Information Exchange Materials for Research Partnership on Conservation of Northwest Pacific Marine Environment (Extract)

1. Water environment in Japan

(1) Water qualities in coastal zones of Japan sea and East China sea

1) Rivers

Water qualities of main points in major rivers from FY 2007 to FY 2011

River (Main point)	FY	pH	BOD (mg/L)	COD_{Mn} (mg/L)	SS (mg/L)	DO (mg/L)	Coliform group (MPN/100mL)
Teshio	07	7.3	0.8	-	15	11.0	4.0×10^2
(Nakagawa)	08	7.3	0.7	-	12	11.0	5.5×10^2
	09	7.3	0.5	-	7	11.4	3.2×10^2
	10	7.3	0.5	-	9	11.4	2.3×10^2
	11	7.4	0.6	-	7	11.5	6.0×10^2
Ishikari	07	7.4	1.0	4.9	20	10.9	1.6×10^3
(Ishikariohashi)	08	7.4	1.5	4.7	22	10.9	3.2×10^3
	09	7.3	1.0	4.8	18	10.9	3.9×10^3
	10	7.3	0.9	4.7	24	11.2	3.2×10^3
	11	7.3	1.0	4.8	23	11.1	3.1×10^3
Iwaki	07	7.2	1.5	3.6	10	10.1	5.9×10^4
(Goshogawara)	08	7.2	1.7	4.0	11	9.8	8.9×10^4
	09	7.1	2.1	3.7	12	10.0	3.5×10^4
	10	7.2	1.8	4.1	10	10.0	3.8×10^4
	11	7.2	1.9	3.5	11	10.4	1.1×10^5
Yoneshiro	07	7.2	1.0	2.2	5	10.9	9.2×10^2
(Futatsui)	08	7.3	1.2	2.7	5	10.7	3.6×10^3
	09	7.2	1.0	2.4	5	11.6	2.2×10^3
	10	7.2	1.1	2.4	5	10.4	2.5×10^3
	11	7.2	1.1	2.3	7	10.6	2.8×10^3
Omono	07	7.1	1.3	2.0	8	10.7	1.0×10^3
(Tsubakikawa)	08	7.1	1.2	2.8	8	11.0	2.9×10^3
	09	7.1	1.1	2.9	8	10.9	3.2×10^3
	10	7	1.1	2.7	10	10.2	4.4×10^3
	11	7	1.1	2.6	9	10.8	2.4×10^3
Mogami	07	7.0	1.0	2.7	12	11.0	1.7×10^3
(Sagoshi)	08	7.0	0.9	3.3	11	10.8	2.8×10^3

	09	7.0	0.7	2.3	7	10.7	1.8×10^3
	10	7.1	0.8	2.9	9	10.8	7.3×10^3
	11	7.1	0.7	3.1	10	11.0	1.1×10^3
Agano	07	6.9	0.8	-	5	10.9	6.9×10^2
(Ounbashi)	08	6.8	0.6	-	6	11.1	1.5×10^3
	09	6.9	0.7	-	5	10.9	1.5×10^3
	10	7.1	1.1	-	10	11.0	2.6×10^3
	11	7.3	1.4	-	20	11.1	6.0×10^2
Shinano	07	7.1	1.4	4.1	32	10.1	4.5×10^4
(Heiseiohashi)	08	6.9	1.3	3.6	18	10.3	2.5×10^3
	09	7.2	1.7	3.9	16	10.0	5.9×10^3
	10	7.0	1.6	3.5	22	10.0	6.9×10^3
	11	6.9	1.1	4.3	32	10.4	4.2×10^3
Seki	07	7.2	1.2	3.9	13	10.2	2.3×10^4
(Naoetsubashi)	08	7.0	1.0	4.0	14	10.1	4.7×10^3
	09	7.2	1.1	4.0	8	10.0	2.5×10^4
	10	7.1	0.9	4.2	17	10.5	2.6×10^4
	11	7.1	1.0	3.3	15	11.0	3.2×10^4
Jinzu	07	7.7	1.2	2.1	4	10.9	1.0×10^4
(Jinzuohashi)	08	7.6	1.1	-	4	11.1	5.7×10^3
	09	7.6	0.8	-	7	10.9	7.7×10^3
	10	7.5	1.2	2.3	5	11.1	1.2×10^4
	11	7.6	0.8	2.4	5	10.9	1.5×10^4
Kuzuryu	07	7.5	0.7	2.0	4	10.7	1.1×10^4
(Nakatsuno)	08	7.6	0.8	1.8	4	10.6	8.3×10^3
	09	7.6	0.9	1.8	3	10.2	7.9×10^3
	10	7.5	0.8	1.4	4	10.5	1.6×10^3
	11	7.5	0.5	1.4	3	10.7	2.4×10^3
Yura	07	7.5	0.7	2.4	4	10.1	1.1×10^4
(Hamibashi)	08	7.5	0.8	2.2	3	10.0	4.0×10^3
	09	7.4	0.8	2.6	5	9.8	5.5×10^3
	10	7.5	0.8	2.5	4	10.0	1.0×10^4
	11	7.4	0.7	2.2	4	10.2	3.6×10^3
Sendai	07	7.2	0.9	2.2	6	9.8	4.1×10^3
(Gyotoku)	08	7.4	1.4	2.2	4	10.0	1.4×10^3

	09	7.4	0.7	2.3	3	10.1	4.4 $\times 10^3$
	10	7.6	0.8	2.2	3	10.3	6.8 $\times 10^3$
	11	7.3	1.0	2.2	4	10.7	9.9 $\times 10^2$
Hii	07	7.4	0.6	2.2	15	10.0	5.9 $\times 10^3$
(Otsu)	08	7.6	0.5	2.2	7	10.1	1.8 $\times 10^3$
	09	7.7	0.6	2.0	5	10.2	1.5 $\times 10^3$
	10	7.5	0.7	2.7	5	10.2	2.0 $\times 10^3$
	11	7.4	0.5	2.4	6	10.1	4.2 $\times 10^3$
Gono	07	7.5	0.9	3.0	4	9.8	1.9 $\times 10^3$
(Mikunibashi)	08	7.5	0.8	3.0	4	9.9	3.4 $\times 10^3$
	09	7.5	0.7	2.9	3	9.9	3.1 $\times 10^3$
	10	7.5	0.8	3.3	6	9.9	5.2 $\times 10^3$
	11	7.4	0.9	2.3	3	10.2	2.3 $\times 10^3$
(Takatsu)	07	7.2	0.5	2.1	2	9.9	7.1 $\times 10^3$
(Takatsuohashi)	08	7.3	0.7	2.3	2	9.8	1.1 $\times 10^4$
	09	7.3	0.7	2.0	2	9.7	1.1 $\times 10^4$
	10	7.2	0.5	1.6	2	9.9	3.3 $\times 10^3$
	11	7.3	<0.5	1.5	1	10.3	1.1 $\times 10^3$
Onga	07	7.9	2.1	4.5	8	10.0	1.4 $\times 10^4$
(Hinodebashi)	08	7.8	1.6	3.6	6	9.4	3.0 $\times 10^4$
	09	7.8	2.3	4.0	8	10.2	5.4 $\times 10^4$
	10	8.0	2.0	3.9	9	10.5	1.7 $\times 10^4$
	11	7.7	1.8	3.6	6	9.6	1.7 $\times 10^4$
Chikugo	07	7.6	1.2	3.4	7	9.7	2.3 $\times 10^4$
(Senoshita)	08	7.6	1.4	3.9	8	10.4	5.4 $\times 10^4$
	09	7.8	2.0	4.3	6	10.7	1.4 $\times 10^4$
	10	7.6	1.8	3.2	5	10.0	1.5 $\times 10^4$
	11	7.6	1.7	3.3	6	10.0	1.5 $\times 10^3$
Midori	07	8.1	1.3	2.4	7	11.0	1.5 $\times 10^3$
(Kamisugizeki)	08	7.9	1.4	2.5	6	10.2	3.9 $\times 10^3$
	09	8.1	1.5	2.4	7	10.8	3.9 $\times 10^3$
	10	7.7	1.1	2.6	6	10.3	6.6 $\times 10^3$
	11	8.1	1.5	3.4	6	11.5	5.0 $\times 10^3$

(Source: Website of Ministry of Land, Infrastructure, Transport and Tourism)

2) Coastal waters

Average water qualities of major coastal waters in FY 2010

Prefecture	Coastal water	COD_{Mn}	Nitrogen	Phosphorus
Hokkaido	Ishikarikaiiki (1)	2.0	-	-
Hokkaido	Ishikarikaiiki (2)	2.2	-	-
Hokkaido	Ishikarikaiiki (3)	2.0	-	-
Aomori	Fukaurakochuo	2.2	-	-
Akita	Akitafunakawahakuchikoro (Akita)	2.1	-	-
Yamagata	Sakatako (dai2kuiki)	1.9	-	-
Yamagata	Sakatako (dai3kuiki)	2.4	-	-
Yamagata	Sakatako (dai5kuiki)	1.7	-	-
Niigata	Nigatakaiiki (Nigatahigashiko)	3.1	-	-
Niigata	Manowan	1.4	0.12	0.015
Toyama	Toyamashinkokaiiki (ko)	3.0	-	-
Toyama	Toyamashinkokaiiki (otsu)	2.1	-	-
Ishikawa	Nanaonanwan (ko)	1.8	0.27	0.017
Ishikawa	Nanaonanwan (otsu)	2.8	0.45	0.067
Fukui	Tsurugawankaiiki (ko)	1.4	0.15	0.013
Fukui	Tsurugawankaiiki (otsu)	1.6	0.27	0.029
Kyoto	Asokai	3.5	0.53	0.036
Kyoto	Kumihamawan	3.2	0.41	0.029
Kyoto	Miyazuwan	2.2	0.37	0.014
Hyogo	Saninkaiganchisakikaiiki	1.3	-	-
Tottori	Tottorikenchisakikaiiki	1.4	-	-
Shimane	Mihowan	1.7	-	-
Yamaguchi	Toyoura-Hohokuchisakikaiiki	1.2	0.12	0.006
Yamaguchi	Yuyawan	1.4	0.13	0.010
Fukuoka	Hakatawan (seibukaiiki)	1.7	0.28	0.017
Fukuoka	Hakatawan (chubukaiiki)	2.4	0.44	0.024
Fukuoka	Hakatawan (tobukaiiki)	2.7	0.57	0.034
Saga	Imariwan (2)	2.5	0.26	0.023
Saga	Karatsuwan (2)	1.7	0.23	0.026
Nagasaki	Nagasakiwan (1)	1.5	0.46	0.033
Nagasaki	Nagasakiwan (2)	1.3	0.20	0.018
Kumamoto	Yatsushiroko	2.0	-	-
Kagoshima	Satsumahantonanbukaiiki	1.5	-	-
Okinawa	Nahakokaiiki	1.2	-	-

(Source: Website of Ministry of Environment)

(2) State of Sewerage construction in prefectures along Japan sea or East China sea

Coverage ratio of domestic wastewater treatment and sewerage system

Prefecture	Coverage ratio of domestic wastewater treatment	Coverage ratio of sewerage system
Hokkaido	93.9	89.7
Aomori	73.0	55.5
Akita	81.3	59.6
Yamagata	88.1	73.2
Niigata	82.7	68.9
Toyama	94.4	80.6
Ishikawa	90.9	79.8
Fukui	91.5	73.5
Kyoto	96.1	91.7
Hyogo	98.3	91.7
Tottori	90.4	65.1
Shimane	73.4	42.8
Yamaguchi	82.0	60.8
Fukuoka	88.4	77.4
Saga	75.6	52.8
Nagasaki	75.2	58.6
Kumamoto	81.0	63.5
Kagoshima	71.7	39.8
Okinawa	82.0	67.1

(Source: Website of Ministry of Land, Infrastructure, Transport and Tourism)

(3) Water environment in Dokai Bay

(Source: 'REGIONAL OVERVIEW Case studies of river and direct inputs of *contaminants with focus on the anthropogenic and natural changes in the selected areas of the NOWPAP region POMRAC Technical Report #10', NOWPAP POMRAC, 2011)*

Figure 1.1. Location of the selected case study areas within NOWPAP region.

