

Water quality in Lake Kasumigaura

1 Environmental quality standards for water pollution

Environmental quality standards for water pollution in Japan have been established under the Basic Environment Law as the criteria to be achieved for the purpose of protecting human health and the living environment.

They are also applied to determine the pollution status in public water bodies. Environmental quality standards for water pollution consist of two kinds of standards: those for protecting human health, and those for conserving the living environment.

The former are set for 27 harmful substances such as cadmium and cyanide, and are applied to all public water bodies. The latter are set for such parameters as pH, biochemical oxygen demand (BOD) and chemical oxygen demand (COD), and the standard values are established for each type of water body (i.e., rivers, lakes and coastal waters).

(1) Environmental quality standards for Lake Kasumigaura

Environmental quality standards for water pollution in Lake Kasumigaura have been established as follows.

Environmental quality standards for COD, etc. (EPA Notification; 6 Nov., 1972)

Water body	Class
L. Kasumigaura (Nishiura), L. Kitaura (incl. Wani R.), Hitachi-Tone R.	A (Lakes)*

* Must be achieved as quickly as possible within a period not exceeding 5 years.



Class	Standard value				
	pH	COD	Suspended solids (SS)	Dissolved oxygen (DO)	Coliform
A	$6.5 \leq \text{pH} \leq 8.5$	$\leq 3 \text{ mg/L}$	$\leq 5 \text{ mg/L}$	$\geq 7.5 \text{ mg/L}$	$\leq 1000 \text{ MPN/100 mL}$

Environmental quality standards for nitrogen and phosphorous (EPA Notification; 5 Apr., 1986)

Water body	Class	Standard value	
		Total nitrogen (TN)	Total phosphorous (TP)
L. Kasumigaura (Nishiura), L. Kitaura (incl. Wani R.), Hitachi-Tone R.	III*	$\leq 0.4 \text{ mg/L}$	$\leq 0.03 \text{ mg/L}$
	IV	$\leq 0.6 \text{ mg/L}$	$\leq 0.05 \text{ mg/L}$

* Must strive to achieve the standards for Class IV by taking the lake characteristics into account.

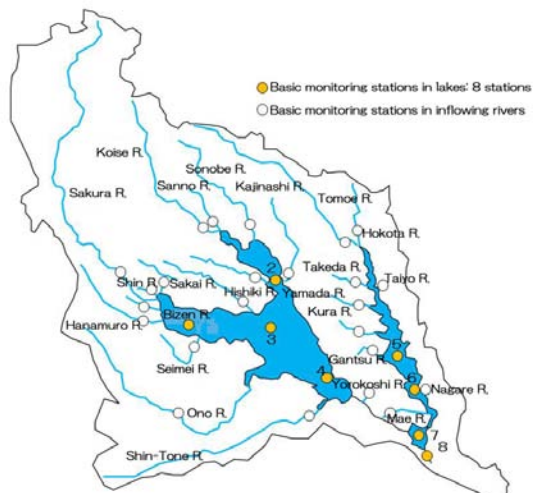
(2) Environmental quality standards for the inflowing rivers of Lake Kasumigaura

Twenty-four of the rivers that flow into Lake Kasumigaura, including the Ono, Sakura, Koise and Tomoe Rivers, have been designated as class "A" rivers by the Ibaraki Prefectural Notification (in 1973 and 1974).

Class	Standard value				
	pH	BOD	SS	DO	Coliform
A	$6.5 \leq \text{pH} \leq 8.5$	$\leq 2 \text{ mg/L}$	$\leq 25 \text{ mg/L}$	$\geq 7.5 \text{ mg/L}$	$\leq 1000 \text{ MPN/100 mL}$

2 Supervision of water quality

In order to supervise pollution status, Ibaraki Prefecture monitors the water-quality parameters in public water bodies periodically, based on an annual monitoring plan. In Lake Kasumigaura and its inflowing rivers, there are a total of 52 monitoring stations (21 in lakes and 31 in rivers), of which 32 stations (8 in lakes and 24 in rivers) are basic monitoring stations. In these stations, water-quality parameters are measured monthly or bimonthly, taking the significance and pollution status of the site into account.



