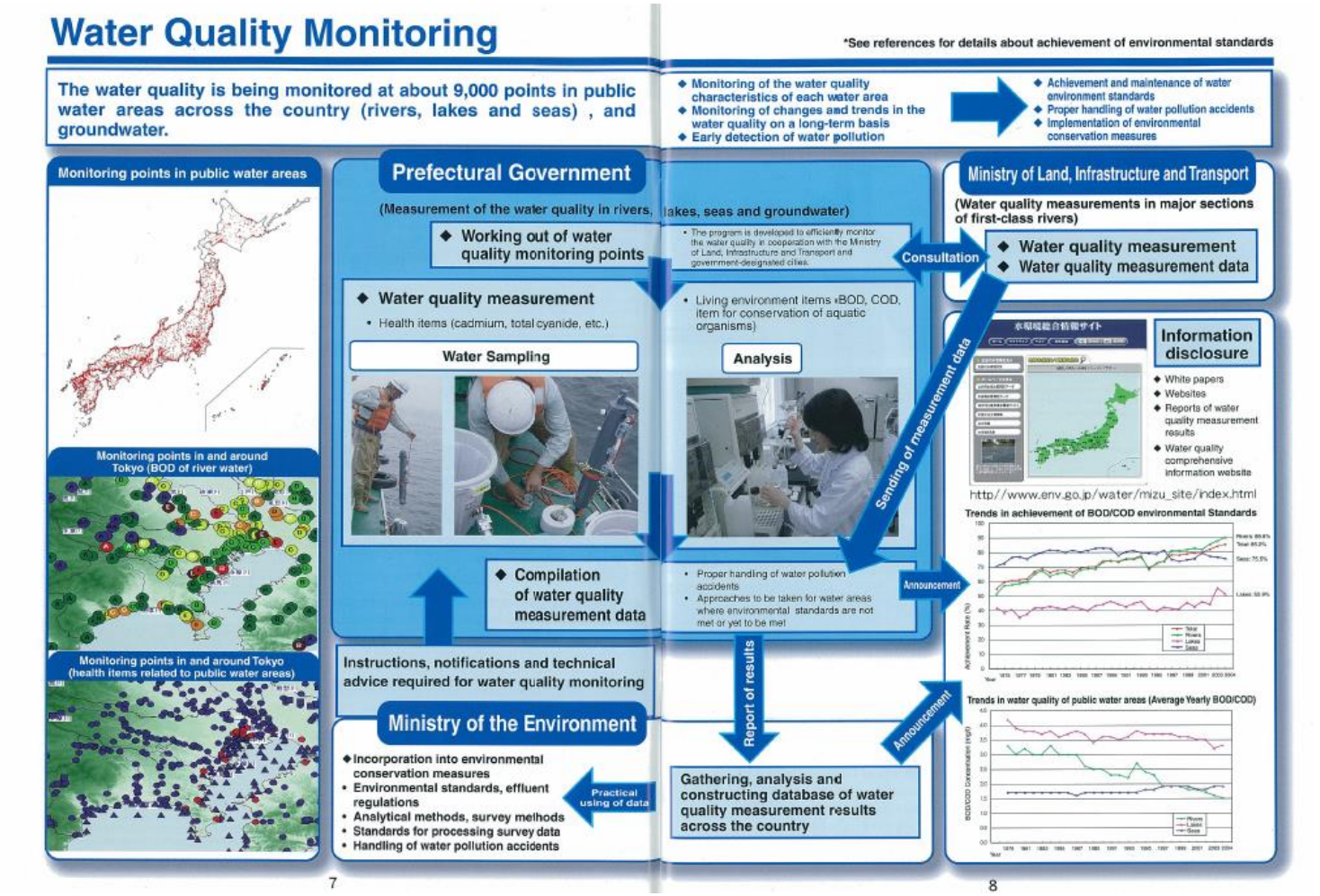
Growing numbers

Persistent

Bioaccumulation

Excerpt from NIH website https://www.niehs.nih.gov/health/topics/agents/pfc

The water quality is being monitored at about 9,000 points in public water areas in Japan (rivers, lakes and seas) , and groundwater. This monitoring is essential for protecting clean water and our healthy life.