Population changes in the past 50 years in Kitakyushu City are shown in Fig. 5.1. The population was over one million in 1961, reaching a peak of 1.068 million in 1979. Since then, it has been decreasing, and the current population (2009) is around 983,000. The reason for the decline is mainly decreasing birth rates.

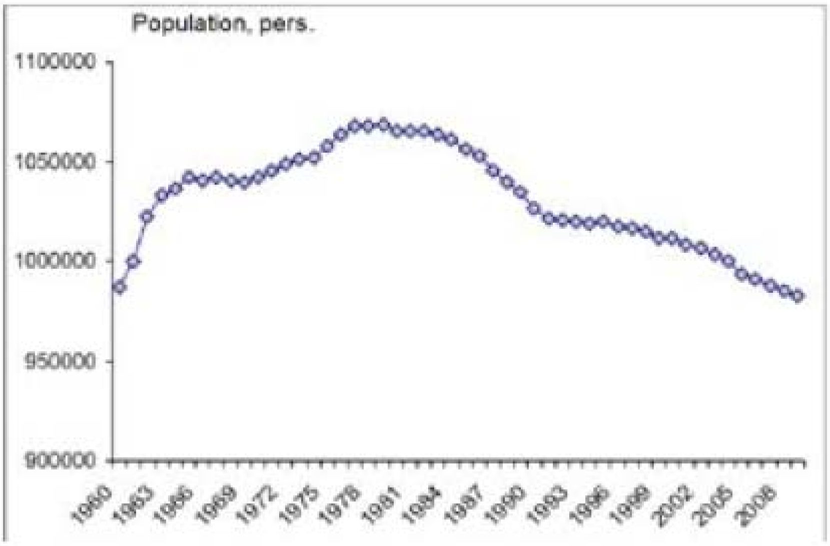


Figure 5.1. The population dynamic in the Kitakyushu City in 1960-2008

The agriculture output in the Kitakyushu City area decreased by half since 1990 (Fig. 5.2) in the accordance with the same decrease of crop acreage.

The distribution and volume of pesticides and fertilizers since 1985 are shown on Fig. 5.3. The distribution of fertilizers dropped by half between 1985 and 2000, as did the acreage under cultivation. This is especially true for the chemical fertilizers use. The organic fertilizers distribution has been even increased in the middle of 90^{th}, but due to prevailing of the chemical ones, the summary usage of fertilizers decreased. However, the distribution of pesticides dropped off dramatically in this period – to one fourth of the former use in just 15 years (Fig. 5.3). After 2000, there were no large changes in the distribution of pesticides and fertilizers.

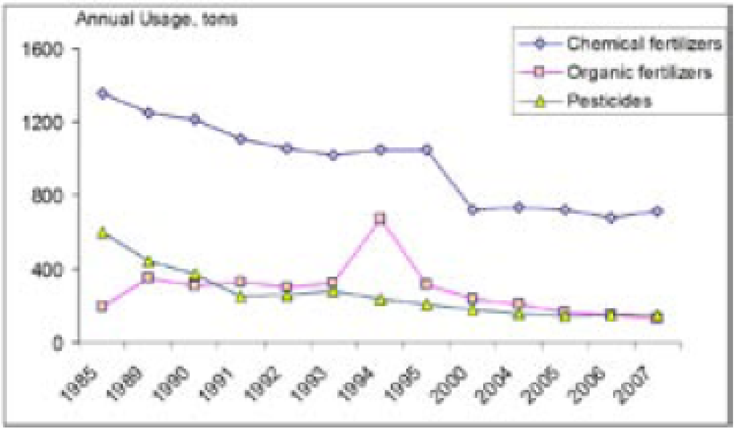


Figure 5.3. The annual usage of fertilizers and pesticides in the Kitakyushu City area.

There are 5 main sewage treatment plants in Kitakyushu City. Their summary treatment capacities cover population 989438 inhabitants that is cover all population. These facilities use a standard activated sludge process. The area provided by wastewater treatment plants has been expanding since the first sewage treatment facility was constructed in 1963 in the west of Kitakyushu City to 90% in 1990 and 99.8% in 2005 (Fig. 5.4).

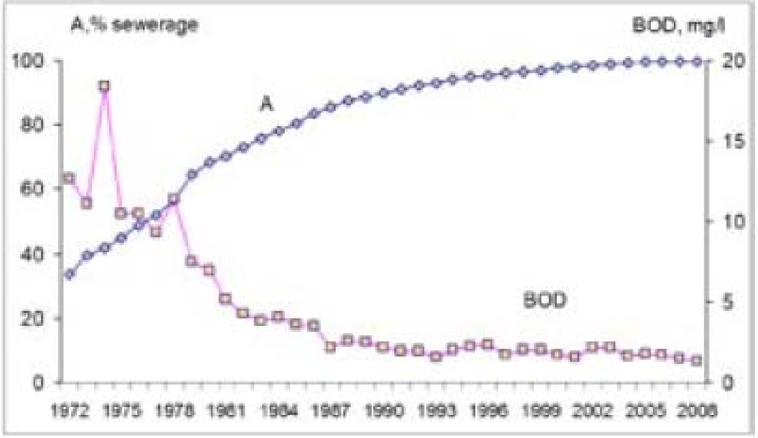


Figure 5.4. The changes in sewerage coverage and averaged BOD in the rivers within Kitakyushu City area.

River water quality within the Kitakyushu City area is examined every month at 27 sampling points on the 16 rivers, presented mainly on Figure 3.2. There is significant spatial variability of the BOD parameter among the rivers (Fig. 5.5).

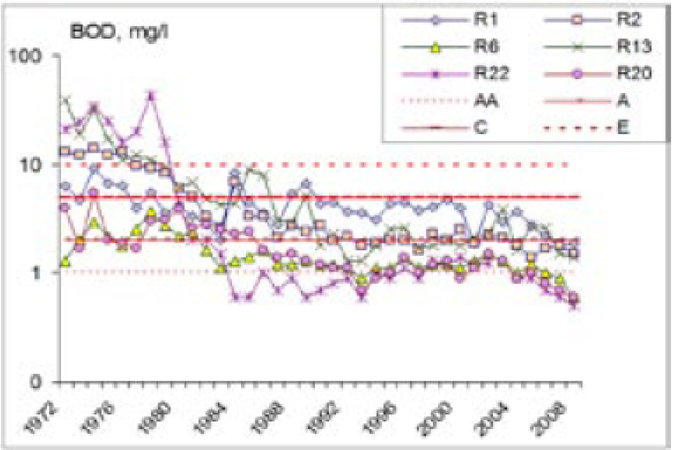


Figure 5.5. The inter annual change of annually averaged BOD in the typical rivers within the Kitakyushu area (R1, R2, R6, R13, R20, and R22, see Fig. 3.2) in the comparison with Environmental Quality Standards for different water use (AA, A, C, E).

Seawater at 18 sampling points around Kitakyushu City is examined every month (Fig. 3.2). Figure 5.6 shows the inter annual variation of the COD in the sea from 1968 to 2009.

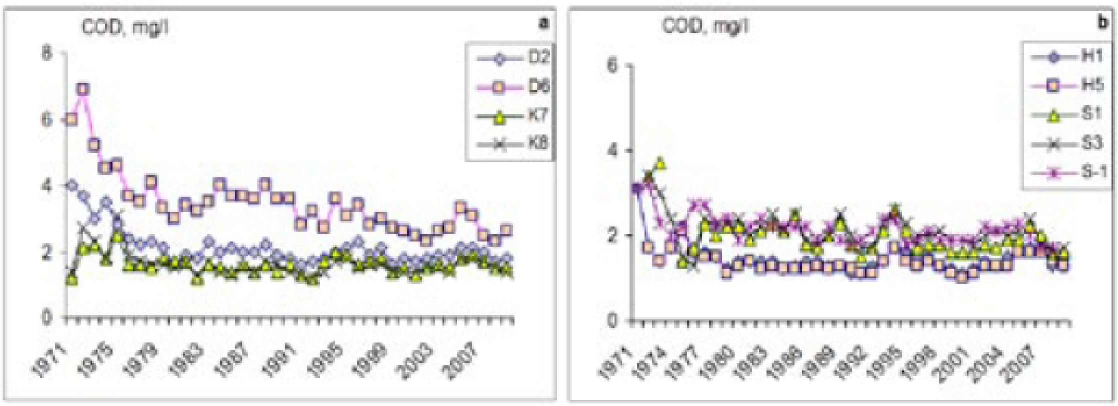


Figure 5.6. Inter annual change of annually averaged COD at the sea monitoring stations around Kitakyushu City area (see Fig. 3.2 for location)

The inter annual changes of the annually averaged total nitrogen concentrations in Dokai Bay and within adjacent sea areas somewhat similar to phosphorus. In Dokai Bay total nitrogen dropped 4-5 times from 1987 till 2002, and since that shows near constant concentration 0.46-0.55 mg/l in outer part (St. D2) and 1.5-1.9 mg/l in inner part (St. D6) (Fig. 5.8c). In Hibiki Nada, the sampling points that are affected by Dokai Bay showed high nitrogen concentrations in the 1980's. However, in the 1990's nitrogen concentrations in Hibiki Nada as well as in Suo Nada did not change along with the improvement of water quality in Dokai Bay (Fig. 5.8a, b). Concentration of total nitrogen in Kanmon Straight, at least in vicinity of Kitakyushu City (St. K7, K8), continue to be elevated compare with Hibiki Nada and/or Suo Nada (Fig. 5.8a), and this is distinct feature of nitrogen distribution against phosphorus one.