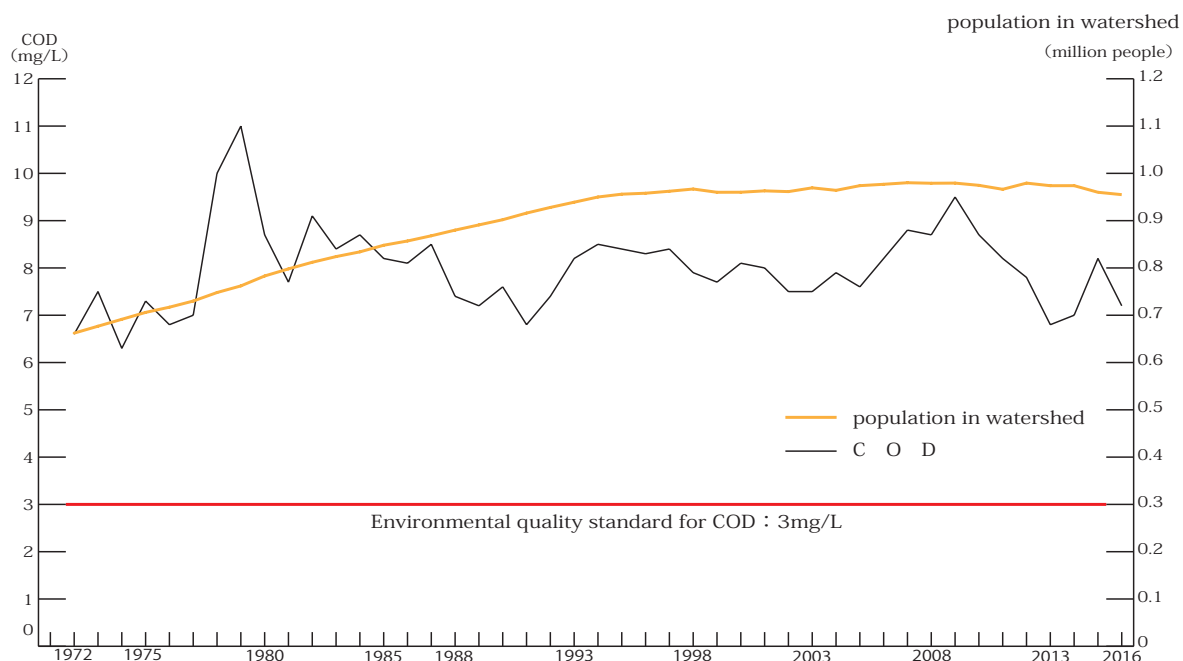
Basic monitoring stations in the lakes	Region
1. Kakeuma-oki	L. Kasumigaura (Nishiura)
2. Tamatsukuri-oki	
3. Lake center	
4. Aso-oki	
5. Kamaya-oki	L. Kitaura
6. Jingu Bridge	
7. Sotonasakaura	Hitachi-Tone R.
8. Ikisu	

Water quality monitoring stations in the lakes and inflowing rivers (basic monitoring stations)

3 Water quality in lakes

Chemical oxygen demand in Lake Kasumigaura begun to rise in the early 1970s and exceeded 10 mg/L (as an annual average) in 1978 and 1979. To address this situation, Ibaraki Prefecture has worked on general countermeasures for water quality conservation. In 1981, the Ordinance to Prevent Eutrophication of Lake Kasumigaura was established. In addition, the Plan for Conservation of Water Quality in Lake Kasumigaura was established under the Special Measure Act for the Preservation of Lake Water Quality. As a result, COD decreased gradually to 6.8 mg/L in 1991. In recent years, COD has varied widely from 9.5 mg/L in 2008 to 6.8 mg/L in 2013. As a long-term trend, however, COD value has been nearly constant (around 8 mg/L) since the 1980s.

The variation of COD in Lake Kasumigaura is considered to be closely related to the transition of dominant phytoplankton species. High COD values have been recorded in summer during the period when algal blooms by *Microcystis* spp. occur frequently. During the period from 1999–2006, both phytoplankton biomass and COD were low. Meanwhile, during the periods 1993–1996 and 2007–2010, filamentous cyanobacteria were dominant throughout the year, and COD was high. Such successions of phytoplankton species are supposedly related to the transparency of lake water. When transparency is low, diatoms tends to dominate. As transparency improves, filamentous cyanobacteria and then *Microcystis* spp. tend to dominate, sequentially.



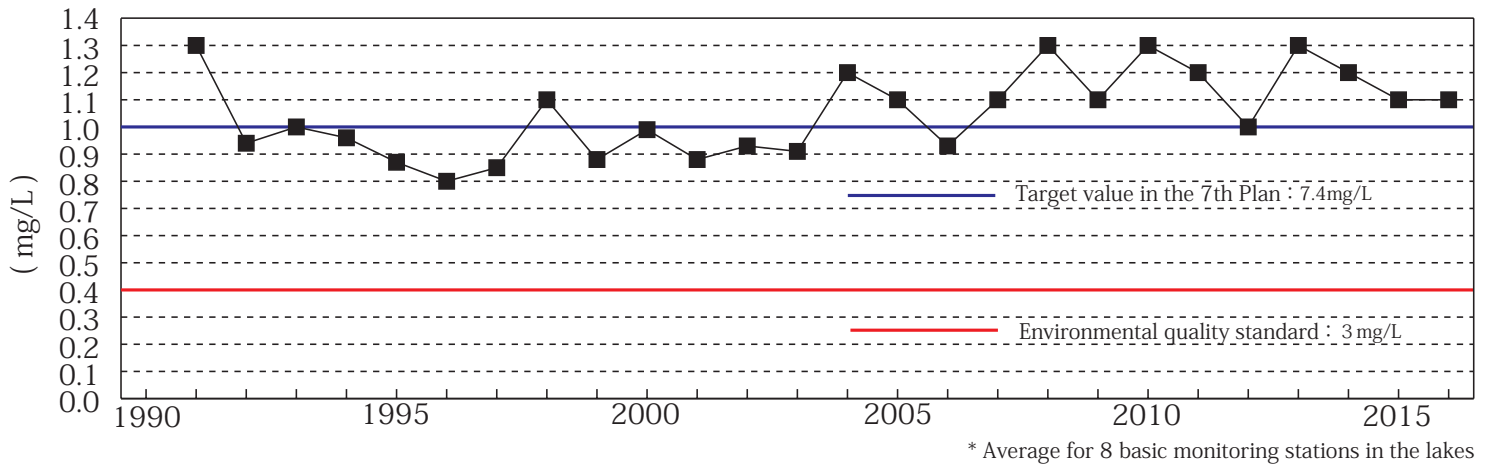
Temporal variations of the basin population and COD (annual average) in the water of Lake Kasumigaura