Ministry of the Environment: Water and Soil Environmental Management in Japan
http://www.env.go.jp/en/water/wq/pamph/index.html (retrieved in 29 Januray 2019)

水生生物による水質調査

Water quality survey based on aquatic life (biota)

水質階級

Class of water quality	Pollution level
Class I	Clean
Class II	Relatively clean
Class III	Polluted
Class IV	Heavily polluted

別紙2

全国水生生物調査結果　集計用紙

調査団体名				複数団体が合同で実施している場合は、代表的な団体名をひとつ記入し、他の団体名は代表的な団体の後ろに（　）をつけて記入して下さい。	
市町村名				調査参加人数	人
調査担当者名		連絡先住所		〒	
担当者連絡先	TEL		FAX	E-mail	

指標生物（見つかった指標生物に○印、数が多かった上位から2種類（最大3種類）に●印をつけて下さい）

水質階級Ⅰ	1	アミカ類	
	2	ナミウズムシ	
	3	カワゲラ類	
	4	サワガニ	
	5	ナガレトビケラ類	
	6	ヒラタカゲロウ類	
	7	ブユ類	
	8	ヘビトンボ	
	9	ヤマトビケラ類	
	10	ヨコエビ類	
水質階級Ⅱ	11	イシマキガイ	
	12	オオシマトビケラ	
	13	カワニナ類	
	14	ゲンジボタル	
	15	コオニヤンマ	
	16	コガタシマトビケラ類	
	17	ヒラタドロムシ類	
	18	ヤマトシジミ	
水質階級Ⅲ	19	イソコツブムシ類	
	20	タニシ類	
	21	ニホンドロソコエビ	
	22	シマイシビル	
	23	ミズカマキリ	
	24	ミズムシ	
水質階級Ⅳ	25	アメリカザリガニ	
	26	エラミミズ	
	27	サカマキガイ	
	28	ユスリカ類	
	29	チョウバエ類	

水質階級の判定	水質階級	Ⅰ	Ⅱ	Ⅲ	Ⅳ
	1. ○印と●印の個数				
	2. ●印の個数				
	3. 合計（1欄＋2欄）	0	0	0	0

この地点の水質階級は　　です

調査地点の概要
（生物を採取した場所の状況について記入して下さい）

調査河川名	
調査地点名	
昨年度の調査状況（昨年度調査に参加した方のみチェックして下さい）	今年の調査地点は昨年度と同じですか？ ☐ 同じ場所で調査した 昨年度の水質階級は ☐ Ⅰ ☐ Ⅱ ☐ Ⅲ ☐ Ⅳ ☐ ちがう場所で調査した
調査日時	年　月　日　時 開始時刻を24時間で記入して下さい。（午後2時は14時）
天　気	☐ はれ　☐ くもり　☐ 雨 調査時の天気をチェックして下さい
水　温	℃（小数点1桁まで記入して下さい）
川　幅	約　m 水の流れの幅を記入して下さい（小数点1桁まで記入できます）
生物採取場所	☐ 川の中心 ☐ 上流から見て右岸 ☐ 上流から見て左岸 採取した場所をチェックして下さい
水　深	約　cm 採取した場所の平均的な水深を記入して下さい
以下は、生物を採取した場所にあてはまるものをチェックして下さい	
流れのはやさ	☐ 速い（毎秒60cm以上） ☐ 普通（毎秒30～60cm） ☐ 遅い（毎秒30cm以下）
川底の状態	☐ 頭大の石が多い　☐ こぶし大の石が多い ☐ 小石と砂　☐ コンクリート ☐ 砂と泥　☐ 泥 ☐ コケ　☐ その他
水のにおい	☐ においは感じられない ☐ においが感じられる （ドブ、石油、薬のような不快感のあるにおい）
水のにごり	☐ 透明またはきれい ☐ 少しにごっている ☐ 大変にごっている

その他の生物（水生昆虫、貝、エビ・カニ類）		魚　類
水草類	鳥　類	その他、気づいたこと

https://www2.env.go.jp/water-pub/mizu-site/mizu/suisei/manual/hyo_syukei.pdf

Nationwide Survey of Aquatic life

This survey is designed to study the biota of rivers, which are home to a variety of aquatic life (river crabs, water moths, etc.), thereby monitoring the water quality of sampling areas. Being a simple survey that can be done by everyone from children to adults, it has become an annual event.

Water and Soil Environmental Management in Japan (pamphlet)