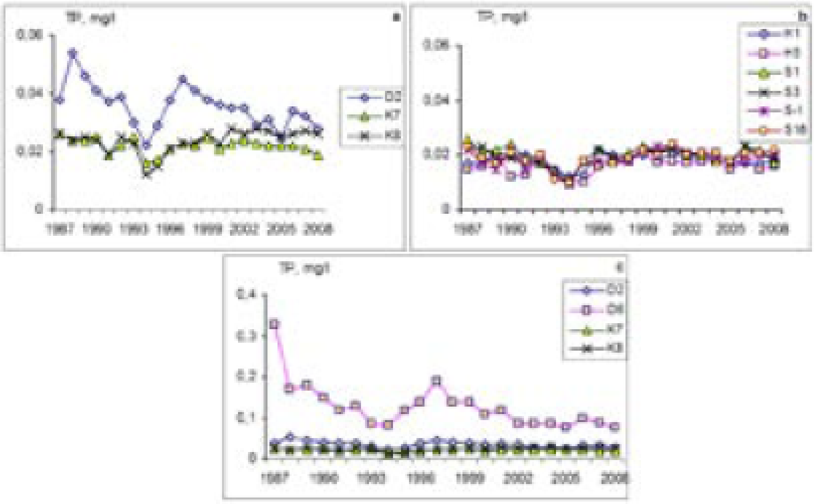


Figure 5.7. Annual changes of the annually averaged total phosphorus concentration at the sea monitoring stations around Kitakyushu City area.

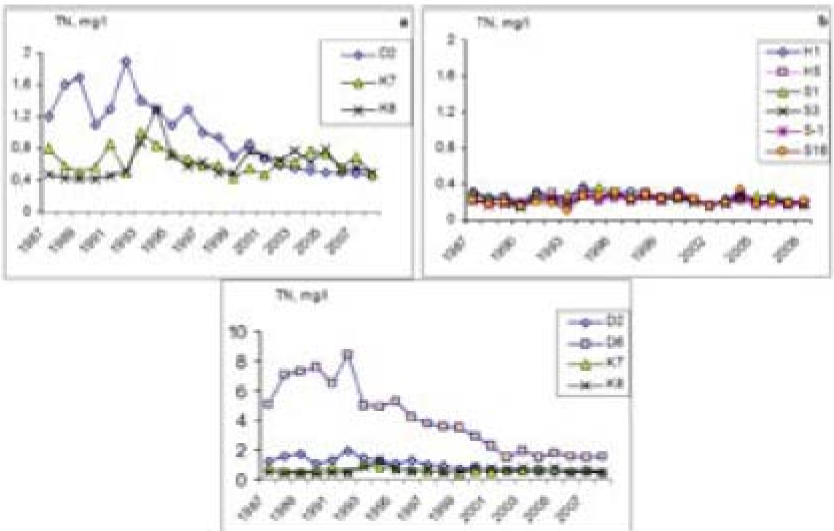


Figure 5.8. Annual changes of the annually averaged total nitrogen concentration at the sea monitoring stations around Kitakyushu City area.

Figure 5.11 illustrates the inter annual variations in occurrences of red tides in the inner part of Dokai Bay. Although the quality of the seawater has improved, the frequency of red tides, which mainly occur in summer, did not change between 1980 and 2006. The planktons composing the red tides, however, have changed from a single to multiple species.

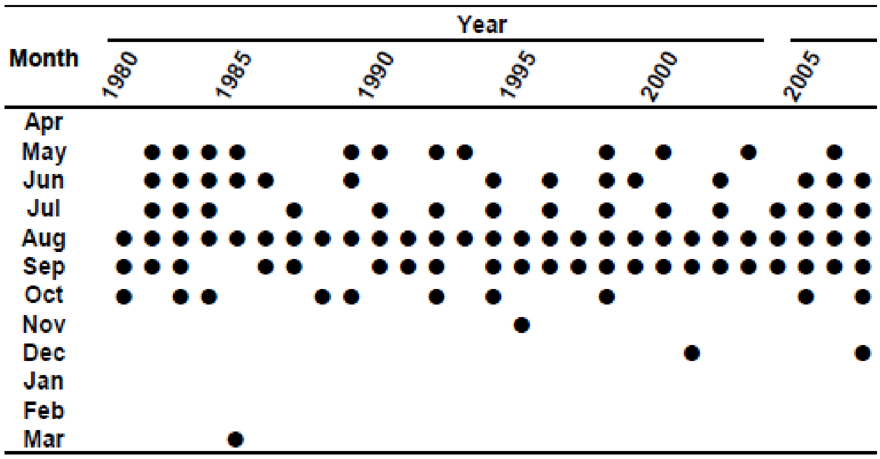
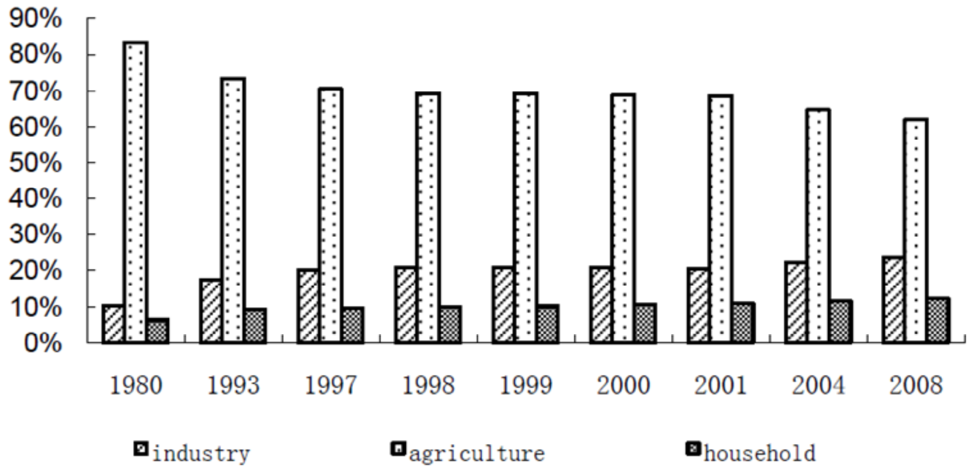


Figure 5.11. Inter annual variations in occurrences of red tides in the inner part of Dokai Bay. Black circles show that a red tide occurred at the time of survey once a month.

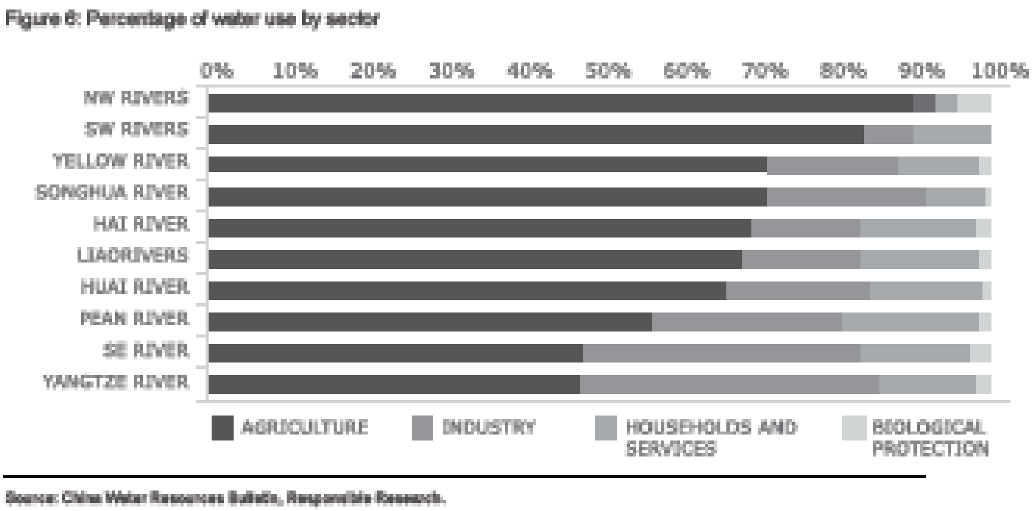
2. Water environment in China

(1) Water use in China



The percentage of water use by major user sector, 1980-2008

(Source: Conference materials of International meeting for the research on conservation of Northwest Pacific marine environment, March 9th, 2012)



(Source: 'WATER IN CHINA', Lucy Carmody, February, 2010)

(2) Rivers in China

The 10 most important rivers in China

RIVER SYSTEMS	ENVIRONMENT, SOCIAL and GOVERNANCE ISSUES
Yangtze River (Changjiang) The longest river in China and the third longest in the world at 6,300km, it originates in the Tibetan plateau and flows through Qinghai, Tibet, Yunnan, Sichuan, Hubei, Hunan, Jiangxi, Anhui and Jiangsu before entering the East China Sea in Shanghai. It has eight major tributaries and a catchment area of 1,8 m km^2, around 20% of China's land mass. The Three Gorges dam is situated on the Yangtze.	• Social and environmental impacts of massive hydropower projects – Three Gorges and related projects. • Investments that bolster integrated water resource management. • Source important for transportation and irrigation. • Suffers from sewage and industrial waste dumping. > 14% of the water quality is poor = cannot support swimming and drinking.
Yellow River (Huanghe) The second longest river at almost 5,500km. The river is notable for its associations with ancient Chinese culture and civilization. Originating in the Bayanhar Mountains in Qinghai Province it meanders across 9 provinces and reaches the ocean in Shandong Province.	• Impact of agri-chemicals on the river in China's agricultural heartland as it suffers from intense irrigation. • Water volumes decreasing and flows less predictable. > 30% of the water quality is poor = cannot support drinking.
Heilongjiang River (Heilongjiang) This river (the Black Dragon River) marks the boundary between Russian and China. It runs east across Northern China and empties into the Sea of Okhotsk. Its entire length is over 4,300km making it the 11th largest river in the world. Its banks are still well forested in places.	• Natural habitat of Siberian Tiger, black bear and many rare bird species. • Pollution from lack of water treatment by heavy industry. • Potential for border conflict with Russia.
Songhuajiang River (Songhuajiang) - This river (also known as the Sungari) is around 2,000km long and is in the Northeast. It is the largest tributary of the Heilongjiang River and flows from the Changbai Mountains.	• Pollution from lack of water treatment by heavy industry. • In November 2005 an explosion at a petrochemical plant in Jilin contaminated drinking water supply with benzene. • Potential for transnational tension with Russia. > 65% of the water testing stations show quality is poor which means these areas cannot support drinking.
Zhujiang River (the Pearl River) The Pearl is the second largest by volume, after the Yangtze and the longest river in Southern China. It flows into the South China Sea between Hong Kong and Macau where it forms a delta. The river flows through the dense population zones of Guangdong, Guangxi, Yunnan, and Guizhou Provinces. The river basin is over 400,000km^2 in area.	• Water treatment from a range of industries including textile and apparel. • Initiatives under way to clean up the Pearl River Delta. • Surrounded by fertile soil and abundant natural resources.
Brahmaputra River (Yaluzangbujiang) From its source in Tibet the Brahmaputra River flows first east and then south into the Indian Ocean. About 1,800 miles (2,900 km) long, the Brahmaputra has the largest canyon in the world at over 500km long and 6,000 m deep.	• Natural habitat of rare river dolphins. • Dam building and river diversion. • Potential for border tension with India. • Source important for transportation and irrigation.
Lancang River (Lancang Jiang) Also known as the Mekong River, it is the longest river in the Southeast Asia, with a total length of over 2,300 km. Its source is in Qinghai and it runs south until it leaves China at Yunnan Province. The Mekong finally reaches the Pacific Ocean in South Vietnam. Many ethnic and tribal minorities live along the banks of the Lancang in China and North Vietnam.	• Social and environmental impacts of dams and hydropower projects. • River flow diversion from downstream countries, Vietnam in particular. • Many different ethnic and tribal minorities live along the river.
Huai River (Huai He) This 1,078km river originates in the Tongbai Mountain in Henan province. It flows through northern Anhui, finally entering the Yangtze River at Jiangdu, Yangzhou.	• Investment in flood control > 60% of the water quality is poor = cannot support drinking.
Hai River (Hai He) The longest tributary of this sediment-rich ruver runs 1,329 km through Beijing and Tianjin before emptying into the Bohai Gulf of the Yellow Sea.	• Hai's flood control has a significant economic and environmental impact on the second and third largest cities in China, Beijing and Tianjin, respectively. • Water treatment needed for a range of industrial pollution. > 70% of the water quality is poor = cannot support drinking.
Liao River (Liao He) This is also known as the 'Mother' River. It flows through Hebei, Inner Mongolia, Jilin, and Liaoning provinces, and at last empties into the Bohai Sea, with a drainage area of over 200,000km^2	• Pollution from lack of water treatment by heavy industry. > 60% of the water quality is poor = cannot support drinking.