Temporal variations in the lake water quality parameters (annual averages)

(1) COD

(unit : mg/L)

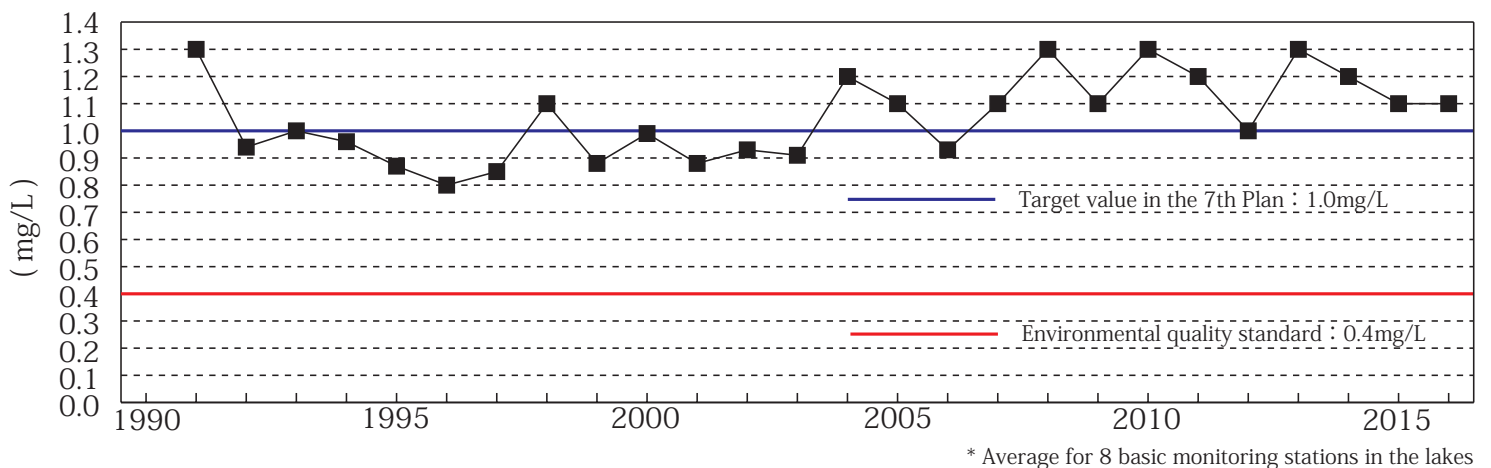
fiscal year Region	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Lake Kasumigaura (Nishifura)	7.0	7.8	8.4	8.7	9.0	8.9	8.6	7.6	7.7	7.6	7.7	7.3	7.5	7.8	7.6	8.2	8.5	8.4	9.3	8.2	8.1	7.5	6.6	6.6	7.8	6.8
Lake Kitaura	6.3	6.8	8.1	8.0	7.4	7.4	7.9	8.0	8.1	9.2	8.5	7.8	7.7	8.3	7.7	8.4	9.5	9.3	10	9.1	8.0	8.3	7.3	7.5	8.9	7.8
Hitachi-Tone River	6.9	7.4	8.1	8.4	8.1	8.0	8.5	8.6	7.4	8.3	8.2	7.8	7.2	7.7	7.4	8.1	8.8	8.7	9.3	9.2	8.5	8.0	6.7	7.3	8.3	7.2
Average	6.8	7.4	8.2	8.5	8.4	8.3	8.4	7.9	7.7	8.1	8.0	7.5	7.5	7.9	7.6	8.2	8.8	8.7	9.5	8.7	8.2	7.8	6.8	7.0	8.2	7.2



(2) TN

(unit : mg/L)

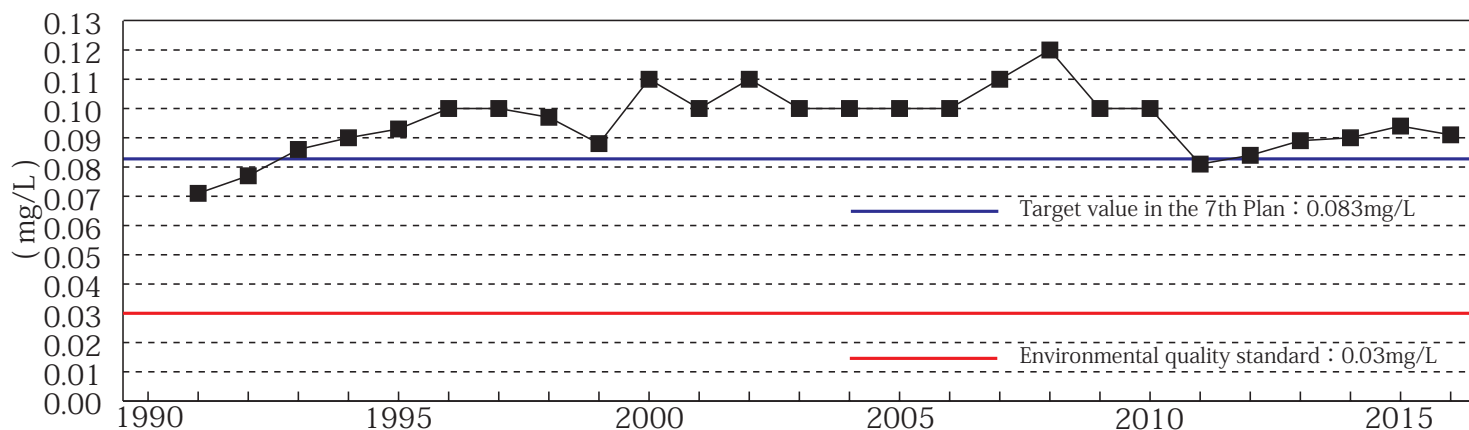
fiscal year Region	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Lake Kasumigaura (Nishifura)	1.4	1.0	1.2	0.98	0.96	0.91	0.89	1.3	0.93	1.0	0.89	0.96	0.95	1.2	1.1	0.99	1.1	1.4	1.2	1.3	1.2	1.0	1.3	1.2	1.1	1.1
Lake Kitaura	1.2	0.81	0.92	0.95	0.71	0.68	0.77	0.84	0.85	0.95	0.88	0.86	0.88	1.5	1.1	0.93	1.2	1.3	1.2	1.6	1.6	1.2	1.4	1.4	1.2	1.3
Hitachi-Tone River	1.1	0.89	0.95	0.92	0.85	0.73	0.86	0.94	0.81	0.95	0.87	0.97	0.84	0.92	1.0	0.83	1.1	1.2	0.96	1.1	0.93	0.91	1.1	1.1	0.89	0.92
Average	1.3	0.94	1.0	0.96	0.87	0.80	0.85	1.1	0.88	0.99	0.88	0.93	0.91	1.2	1.1	0.93	1.1	1.3	1.1	1.3	1.2	1.0	1.3	1.2	1.1	1.1