(Source: 'WATER IN CHINA', Lucy Carmody, February, 2010)

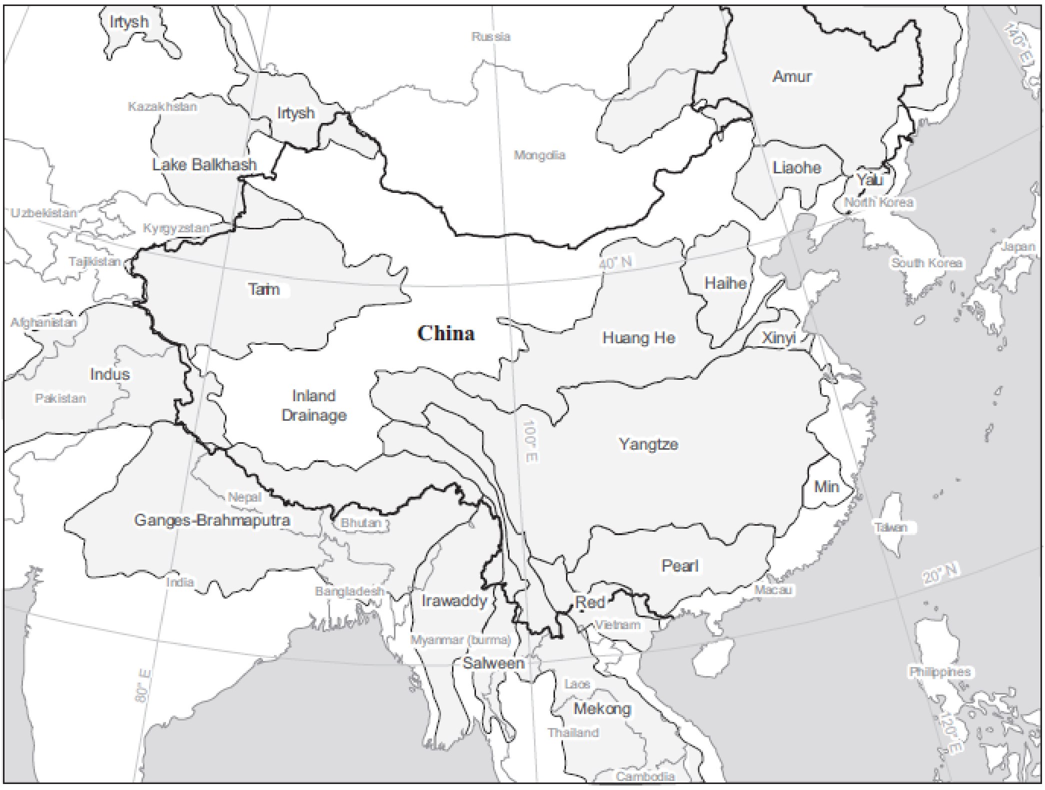


FIGURE 5.1 MAJOR RIVER BASINS IN CHINA.

Source: ESRI, USGS/WWF. Lambert conformal conic projection. Courtesy of Matthew Heberger.

(Source: 'The World's Water, Chapter 5 (2008-2009): China and Water', Peter H. Gleick,
http://www.worldwater.org/data20082009/ch05.pdf)

TABLE 5.2 Major Rivers in China With Their Average Annual Runoff

River	Length (km)	Drainage Area (km^2)	Average annual runoff (km^3)
Changjiang (Yangtze)	6,300	1,808,500	951.3
Huang He (Yellow)	5,464	752,443	66.1
Heilongjiang (Amur)	3,420	896,756 *	117.0
Songhua (Sungari)	2,308	557,180	76.2
Xijiang (Pearl)	2,210	442,100	333.8
Yarlung Zangbo	2,057	240,480	165.0
Tarim	2,046	194,210	35.0
Lancangjiang	1,826	167,486	74.0
Nujiang	1,659	137,818	69.0
Liao He	1,390	228,960	14.8
Hai He	1,090	263,631	28.8 **
Huai He	1,000	269,283	62.2
Irtysh	633	57,290	10.0
Luan He	877	44,100	6.0
Minjiang	541	60,992	58.6
Total		5,224,473	2,039.0

Notes:
* Including the Songhua River Basin
** Including the Luan He River Basin
Source: http://www.eoearth.org/article/Water_profile_of_China

(Source: 'The World's Water, Chapter 5 (2008-2009): China and Water', Peter H. Gleick,
http://www.worldwater.org/data20082009/ch05.pdf)

(3) Water qualities in China

1) Rivers

Weekly report on auto monitoring for particular sectional water quality of nationwide major river systems
The 48th week in 2011 (Announced on November 28, 2011)
We conducted nationwide motoring of particular sectional water quality of major 115 river systems across the country at the 48th week in 2011 (November 21 to November 27) and checked eight indexes (water temperature, pH, turbidity, dissolved oxygen, electric conductivity, permanganate index, ammonium-nitrogen, and total organic carbon) at the auto monitoring points. As a result of this research, we acquired the following data: Section of water quality Class I to III: 90, 78% Section of water quality Class IV: 7, 6% Section of water quality Class V: 8, 7% Section of water quality Class V-deteriorated: 10, 9% On that week, the water quality of the section of Huai Bei Xiao Wang Qiao of Tuo He in the Huai He river system, the section of the Su Zhou Si Xian Gong Lu Qiao of the Xin Bien river, and the point of Tai Hu Yi Xing Lan Shan Zui in the Tai Hue river system were slightly improved. The water quality of the section of Hu Ma of the Hei Long Jiang in the Song Hua Jiang river system, the section of the Wei Nan Tong Guan Diao Qiao of the Wei River in the Huang He river system, and the section of Shanghai Qing Pu Ji Shui Gang of the Ji Shui Gang river in the Huang He river system were slightly deteriorated. These changes of the water quality were mainly caused by changes of dissolved oxygen and ammonium-nitrogen levels and permanganate index density. Detail measurement data is available in the table of water quality data of particular sectional water quality of major river systems across the country at the 48th week in 2011.
China Environment Monitoring Total Station

Table of water quality data of particular sectional water quality of major river systems across the country at the 1st week in 2012

Serial Number	River System	Name of Point	Condition of Section	pH*	DO (mg/l)	COD_{Mn} (mg/l)	NH_3-N (mg/l)	Water Quality: This Week	Water Quality: Previous Week	Major Contamination Index
1	Song Hua Jiang	Chang Chun Song Hua Jiang Cun		7.05	6.88	3.90	0.49	II	II	
2		Zhao Yuan		7.14	8.40	3.60	0.87	III	III	
3		Tong Jiang	Before merge into Hei Long Jiang	8.35	10.30	5.90	0.38	III	III	
4		Hu Lun Bei Er Hei Shan Tou	Border	7.93	8.63	6.00	0.35	III	III	
5		Hu Ma	Border	7.61	4.31	3.50	0.20	IV	III	Dissolved oxygen
6		Hei He	Border	7.78	9.77	5.60	0.32	III	III	
7		Bai Cheng Bai Sha Tan	Before merge into Song Hua Jiang	7.60	10.10	5.60	1.24	IV	IV	Ammonium-nitrogen
8		Hu Lun Bei Er Cuo Gang	Hai La Er He	7.60	7.57	5.10	0.51	III	III	
9		Hu Lun Bei Er Da Tie Qiao	Before merge into Er Gu Na He	7.65	9.65	2.20	0.14	II	II	
10		Hu Lin Hu Tou	Border	7.12	9.32	3.70	0.09	II	II	
11		Fu Yuan Wu Su Zhen	Before merge into Hei Long Jiang (Border)	7.09	12.00	2.30	0.20	II	II	

12		Yan Bian Quan He	Border	8.55	8.38	12.10	0.45	V	V	Permanganate index
13	Liao He	Tie Ling Zhu Er Shan		7.60	5.97	4.50	0.44	III	II	
14		Pan Jin Xing An	Before entering into the sea	7.17	4.83	6.70	0.22	IV	IV	Dissolved oxygen, Permanganate index
15		Ying Kou Liao He Gong Yuan	Before entering into the sea	6.92	8.43	9.20	1.53	V	V	Ammonium-nitrogen, Permanganate index
16		Chang Bai Lv Jiang Cun	Border	7.70	10.10	0.40	0.36	II	II	
17		Ji An Shang Huo Long	Border	8.84	11.50	2.80	0.02	II	II	
18		Dan Dong Jiang Qiao	Before entering into the sea (Border)	6.91	8.43	2.20	0.26	II	II	
19	Hai He	Tian Jin San Cha Kou	Before entering into the sea	7.81	3.64	5.80	1.75	V	IV	Ammonium-nitrogen, Dissolved oxygen
20		Mi Yun Gu Bei Kou	Inlet of Mi Yun Reservoir	8.05	9.64	2.30	0.36	II	II	
21		Men Tou Gou Yan He Cheng	Outlet of the government dam	8.60	11.50	4.50	0.31	III	III	
22		Tian Jin Guo He Qiao	Inlet of Yu Qiao Dam	8.48	9.86	3.00	0.45	II	II	
23		Zhang Jia Kou Ba Hao Qiao	Inlet of Guan Ting Dam	7.66	7.14	7.30	6.07	Deteriorated V	Deteriorated V	Ammonium-nitrogen, Permanganate index
24		Liao Cheng Cheng Gou Wan	Border between three provinces, Yu, Ji, and Lu	7.64	1.11	8.00	5.38	Deteriorated V	Deteriorated V	Dissolved oxygen, Permanganate index, Ammonium-nitrogen
25	Huai He	Xin Yang Huai Bin Shui Wen Zhan	Border between Yu and Huan	8.08	9.06	3.30	0.08	II	II	
26		Fu Nan Wang Jia Ba	Border between Yu and Huan	7.84	8.78	4.70	0.63	III	III	
27		Huai Nan Shi Tou Bu		8.04	8.12	4.80	0.29	III	III	
28		Beng Bu Beng Bu Zha	Above the water gate	7.84	8.82	4.40	0.15	III	III	
29		Chu Zhou Xiao Liu Xiang	Border between Huan and Su	8.05	7.21	2.50	0.20	II	II	
30		Xu Yi Huai He Da Qiao	Border between Huan and Su	7.83	8.29	3.90	0.46	II	III	
31		Zhu Ma Dian Ban Tai	Border between Yu and Huan	8.43	8.85	4.00	0.83	III	III	