(3) TP

(unit : mg/L)

fiscal year Region	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Lake Kasumigaura (Nishitōra)	0.076	0.082	0.092	0.092	0.10	0.12	0.10	0.10	0.091	0.12	0.11	0.12	0.11	0.10	0.11	0.10	0.10	0.11	0.099	0.09	0.076	0.084	0.086	0.085	0.090	0.089
Lake Kitaura	0.061	0.071	0.079	0.096	0.093	0.085	0.09	0.089	0.096	0.12	0.10	0.095	0.099	0.13	0.092	0.11	0.13	0.16	0.12	0.13	0.093	0.090	0.11	0.096	0.11	0.11
Hitachi-Tone River	0.069	0.074	0.083	0.081	0.082	0.088	0.09	0.091	0.076	0.080	0.086	0.087	0.083	0.088	0.093	0.096	0.11	0.12	0.096	0.10	0.081	0.080	0.078	0.092	0.090	0.082
Average	0.071	0.077	0.086	0.090	0.093	0.10	0.10	0.097	0.088	0.11	0.10	0.11	0.10	0.10	0.10	0.10	0.11	0.12	0.10	0.10	0.081	0.084	0.089	0.090	0.094	0.091

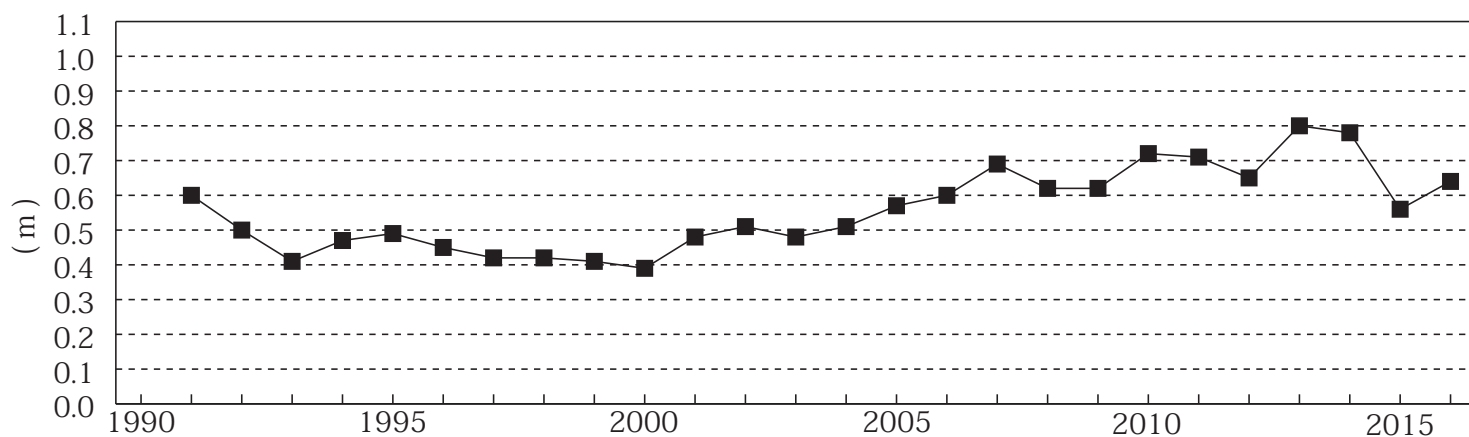


* Average for 8 basic monitoring stations in the lakes

(4) Transparency

(unit : m)

fiscal year Region	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Lake Kasumigaura (Nishitōra)	0.6	0.5	0.39	0.42	0.40	0.36	0.37	0.37	0.38	0.38	0.47	0.45	0.50	0.47	0.49	0.56	0.72	0.64	0.60	0.68	0.66	0.63	0.76	0.81	0.52	0.68
Lake Kitaura	0.7	0.6	0.46	0.59	0.68	0.66	0.54	0.53	0.47	0.43	0.55	0.68	0.52	0.62	0.72	0.66	0.63	0.59	0.63	0.82	0.81	0.68	0.83	0.73	0.58	0.62
Hitachi-Tone River	0.6	0.5	0.39	0.44	0.48	0.42	0.41	0.40	0.40	0.39	0.44	0.45	0.43	0.48	0.59	0.63	0.69	0.63	0.64	0.73	0.70	0.68	0.86	0.75	0.63	0.60
Average	0.6	0.5	0.41	0.47	0.49	0.45	0.42	0.42	0.41	0.39	0.48	0.51	0.48	0.51	0.57	0.60	0.69	0.62	0.62	0.72	0.71	0.65	0.80	0.78	0.56	0.64