32		Xin Yang Jiang Ji Shui Wen Zhan	Border between Yu and Huan	7.12	9.36	3.40	0.37	II	II	
33		Jie Shou Qi Du Kou	Border between Yu and Huan	7.90	8.92	3.90	1.03	IV	IV	Ammonium-nitrogen
34		Zhou Kou Shen Qiu Zha	Above the water gate	8.14	7.06	2.70	0.93	III	III	
35		Fu Yang Xu Zhuang	Border between Yu and Huan	8.08	7.63	8.70	0.13	IV	IV	Permanganate index
36		Fu Yang Zhang Da Qiao	Border between Yu and Huan	7.73	2.84	6.10	8.52	Deteriorated V	Deteriorated V	Ammonium-nitrogen, Dissolved oxygen, Permanganate index
37		Zhou Kou Lu Yi Fu Qiao Zha	Border between Yu and Huan	9.30	8.23	8.00	0.27	Deteriorated V	Deteriorated V	pH, Permanganate index
38		Yong Cheng Huang Kou	Border between Yu and Huan	7.97	12.10	6.40	0.23	IV	IV	Permanganate index
39		Bo Zhou Yan Ji	Border between Yu and Huan	7.86	2.77	19.30	18.00	Deteriorated V	Deteriorated V	Permanganate index, Dissolved oxygen, Ammonium-nitrogen
40		Huai Bei Xiao Wang Qiao	Border between Yu and Huan	7.24	11.80	5.80	0.25	III	IV	
41		Su Zhou Si Xian Gong Lu Qiao	Border between Huan and Su	8.41	11.10	6.00	0.05	III	IV	
42		Si Hong Da Qu	Border between Huan and Su	8.16	8.80	2.70	0.37	II	II	
43		Su Zhou Yang Zhuang	Border between Su and Huan	8.14	5.70	9.60	2.38	Deteriorated V	Deteriorated V	Ammonium-nitrogen, Permanganate index
44		Xu Zhou Li Ji Qiao	Border between Su and Lu	8.40	7.38	5.40	0.18	III	II	
45		Zao Zhuang Tai Er Zhuang Da Qiao	Border between Lu and Su	8.28	7.41	4.90	0.30	III	III	
46		Pi Zhou Pi Cang Ai Shan Xi Da Qiao	Border between Lu and Su	7.94	10.90	4.80	0.28	III	III	
47		Xu Zhou Xiao Hong Quan	Border between Lu and Su	8.34	15.80	5.60	0.22	III	III	
48		Lin Yi Zhong Fang Qiao	Border between Lu and Su	7.80	12.90	4.10	0.36	III	II	
49		Lin Yi Lao Gou Qiao	Border between Lu and Su	7.06	10.30	5.40	0.86	III	III	
50		Lin Yi Qing Quan Si	Border between Lu and Su	8.22	9.84	3.70	0.39	II	III	
51		Lian Yun Gang Da Xing Qiao	Border between Lu and Su	8.02	10.30	6.00	0.34	III	III	

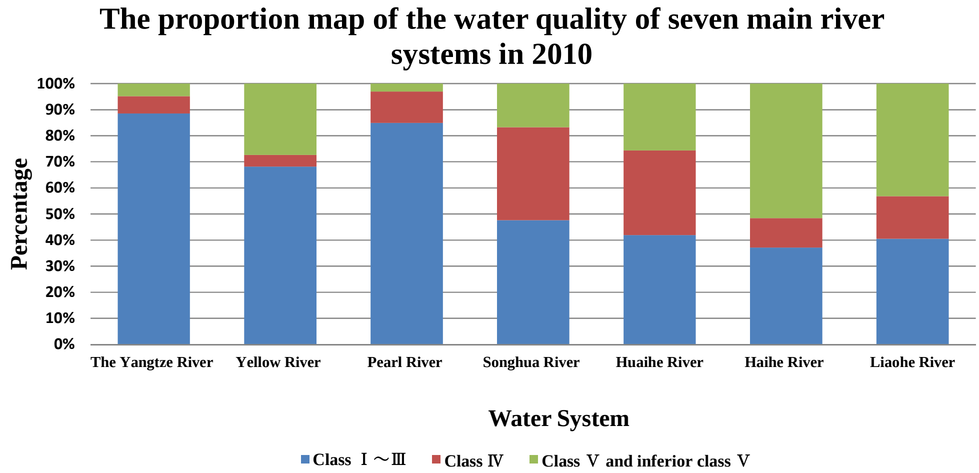
52	Huang He	Lan Zhou Xin Cheng Qiao		8.34	6.93	2.10	0.21	II	II	
53		Zhong Wei Xin Dun	Border between Gan and Ning	7.80	10.80	2.40	0.37	II	II	
54		Shi Zui Shan Ma Huang Gou	Border between Ning and Meng	8.99	9.53	2.80	0.67	III	III	
55		Wu Hai Hai Bo Wan	Border between Ning and Meng	8.18	8.22	4.00	0.61	III	III	
56		Bao Tou Hua Jiang Ying Zi		8.04	8.54	5.10	0.35	III	II	
57		Ji Yuan Xiao Lang Di	Outlet of the dam	7.88	7.18	2.70	0.18	II	II	
58		Ji Nan Bo Kou		8.24	11.10	3.00	0.25	II	II	
59		Hai Dong Min He Qiao	Border between Qing and Gan	8.40	6.91	3.50	1.57	V	V	Ammonium-nitrogen
60		Yun Cheng He Jin Da Qiao	Before entering into Huang He	8.41	6.35	35.10	13.20	Deteriorated V	Deteriorated V	Permanganate index, Ammonium-nitrogen
61		Tian Shui Niu Bei	Border between Gan and Shan	8.20	11.10	3.00	0.32	II	III	
62		Wei Nan Tong Guan Diao Qiao	Before entering into Huang He	7.75	7.48	2.90	1.41	IV	III	Ammonium-nitrogen
63	Chang Jiang	Pan Zhi Hua Long Dong		8.41	7.94	0.70	0.15	I	I	
64		Chong Qing Zhu Tuo	Border between Chuan and Yu	7.14	7.84	1.30	0.32	II	II	
65		Yi Chang Nan Jin Guan	Outlet of San Xia Dam	8.23	6.98	2.20	0.16	II	II	
66		Yue Yang Cheng Ling Ji		8.41	10.00	2.20	0.25	II	II	
67		Jiu Jiang He Xi Shui Chang	Border between E and Gan	7.60	9.48	2.40	0.25	II	II	
68		An Qing Huan He Kou		7.86	8.07	2.30	0.29	II	II	
69		Nan Jing Lin Shan	Border between Huan and Su	7.64	8.98	1.60	0.20	II	II	
70		Chi Shui Lian Yu Xi	Border between Qian and Chuan	8.17	8.26	1.40	0.11	I	I	
71		Le Shan Min Jiang Da Qiao	Before merge into Da Du He	7.69	6.79	2.80	0.40	II	II	

72		Yi Bin Liang Jiang Gou	Before entering into Chang Jiang	7.66	8.59	1.70	0.16	II	I	
73		Lu Zhou Tuo Jiang Er Qiao	Before entering into Chang Jiang	7.77	7.79	1.80	0.15	I	II	
74		Guang Yuan Qing Feng Xia	Border between Shan and Chuan	8.41	11.10	1.10	0.09	I	I	
75		Chang De Sha He Kou	Inlet to Dong Ting Hu	6.49	--	1.00	0.34	II	III	
76		Chang Sha Xin Gang	Inlet to Dong Ting Hu	7.13	5.74	1.70	0.54	III	III	
77		Nan Chang Chu Cha	Inlet to Po Yang Hu	6.85	6.75	2.80	2.49	Deteriorated V	Deteriorated V	Ammonium-nitrogen
78		Wu Han Zong Guan	Before entering into Chang Jiang	7.38	8.57	2.50	0.15	II	II	
79		Nan Yang Tao Cha	Intake	7.79	9.40	2.80	0.16	II	I	
80		Yang Zhou San Jiang Ying	Service water intake for the north area	7.22	8.79	1.00	0.19	II	I	
81	Zhu Jiang	Gui Gang Shi Zui		7.72	7.59	1.20	0.57	III	II	
82		Wu Zhou Jie Shou	Border between Gui and Yue	7.35	8.18	0.90	0.17	II	II	
83		Guang Zhou Chang Zhou		7.24	2.91	1.70	1.20	V	V	Dissolved oxygen, Ammonium-nitrogen
84		Zhong Shan Heng Lan	Meeting point into the sea	7.21	8.77	1.40	0.34	II	II	
85		Qing Yuan Qi Xing Gang		6.93	7.87	0.90	0.17	II	II	
86		Nan Ning Lao Kou		7.82	6.75	1.40	0.18	II	II	
87		Gui Lin Yang Shuo		8.30	9.26	1.10	0.18	II	II	
88		Ping Xiang Ping Er Guan	Border	7.24	7.35	1.60	0.29	II	II	
89		Hai Kou Tie Qiao Cun	Meeting point into the sea	7.13	7.41	1.50	0.12	II	II	
90	Zhe Min Pian	Hang Zhou Jiu Keng Kou	Border between Huan and Zhe	7.96	9.13	2.50	0.06	II	II	
91		Fu Zhou Bai Yan Tan	Meeting point into the sea	6.56	7.97	4.30	0.22	III	III	
92	Rivers in	Xi Shuang Ban Na Gan Lan Ba	Exit	7.72	7.04	1.10	0.12	II	II	

93	the southwest area	Hong He Zhou He Kou	Exit	7.94	7.39	2.00	0.24	II	II	
94		De Hong Zhou Ga Zhong Qiao	Exit	7.52	7.17	1.30	0.08	II	II	
95	Tai Hu	Wu Xi Sha Zhu	Lake	7.99	10.60	4.10	0.20	III	II	
96		Yi Xing Lan Shan Zui	Lake	7.47	8.82	2.10	0.90	III	IV	
97		Su Zhou Xi Shan	Lake	7.28	8.56	2.60	0.24	II	II	
98		Hu Zhou Xin Tang Gang	Border between Zhe and Su	7.59	9.35	4.40	0.55	III	III	
99		Qing Pu Ji Shui Gang	Border between Su and Hu	7.49	5.76	4.80	1.73	V	III	Ammonium-nitrogen
100		Jia Xing Wang Jiang Jing	Border between Su and Zhe	7.14	3.49	5.40	2.08	Deteriorated V	Deteriorated V	Ammonium-nitrogen, Dissolved oxygen
101		Jia Xing Xie Lu Gang	Border between Su and Zhe	6.91	4.60	7.90	1.55	V	V	Ammonium-nitrogen, Dissolved oxygen, Permanganate index
102	Chao Hu	He Fei Hu Bin	West area of the lake	7.29	9.86	3.80	0.24	II	III	
103		Chao Hu Yu Xi Kou	East area of the lake	8.04	8.06	5.80	0.30	III	II	
104	Dian Chi	Kun Ming Guan Yin Shan	Wai Hai	9.26	8.33	5.20	0.18	Deteriorated V	Deteriorated V	pH
105		Kun Ming Xi Yuan Sui Dao	Cao Hai	7.48	5.98	10.80	0.20	V	IV	Permanganate index
106	Other large reservoir lakes	Yue Yang Yue Yang Lou	Outlet of the lake	8.31	9.28	1.10	0.18	II	II	
107		Jiu Jiang Ha Ma Shi	Outlet of the lake	7.77	7.83	2.50	0.31	II	II	
108		Jiu Jiang Du Chang	Lake	7.03	7.64	2.00	0.36	II	III	
109		Dan Jiang Kou Hu Jia Ling	Dam	8.16	8.09	2.10	0.15	II	II	
110		Yu Xi Gu Shan	Lake	8.73	8.22	1.00	0.06	I	I	
111		E Zhou Qi Xing	Before entering into Chang Jiang	7.77	9.17	2.50	0.05	II	II	
112		Xin Zhou Wan Jia Zhai Dam	Dam	8.28	9.99	2.50	0.35	II	II	
113		Fu Shun Da Huo Fang Dam	Dam	7.31	8.20	2.40	0.03	II	II	
114		Liao Yang Tang He Reservoir	Reservoir	7.20	6.67	2.00	0.04	II	II	
115		Shi Jia Zhuang Gang Nan Dam	Dam	7.73	9.08	1.90	0.07	I	I	
《Environmental quality standard for surface water》(GB 3838-2002) Water Quality Standard Class III				6～9	≥5	≤6	≤1.0	--	--	

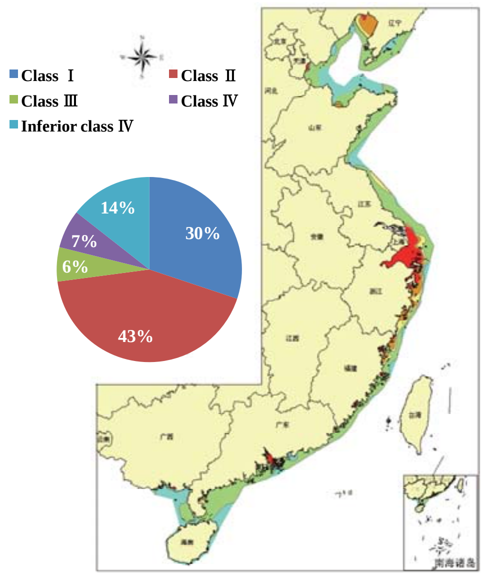
Note: *pH shows dimensionless number. ★ shows that the water flow of the relevant section stops.

(Source: 'Weekly report on auto monitoring for particular sectional water quality of nationwide major river systems', November 28, 2011, Ministry of Environmental Protection of the People's Republic of China: Data Center)

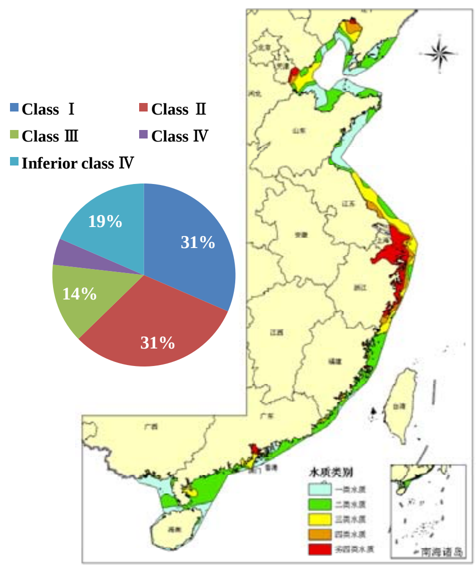


(Source: Conference materials of International meeting for the research on conservation of Northwest Pacific marine environment, March 9th, 2012)

2) Coastal waters



The coastal water quality map in 2009

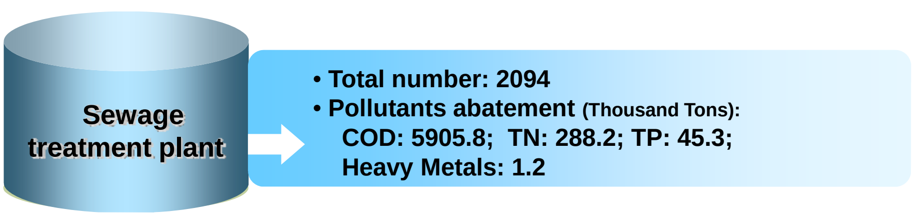


The coastal water quality map in 2010

(Source: Conference materials of International meeting for the research on conservation of Northwest Pacific marine environment, March 9th, 2012)

(4) Sewage works in China

Centralized pollution treatment facilities in China



*(Source: **The First National General Investigation Bulletin of Pollution Sources,** 2010.2.6)*

(5) Water environment in Jiaozhou Bay

(Source: 'REGIONAL OVERVIEW Case studies of river and direct inputs of contaminants with focus on the anthropogenic and natural changes in the selected areas of the NOWPAP region POMRAC Technical Report #10', NOWPAP POMRAC, 2011)

Figure 1.1. Location of the selected case study areas within NOWPAP region.

Since 1970s, the economy of Qingdao kept developing rapidly, the average economic growth rate was about 12.6%, GDP increased from 3.8 billion RMB in 1978 to 485 billion RMB in 2009 (Figure 4.1).

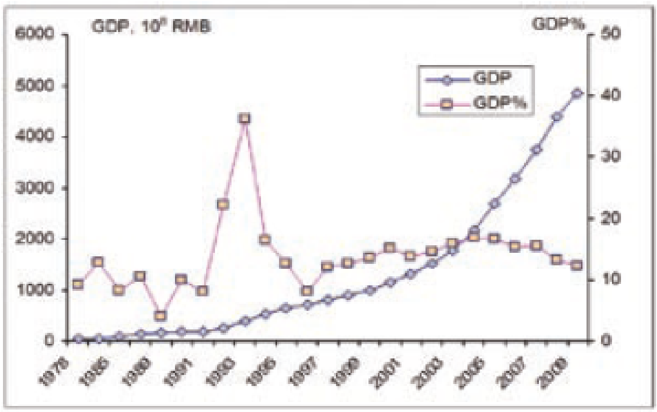


Figure 4.1. The GDP and GDP growth rate of Qingdao from 1978 to 2009

Since 1970s, the population of Qingdao City increased a few annually, with an annual natural population growth rate of 6.0 ‰, the total population increased from 5.85 million in 1978 to 7.63 million in 2009 (Figure 4.2).

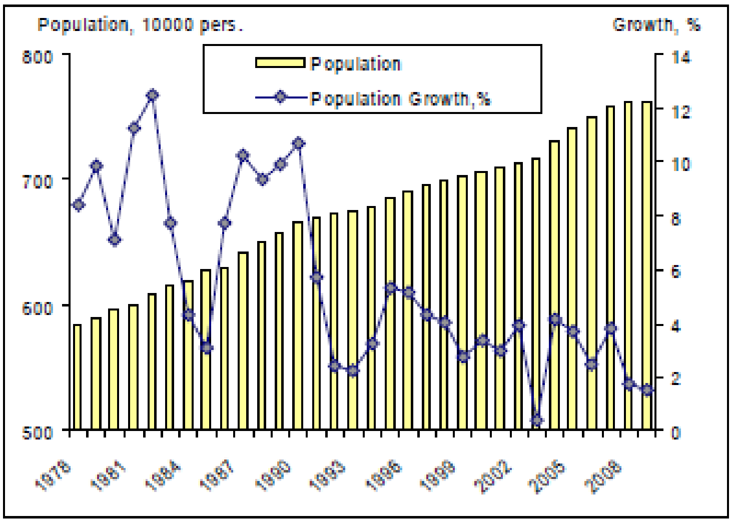


Figure 4.2. The Population and Population natural growth rate from 1978 to 2009

This increase has been provided by the industrial and tertiary activity. The volume of agriculture production has been elevated about three times during last 30 years as well, but the contribution of agriculture to the total output dropped from 25% to 5%. This is accompanied by the 1.5 times reduction of cultivated areas. Such intensification of agriculture was tied with tremendous increase of chemical fertilizers used from $1.9*10^3$ tons in 1949 to about $50*10^3$ tons in 1978, and to $325*10^3$ tons in 2004 (Fig. 4.4).

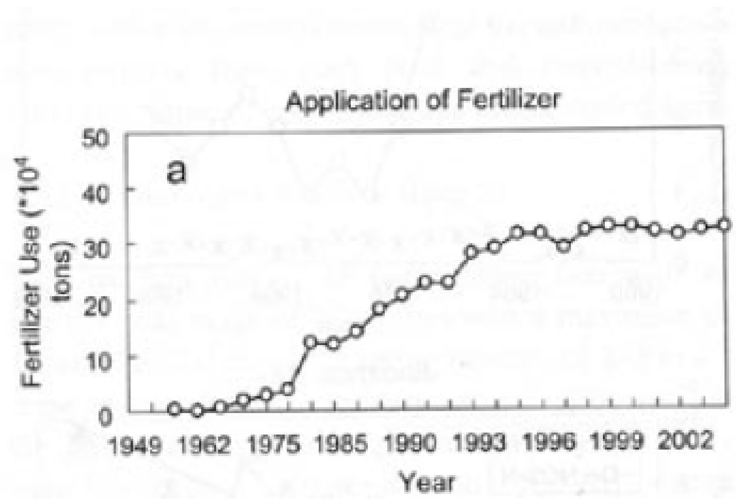


Figure 4.4. The application of chemical fertilizers at the Jiaozhou Bay watershed (from Zhang, 2007 by Qingdao Municipal Statistic Bureau, 2005).