* Average for 8 basic monitoring stations in the lakes

4 Water quality in inflowing rivers

(1) BOD

(unit : mg/L)

Region	River	Station	B O D														
			2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Lake Kasumigaura (Nishiura)	Shin-Tone River	Shin-Tone Bridge	3.3	4.0	2.9	3.7	3.1	3.8	3.3	3.2	3.0	3.7	3.7	3.9	3.8	4.3	4.0
	Ono River	Okuhara-Ohashi Bridge	2.3	1.9	1.6	1.6	1.5	1.9	1.6	1.7	1.3	1.8	1.8	1.8	1.5	1.4	1.5
	Seimei River	Katsu Bridge	2.6	1.9	1.9	2.3	1.9	2.7	2.0	2.4	2.5	2.3	2.8	2.4	2.4	2.4	3.1
	Hanamuro River	Shinwa Bridge	3.4	3.2	2.5	2.3	1.7	2.5	1.9	2.0	1.5	2.5	3.2	2.3	1.7	2.0	2.6
	Bizen River	Bizengawa Bridge	3.3	3.7	3.3	3.0	2.7	3.3	2.9	3.1	3.1	3.1	3.1	3.1	2.9	3.5	3.3
	Sakura River	Eiri Bridge	2.1	1.8	1.6	1.9	1.5	2.1	1.7	2.1	1.3	1.8	1.8	1.7	1.5	1.3	1.8
	Shin River	Shinten Bridge	4.0	4.0	4.6	3.2	3.8	3.9	3.4	3.1	2.7	3.7	6.3	4.8	4.2	4.6	5.0
	Sakai River	Bridge on Route 354	2.7	3.2	2.8	2.5	2.6	2.8	2.8	2.8	2.0	2.8	2.7	2.2	2.0	2.1	2.0
	Ichinose River	Kawanaka Bridge	1.5	1.6	1.5	1.6	1.6	1.9	1.8	1.9	1.2	1.6	1.8	1.7	1.5	1.9	1.7
	Hishiki River	Hishiki Bridge	1.5	1.5	1.3	1.6	1.2	1.7	1.5	1.3	1.0	1.5	1.7	1.4	1.3	1.5	1.4
	Koise River	Heiwa Bridge	1.8	1.7	1.2	1.4	1.3	1.5	1.3	1.6	1.0	1.6	2.2	1.5	1.9	1.7	1.1
	Sanno River	Tokoro Bridge	4.0	3.2	3.2	2.4	2.6	2.3	2.0	1.9	1.6	2.4	1.9	2.0	1.5	1.7	1.5
	Sonobe River	Sonobe-Shinbashi Bridge	3.5	3.1	2.5	2.3	1.9	2.4	1.7	1.8	1.2	2.2	2.3	2.2	1.8	2.0	1.6
Kajinashi River	Kamijuku Bridge	2.0	1.7	1.7	1.6	1.5	1.8	1.8	1.5	1.1	1.6	1.9	1.5	1.6	1.7	1.4	
Lake Kitaura	Gantsu River	Bridge beside JA	1.6	1.4	1.5	1.5	1.8	1.5	1.4	1.6	1.2	1.8	1.9	1.9	1.5	1.8	1.5
	Kura River	Kurakawa Bridge	2.1	1.8	1.4	1.4	1.4	1.5	1.5	1.7	1.2	1.8	2.0	1.9	1.4	2.0	1.6
	Yamada River	Nioroshi Bridge	2.1	1.8	1.6	1.4	1.4	1.6	1.5	1.9	1.2	1.7	1.9	1.8	1.4	1.6	1.6
	Takeda River	Uchijuku-Ohashi Bridge	1.9	1.9	1.8	1.4	1.5	1.5	1.4	1.7	1.2	1.5	1.8	1.7	1.3	2.1	1.6
	Tomoe River	Shin-Tomoegawa Bridge	1.9	2.3	1.5	1.4	1.5	1.4	1.8	1.9	1.8	2.7	2.0	1.8	1.2	1.6	2.2
	Hokota River	Asahi Bridge	2.4	2.7	2.0	2.5	3.3	3.8	2.6	2.5	2.2	2.9	3.5	2.3	4.4	5.2	5.1
	Taiyo River	Tatsuka Bridge	7.0	1.2	0.9	0.7	0.8	0.7	0.8	1.4	0.7	1.1	1.4	1.1	0.9	1.3	1.0
Nagare River	Suhoi Bridge	4.6	3.2	3.8	5.1	3.3	2.7	2.2	3.5	4.0	4.7	3.5	2.7	2.5	2.7	2.8	
Hitachi-Tone River	Yorokoshi River	Horinouchi Bridge	2.6	3.2	1.2	1.5	2.2	1.7	1.8	1.9	1.3	2.6	1.7	1.7	1.5	2.2	2.2
	Mae River	Itako-Ayame Bridge	3.1	2.4	3.2	3.7	3.4	3.7	3.1	3.7	3.6	3.7	3.9	3.6	3.2	3.9	3.3

(2) COD

(unit : mg/L)

Region	River	Station	C O D														
			2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Lake Kasumigaura (Nishiura)	Shin-Tone River	Shin-Tone Bridge	9.1	8.8	8.6	8.9	8.5	9.1	8.3	8.2	8.2	8.4	8.2	9.2	8.3	8.6	8.1
	Ono River	Okuhara-Ohashi Bridge	5.9	5.1	5.0	5.2	5.2	5.8	4.7	4.9	4.7	4.8	5.0	5.4	4.6	4.3	4.4
	Seimei River	Katsu Bridge	6.2	5.5	5.3	6.0	5.4	6.5	5.7	5.9	5.1	5.7	5.7	5.4	5.3	5.3	5.6
	Hanamuro River	Shinwa Bridge	6.6	5.2	5.4	5.3	4.9	5.6	4.6	4.7	4.2	4.7	4.7	4.3	3.7	4.0	4.2
	Bizen River	Bizengawa Bridge	7.0	7.1	6.7	6.4	6.5	7.3	6.8	6.5	6.1	6.7	6.0	6.4	5.6	5.9	5.7
	Sakura River	Eiri Bridge	5.5	4.6	4.7	5.1	4.9	4.5	4.3	4.7	4.5	4.8	4.9	4.7	4.3	4.5	4.8
	Shin River	Shinten Bridge	8.7	7.9	8.3	7.8	7.8	8.6	8.4	7.2	7.1	7.9	11	8.4	8.0	8.2	7.5
	Sakai River	Bridge on Route 354	7.3	6.8	7.0	6.7	6.9	6.3	6.1	6.6	7.8	7.1	5.9	6.0	5.3	5.9	7.9
	Ichinose River	Kawanaka Bridge	6.1	5.8	5.6	5.8	5.5	6.2	5.3	5.2	5.2	5.3	5.5	5.5	4.9	5.7	5.5
	Hishiki River	Hishiki Bridge	4.7	4.6	4.4	4.5	4.2	4.8	4.5	4.0	4.0	4.1	4.1	4.0	4.0	3.9	3.6
	Koise River	Heiwa Bridge	5.0	4.8	4.5	4.6	4.7	4.6	4.4	4.2	3.7	4.3	4.4	4.3	4.2	4.8	3.6
	Sanno River	Tokoro Bridge	8.2	6.4	6.6	5.9	6.0	5.8	5.3	4.9	4.4	5.4	4.8	5.3	4.1	4.3	4.1
	Sonobe River	Sonobe-Shinbashi Bridge	7.2	6.0	5.7	5.7	5.3	5.9	5.1	4.6	4.2	5.1	4.9	5.4	4.5	4.7	4.3
Kajinashi River	Kamijuku Bridge	6.2	5.6	5.7	5.3	5.1	5.7	5.3	4.5	4.2	4.5	4.8	5.1	4.6	4.5	4.2	
Lake Kitaura	Gantsu River	Bridge beside JA	6.1	5.4	5.5	5.6	5.6	5.5	4.9	4.6	4.6	4.4	4.8	5.8	4.5	5.0	4.5
	Kura River	Kurakawa Bridge	6.6	5.7	5.4	5.3	5.1	5.3	5.5	5.4	4.5	5.0	5.1	5.3	4.7	4.7	4.7
	Yamada River	Nioroshi Bridge	6.3	5.6	5.3	5.0	5.2	5.4	5.7	5.2	4.6	4.9	4.9	5.1	4.9	4.7	4.7
	Takeda River	Uchijuku-Ohashi Bridge	5.3	5.0	4.2	4.1	4.4	4.4	4.5	4.2	4.0	3.8	3.8	4.1	3.5	3.8	3.7
	Tomoe River	Shin-Tomoegawa Bridge	4.5	4.9	4.0	4.2	4.4	4.6	4.7	4.4	4.3	5.1	4.3	4.6	3.8	4.0	4.4
	Hokota River	Asahi Bridge	5.4	5.2	4.7	5.3	6.3	7.2	5.5	4.8	5.5	5.6	6.2	5.3	6.5	5.5	5.4
	Taiyo River	Tatsuka Bridge	7.2	4.5	4.4	4.0	4.1	3.6	4.2	4.3	3.4	3.7	3.2	3.8	3.5	3.7	3.6
Nagare River	Suhoi Bridge	7.1	6.5	6.5	8.6	6.1	6.2	5.4	5.8	7.0	7.7	5.4	5.5	5.1	5.0	4.9	
Hitachi-Tone River	Yorokoshi River	Horinouchi Bridge	7.9	7.0	6.1	5.9	6.4	6.5	7.3	6.2	5.7	6.2	5.1	6.3	5.5	6.0	6.0
	Mae River	Itako-Ayame Bridge	8.6	7.9	8.2	8.3	8.6	9.5	9.5	9.1	8.5	8.4	8.2	8.4	8.0	8.3	7.3

(3) TN

(unit : mg/L)