Dagu River is the biggest and less contaminated river inputting to the Jiaozhou Bay from the north. Another rather clean river is Yang River inputting to the western part of the Bay (Table 4.1, Fig. 3.1). Other rivers input to the eastern part of the Bay, drained the Qingdao city area, and have a pretty high concentration of nutrients and suspended solids (Table 4.1).

Table 4.1. Brief characteristic of the main rivers inputting the Jiaozhou Bay*

	Length, km	Watershed, km^2	Runoff, km^3/y	Sediment load, 10^3 tons/year	NH_4 mgN/l	NO_3 mgN/l	PO_4 mgP/l
Dagu	179	5634.2	0.535	959	0.31	0.25	0.012
Baisha	35	202.9	0.029	5.1	0.54	3.68	0.038
Moshui	42	356.2	0.029	47.6	8.64	3.08	1.507
Yang	41	87.2	0.056	258	0.22	1.19	0.005
Licun	15	108	0.011	29.4	2.34	0.05	2.339

* - from Yao et al., 2010

There were nearly 12 sewage treatment plants in Qingdao in 2005, the drainage network coverage was up to 98%, the sewage treatment rate was up to 63.6%, and by now, the number of sewage treatment plants was up to nearly 19 with treatment ratio increase up to 90.1% (Table 4.2).

Table 4.2. The amount of life sewage discharge and treatment ratio of Qingdao

Year	Life sewage discharge (10^4t)	Treatment amount (10^4t)	Treatment ratio (%)
2001	13475	6769	50.2
2002	13999	6754	48.2
2003	13721	7258	52.9
2004	15053	8957	59.5
2005	16488	10478	63.55
2006	21809	16494	75.6
2007	22318.6	17916.9	80.3
2008	23487.6	20909.8	89.0
2009	25244.5	22733.6	90.1%

The efficiency of the industrial wastewaters treatment within Qingdao city area is provided by the operation of the more than 400 wastewaters treatment facilities, which support the compliance of the discharged wastewaters with the existing standards for the effluents (Table 4.3).

Table 4.3. Status of industrial wastewater treatment

	The amount of industrial wastewater (10^4t)	Wastewater meet the standards (10^4t)	Wastewater meet the standards ratio(%)
2001	9587.68	9474.37	98.82
2002	9292.41	9285.54	99.93
2003	9294.77	9287.78	99.92
2004	9130.38	9123.33	99.92
2005	8856.28	8948.85	99.92
2006	9521.18		99.92
2007	9412.17		99.92
2008	9665.3		99.92
2009	10401.7		99.92

There is limited data for the separate assessment of contaminants input to the Jiaozhou Bay through rivers and direct outputs of wastewaters. Using the available data on the direct loads of contaminants (Table 4.4) and existing data on the chemical composition of the inputting rivers (Figure 4.9) and the rivers discharge (Table 4.1 by Yao et al., 2010), one can evaluate the contribution of rivers and direct wastewater outputs (Fig. 4.16).

Table 4.4. The loads of contaminants through rivers and directly

Year	The amount of wastewater discharged into Jiaozhou Bay directly (10^4t/y)	The amount of water discharged into Jiaozhou Bay from river, (10^4t/y)	The amount of contaminant discharged into Jiaozhou Bay directly, (t/y)				
			COD_{Cr}	TN	NH_3	TP	Oil
2006	10842.75	35428.14	38858.79	4688.45	2595.02	276.5	138.68
2007	13360.39		10534.54	616.82	2436.70	237.41	23.14
2008		46661.2					
2009	22245.00	46793.2	10518	6474	2816		

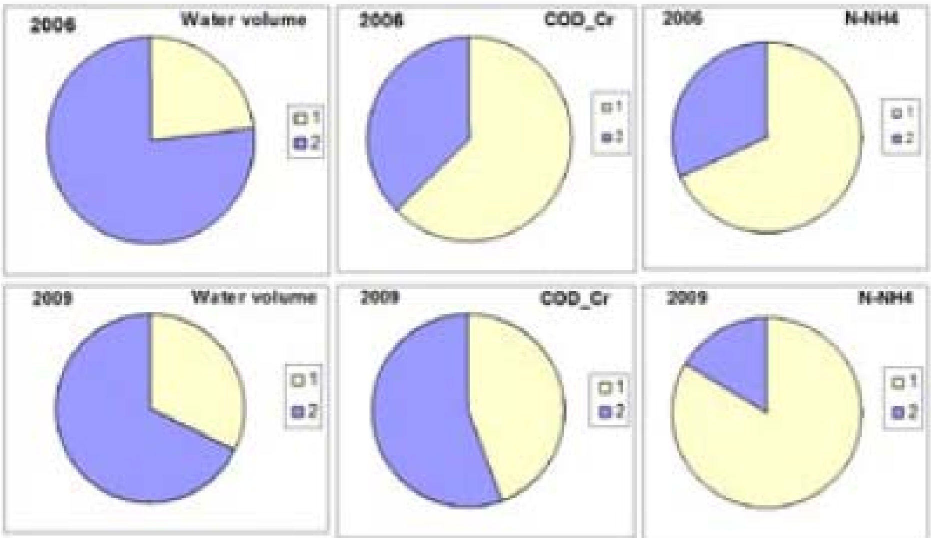


Figure 4.16. The contribution of direct outputs of wastewaters (1) and river runoff (2) to the total land-based input of water and some contaminants to Jiaozhou Bay in 2006 and 2009

Since the 1980s, the annual COD concentration of Jiaozhou Bay seawater has been decreasing basically. During the early 1980s to the early 1990s, the annual COD concentration of Jiaozhou Bay seawater was about 1.2 mg·dm^{-3}, and the highest concentration was about 1.6 mg·dm^{-3}. While after the 1990s, the COD concentration was decreasing faster, and it was decreasing from 1.2 mg·dm^{-3} in the 1990s to 0.8 mg·dm^{-3} now.

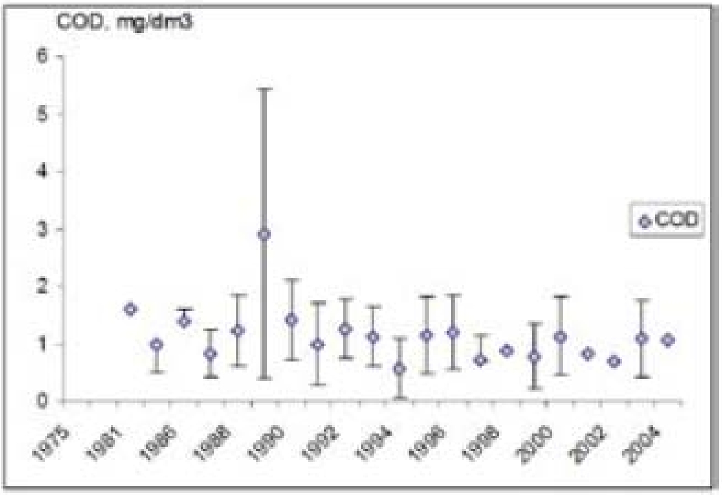


Figure 4.18. The COD annual average concentration of Jiaozhou Bay from 1980 to 2009

The first red tide appeared in 1978 in Jiaozhou Bay. Since the beginning of 1990s, Jiaozhou Bay had been hypereutrophic and the frequency of red tide was continually increasing. The list of the red tide events in Jiaozhou Bay during 2000-2009 is presented in Table 4.5.

Table 4.5. Red tide events HAB occurred in Jiaozhou Bay in 2000-2009

HAB event	HAB area	Causative species	Squares
20/07/2000	Centre of Jiaozhou Bay	*Noctiluca scintinllans*	92km^2
04/04/2001	Fushan Bay	*Noctiluca scintinllands*	small
11/06-12/06/2001	Jiaozhou Bay	*Noctiluca scintillands*	5km^2
07/07 -13/07/2001	Mouth of Jiaozhou Bay	*Mesodinium rubrum*	9.8km^2
28/06 -02/07/2002	Fushan Bay	*Mesodinium rubrum*	60km^2
04/07 -10/07/2003	Tuandao Bay、Huiquan Bay、Taipingjiao Bay、Fushan Bay	*Mesodinium rubrum*	450km^2
02/2004	North-eastern Jiaozhou Bay	*Guinaradia delicatula*	Small
09/02 -28/02/2004	East part of Jiaozhou Bay	*Rhizosolenia delicatula*	70km^2
22/03 -25/03/2004	North-eastern Jiaozhou Bay	*Thalassiosira nordenskЦldii*	70km^2
07/2004	North part of Jiaozhou Bay	*Coscinodiscus asteromphalus*	Small
10/08/2004	Fushan Bay	*Mesodinium rubrum*	50km^2
12/06 -17/06/2005	Lingshan Bay	*Heterosigma akashiwo*	80km^2
07/06 -10/06/2007	Shazikou Bay	*Heterosigma akashiwo*	70km^2
20/08 -23/08/2007	Eastern Qingdao	*Skeletonema costatum*	15 km^2
25/09 -28/09/2007	Shazikou Bay	*Gonyaulax spinifera*	8km^2
28/06 -29/06/2008	Jiaozhou Bay	*Heterocapsa sp.*	5 km^2
07/08 -08/08/2008	Southern Qingdao	*Chattonella antiqua*	86 km^2
2009	Fushan Bay	*Noctiluca scintinllands*	small
2009	Fushan Bay	*Noctiluca scintinllands*	small

3. Water environment in Korea

(1) Sewage works in Korea

(Source: '2010 Statistics of Sewerage', 2011, Ministry of environment, Korea)

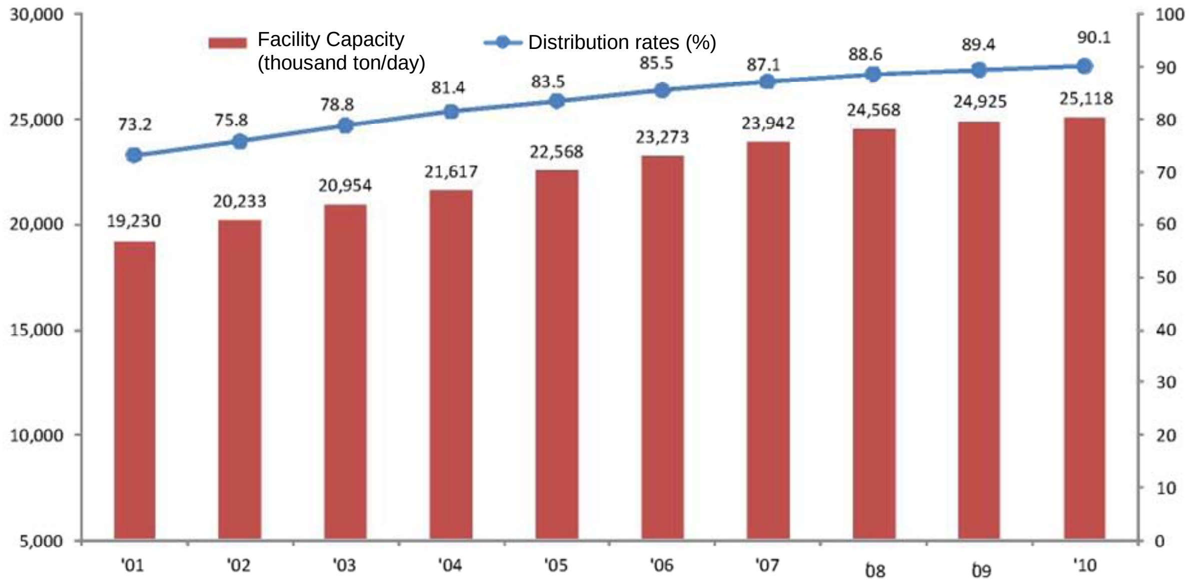
Current State of Sewerage Distribution

As of the end of 2010, the sewerage distribution rate estimated by the proportion of the sewerage treatment population within the areas of sewerage treatment that was treated by sewage treatment facilities (including those of 500m^3 and below) and wastewater treatment plants was 90.1% and the Public Sewage Treatment Facilities that were in operation include 470 plants of 500m^3/day or above and the facility volume was 24,935,010m^3/day; 2,594 plants below 500m^3/day and the facility capacity was 183,045m^3/day.