Region	River	Station	(T - N)														
			2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Lake Kasumigaura (Nishiura)	Shin-Tone River	Shin-Tone Bridge	1.5	1.5	1.5	1.5	1.3	1.4	1.5	1.3	1.3	1.2	1.4	1.4	1.2	1.3	1.2
	Ono River	Okuhara-Ohashi Bridge	2.9	3.5	3.4	3.2	3.6	3.0	2.9	2.8	2.9	2.6	2.5	2.4	2.7	2.5	2.4
	Seimei River	Katsu Bridge	2.3	2.7	2.5	2.3	2.7	1.9	2.1	2.2	2.3	2.0	2.0	1.9	2.1	2.0	2.0
	Hanamuro River	Shinwa Bridge	3.0	3.2	3.0	2.7	3.0	2.5	2.5	2.5	2.5	2.5	2.4	2.2	2.1	2.1	2.2
	Bizen River	Bizengawa Bridge	2.0	2.6	2.6	2.4	2.6	2.3	2.2	1.9	2.0	2.0	1.7	1.6	1.8	1.7	1.5
	Sakura River	Eiri Bridge	1.8	2.1	2.1	2.0	2.3	1.8	2.0	1.7	1.9	1.7	1.5	1.7	1.6	1.6	1.6
	Shin River	Shinten Bridge	3.0	2.8	3.0	3.3	3.3	3.5	3.0	2.7	2.8	3.1	3.0	3.0	2.9	2.9	3.0
	Sakai River	Bridge on Route 354	3.1	3.6	3.6	3.5	3.6	3.5	3.2	3.5	3.3	3.1	3.2	3.4	3.5	3.2	4.1
	Ichinose River	Kawanaka Bridge	4.0	4.3	4.6	4.2	4.3	4.1	3.8	4.1	4.0	3.8	3.3	3.2	3.6	3.4	3.2
	Hishiki River	Hishiki Bridge	3.3	4.7	4.9	4.3	5.0	4.2	4.4	4.3	4.7	4.3	3.9	3.5	4.0	3.5	3.9
	Koise River	Heiwa Bridge	3.0	3.3	3.2	3.3	3.5	3.2	3.2	3.5	2.9	2.9	3.2	3.1	3.3	3.2	2.9
	Sanno River	Tokoro Bridge	2.6	3.6	3.4	3.5	3.3	3.3	3.6	3.6	3.7	3.3	3.7	3.6	3.5	3.6	3.6
	Sonobe River	Sonobe-Shinbashi Bridge	4.7	5.9	6.0	5.4	6.1	5.6	5.5	5.7	6.1	5.4	4.9	4.8	5.3	4.5	5.3
Kajinashi River	Kamijuku Bridge	4.2	5.0	5.3	5.2	5.8	5.8	5.5	5.8	6.2	6.2	5.8	5.7	5.7	5.0	6.0	
Lake Kitaura	Gantsu River	Bridge beside JA	2.6	3.9	3.4	3.6	4.1	3.8	3.3	3.5	3.7	3.3	2.9	2.7	2.7	3.0	2.8
	Kura River	Kurakawa Bridge	4.6	5.2	5.1	5.6	5.5	5.6	4.8	4.6	4.9	4.5	4.0	3.9	4.1	4.2	4.0
	Yamada River	Nioroshi Bridge	4.7	6.1	5.7	5.5	5.8	5.6	4.8	5.0	5.1	4.9	4.4	4.5	4.4	4.6	4.4
	Takeda River	Uchijuku-Ohashi Bridge	5.8	6.3	6.1	6.6	6.3	6.8	5.9	6.3	6.6	6.5	6.3	6.3	6.5	6.4	6.7
	Tomoe River	Shin-Tomoegawa Bridge	5.3	5.9	5.9	5.6	6.0	5.9	6.0	6.2	6.5	6.5	5.9	5.4	5.4	5.6	5.7
	Hokota River	Asahi Bridge	7.0	7.5	7.3	8.9	12	14	11	11	12	10	11	9.4	10	12	14
	Taiyo River	Tatsuka Bridge	5.9	4.6	4.8	4.9	5.0	5.2	4.9	4.8	5.2	5.0	5.2	5.3	5.7	5.3	5.3
	Nagare River	Suhoi Bridge	3.1	3.2	2.8	2.7	2.6	2.7	2.7	2.5	2.1	2.0	2.1	2.1	2.1	2.1	2.0
Hitachi-Tone River	Yorokoshi River	Horinouchi Bridge	3.3	2.8	1.9	2.2	2.7	2.5	2.5	2.2	2.5	2.8	2.3	2.4	2.3	2.0	2.0
	Mae River	Itako-Ayame Bridge	1.0	1.1	1.0	1.0	0.9	1.1	1.1	1.0	1.0	1.1	0.96	1.1	1.1	0.96	

(4) TP

(unit : mg/L)

Region	River	Station	(T - N)														
			2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Lake Kasumigaura (Nishiura)	Shin-Tone River	Shin-Tone Bridge	0.11	0.10	0.080	0.10	0.099	0.092	0.11	0.10	0.12	0.079	0.092	0.089	0.096	0.10	0.11
	Ono River	Okuhara-Ohashi Bridge	0.10	0.084	0.068	0.085	0.080	0.093	0.068	0.072	0.075	0.068	0.077	0.076	0.067	0.074	0.081
	Seimei River	Katsu Bridge	0.14	0.14	0.10	0.14	0.11	0.14	0.13	0.11	0.14	0.092	0.095	0.098	0.088	0.087	0.13
	Hanamuro River	Shinwa Bridge	0.20	0.13	0.11	0.12	0.10	0.10	0.080	0.12	0.11	0.12	0.14	0.12	0.092	0.10	0.12
	Bizen River	Bizengawa Bridge	0.10	0.14	0.10	0.11	0.11	0.11	0.10	0.10	0.14	0.11	0.10	0.090	0.095	0.099	0.10
	Sakura River	Eiri Bridge	0.073	0.075	0.061	0.080	0.085	0.071	0.067	0.068	0.075	0.065	0.063	0.062	0.065	0.061	0.067
	Shin River	Shinten Bridge	0.16	0.17	0.14	0.17	0.17	0.15	0.17	0.16	0.17	0.15	0.22	0.15	0.14	0.15	0.16
	Sakai River	Bridge on Route 354	0.22	0.22	0.24	0.18	0.20	0.15	0.14	0.16	0.23	0.17	0.12	0.14	0.12	0.16	0.23
	Ichinose River	Kawanaka Bridge	0.10	0.11	0.095	0.10	0.11	0.12	0.089	0.090	0.12	0.099	0.098	0.12	0.10	0.12	0.13
	Hishiki River	Hishiki Bridge	0.061	0.062	0.048	0.046	0.056	0.049	0.044	0.051	0.053	0.041	0.046	0.048	0.042	0.053	0.056
	Koise River	Heiwa Bridge	0.080	0.086	0.070	0.082	0.078	0.078	0.070	0.076	0.068	0.073	0.087	0.066	0.070	0.094	0.089
	Sanno River	Tokoro Bridge	0.37	0.24	0.23	0.29	0.21	0.29	0.25	0.26	0.26	0.29	0.23	0.27	0.24	0.21	0.23
	Sonobe River	Sonobe-Shinbashi Bridge	0.31	0.19	0.20	0.20	0.23	0.24	0.13	0.12	0.12	0.11	0.12	0.12	0.10	0.11	0.10
Kajinashi River	Kamijuku Bridge	0.092	0.084	0.072	0.077	0.076	0.078	0.072	0.070	0.072	0.068	0.084	0.074	0.065	0.080	0.086	
Lake Kitaura	Gantsu River	Bridge beside JA	0.080	0.094	0.077	0.088	0.89	0.086	0.078	0.082	0.092	0.059	0.074	0.11	0.069	0.098	0.081
	Kura River	Kurakawa Bridge	0.079	0.084	0.064	0.068	0.070	0.068	0.075	0.074	0.071	0.068	0.073	0.070	0.067	0.079	0.073
	Yamada River	Nioroshi Bridge	0.11	0.12	0.098	0.097	0.095	0.11	0.10	0.097	0.11	0.12	0.11	0.095	0.10	0.11	0.11
	Takeda River	Uchijuku-Ohashi Bridge	0.077	0.084	0.056	0.064	0.072	0.069	0.066	0.066	0.072	0.062	0.067	0.076	0.062	0.064	0.074
	Tomoe River	Shin-Tomoegawa Bridge	0.064	0.076	0.058	0.066	0.071	0.067	0.077	0.079	0.088	0.086	0.076	0.069	0.065	0.074	0.093
	Hokota River	Asahi Bridge	0.093	0.11	0.074	0.087	0.084	0.087	0.087	0.11	0.10	0.11	0.11	0.11	0.16	0.11	0.11
	Taiyo River	Tatsuka Bridge	0.16	0.090	0.069	0.061	0.055	0.048	0.058	0.067	0.051	0.048	0.048	0.056	0.041	0.058	0.064
	Nagare River	Suhoi Bridge	0.18	0.14	0.14	0.37	0.13	0.11	0.12	0.14	0.34	0.36	0.14	0.14	0.15	0.17	0.19
Hitachi-Tone River	Yorokoshi River	Horinouchi Bridge	0.13	0.12	0.068	0.080	0.11	0.084	0.10	0.083	0.12	0.13	0.079	0.089	0.085	0.092	0.10
	Mae River	Itako-Ayame Bridge	0.094	0.10	0.089	0.094	0.098	0.093	0.097	0.10	0.11	0.076	0.084	0.086	0.088	0.089	0.086

* Annual average values for the basic monitoring stations

Reference: "Results of water quality measurements in public water bodies and groundwater" (Ibaraki Prefecture)

5 Problems due to eutrophication

Regarding lake water quality, eutrophication is a special concern. Eutrophication refers to the deterioration of water quality due to massive growth of phytoplankton supported by a plentiful supply of nutrients such as N and P from inflowing rivers and bottom sediment. Eutrophication is also one of the causes of color changes and odor in lake water.

The shift from oligotrophic (with low biological productivity) to eutrophic condition in lake can occur naturally over a time scale of several hundreds ~ thousands of years. On the other hand, the geomorphological characteristics of Lake Kasumigaura (i.e., 10 times larger basin area than lake area, shallow water, long water residence time) are vulnerable to eutrophication. In addition, growing socio-economic activities in the basin have increased the anthropogenic N and P loads into the lake. These conditions have accelerated eutrophication. As a result, massive growths of phytoplankton have occurred frequently, resulting in lower transparency and increasing the COD of lake water.

Decomposition of dead phytoplankton biomass requires dissolved oxygen (DO) in water. Therefore, massive growth of phytoplankton can lower DO concentration, and thus causes massive death of cultured carp and natural fish. In water purification plants, larger amounts of activated carbon are required for the water purification process if the quality of the raw water is more severely deteriorated, which results in increased treatment costs. Deterioration in raw water quality can also cause clogging of filtration facilities and an odor (e.g., musty smell) in tap water.