☐ Sewerage Distribution Trend

Classification	'02	'03	'04	'05	'06	'07	'08	'09	'10
Total Population (a thousand)	48,518	48,824	49,053	49,268	49,624	50,034	50,394	50,644	51,435
Treated Population (a thousand)	36,760	38,449	39,924	41,157	42,450	43,570	44,631	45,263	45,358
Treatment facilities (plant)	207	242 (878)	268 (1,153)	294 (1,404)	344 (1,681)	357 (1,854)	403 (1,991)	438 (2,332)	470 (2,594)
Distribution Rate (%)	75.8	78.8	81.4	83.5	85.5	87.1	88.6	89.4	90.1
Facility capacity (thousand ton/day)	20,233	20,954	21,617	22,568	23,273	23,942	24,568	24,925	25,118

* ( ) refers to the no. of facilities below 500ton/day



The sewerage distribution rates by city/province was highest in Seoul Metropolitan City (100.0%), followed by Busan Metropolitan City (99.1%), Gwangju Metropolitan City (98.1%), Daegu Metropolitan City (98.0%). On the contrary, it was found that Chungcheongnam-do (64.7%) and Jeollanam-do (70.9%) have relatively low distribution rates.

☐ Sewerage Distribution by Watersheds (Unit: people, %)

Watersheds		Total Population	Total Area	Inner area of sewage treatment	Outer area of sewage treatment	Distribution rates (%)
The entire country		51,434,583	99,983	46,357,504	5,077,079	90.1
Sub-total		32,756,675	61,304	29,846,243	2,910,432	91.1
The four major rivers	Han River	19,693,479	25,387	18,638,913	1,054,566	94.6
	Nakdong River	6,976,662	20,668	6,027,787	948,875	86.4
	Geum River	4,202,646	11,212	3,501,879	700,767	83.3
	Yeongsan River	1,883,888	4,036	1,677,664	206,224	89.1
Others		18,677,908	38,679	16,511,261	2,166,647	88.4

(2) Water purification facilities in Korea

Wastewater treatment facilities (Not municipal facilities) and Septic Tank by year (Unit: plant)

City/province	2007			2008			2009			2010.		
	Total	Wastewater treatment facilities	Septic tank	Total	Wastewater treatment facilities	Septic tank	Total	Wastewater treatment facilities	Septic tank	Total	Wastewater treatment facilities	Septic tank
The entire country	3,103,512	351,114	2,752,398	3,082,402	399,788	2,682,614	3,010,841	396,941	2,613,900	3,005,107	402,037	2,603,070
Seoul Metropolitan City	619,177	3,304	615,873	604,837	3,196	601,641	602,066	3,208	598,858	606,502	3,187	603,315
Busan Metropolitan City	265,842	10,722	255,120	260,034	11,325	248,709	261,990	11,497	250,493	259,665	11,762	247,903
Daegu Metropolitan City	150,888	3,293	147,595	153,809	3,758	150,051	154,457	3,969	150,488	154,388	4,005	150,383
Incheon Metropolitan City	137,867	10,999	126,868	139,752	21,459	118,293	124,873	12,456	112,417	125,000	13,430	111,570
Gwangju Metropolitan City	84,958	3,144	81,814	92,548	3,298	89,250	92,629	2,761	89,868	92,405	2,810	89,595
Daejeon Metropolitan City	76,313	3,872	72,441	75,400	4,065	71,335	74,912	3,992	70,920	73,506	3,936	69,570
Ulsan Metropolitan City	65,264	13,483	51,781	51,596	5,197	46,399	49,657	5,206	44,451	39,929	4,796	35,133
Gyeonggi-do	486,762	94,801	391,961	479,732	109,940	369,792	446,768	111,262	335,506	460,345	114,809	345,536
Gangwon-do	139,629	28,749	110,880	141,910	32,802	109,108	146,126	34,443	111,683	140,821	33,190	107,631
Chungcheongbuk-do	35,817	1,209	34,608	124,368	24,915	99,453	125,181	26,758	98,423	127,545	25,417	102,128
Chungcheongnam-do	137,198	33,999	103,199	140,068	42,131	97,937	143,201	43,436	99,765	138,253	44,546	93,707
Jeollabuk-do	129,848	22,815	107,033	123,207	19,742	103,465	114,727	18,436	96,291	118,720	18,659	100,061
Jeollanam-do	193,654	26,667	166,987	201,320	32,335	168,985	191,361	31,931	159,430	195,399	32,672	162,727
Gyeongsangbuk-do	169,309	32,097	137,212	175,548	40,055	135,493	172,008	40,676	131,332	171,728	41,410	130,318
Gyeongsangnam-do	261,592	36,818	24,774	252,951	39,044	213,907	245,875	39,728	206,147	238,714	40,572	198,142
Jeju-do	63,827	5,002	58,825	65,322	6,526	58,796	65,010	7,182	57,828	62,187	6,836	55,351

(Source: '2010 Statistics of Sewerage', 2011, Ministry of environment, Korea)

Expansion and Support for Water Quality Improvement Facilities

<Project Overview>

☐ Continue the investment to make the national rivers/lakes and marshes water environment replete with lives and ecosystem

☐ Expand basic environmental facilities to treat point sources such as treatment plant/pipeline Reinforce the investment to non-point source reduction projects

☐ Basic survey for aquatic ecosystem to recover the health of public waters, continue the projects such as eco-river recovery, etc.

☐ Operate a real-time monitoring system for water pollution & establish preventive system against water pollution

<Operation Plans by Year> (Unit)

Classification	Total projects	By 2009	2010	2011	2012	2013 and after
Wastewater treatment facilities in industrial complexes	462	311	233	309	452	462
Public treatment facilities for cattle excrement	105	132	75	84	100	105
Non-point source pollution reduction facility	410	15	14	23	32	326
Eco-river recovery project	1,529	947	1,054	1,187	1,343	1,529
Establish remote monitoring system for water pollutant emission business	720	934	630	660	700	720
Expand auto water quality assessment network	80	108	57	60	77	80

(Source: 2012 Budgetary and Fund Operation Plan of the Ministry of Environment', December 2011, Ministry of environment, Korea)

(3) Water environment in Masan Bay

(Source: 'REGIONAL OVERVIEW Case studies of river and direct inputs of *contaminants with focus on the anthropogenic and natural changes in the selected areas of the NOWPAP region POMRAC Technical Report #10', NOWPAP POMRAC, 2011)*

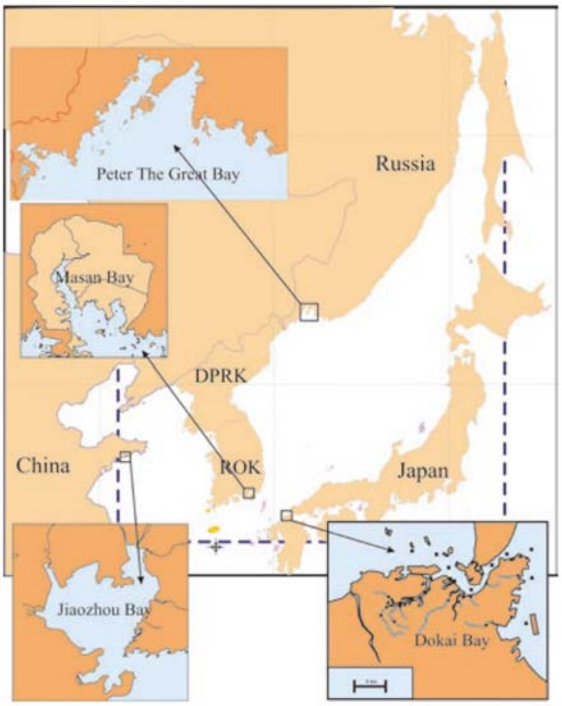


Figure 1.1. Location of the selected case study areas within NOWPAP region.

The watershed of Masan Bay is one of the developed city area in the middle of the Southern Gyeongsang Province, 35 km westward of Busan. There are three cities within Masan Bay area: Masan, Changwon and Jinhae (Fig. 3.3). The population of bigger Masan and Changwon cities becomes rather stable during last 12-14 years, though population of smaller Jinhae city shows some increase – 2-3% annually (Fig 6.1). The overall population of Masan Bay cities agglomeration varies around 1 million persons during last decade with very high population density around 2682 persons/km².

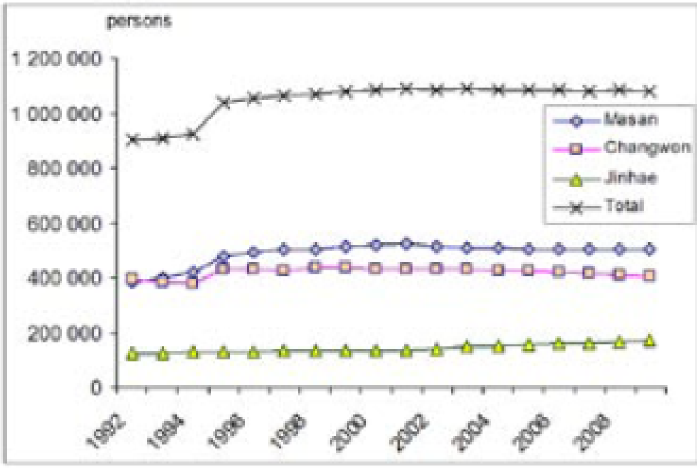


Figure 6.1. The dynamic of population in the Masan, Changwon and Jinhae cities

This rather significant amount of arable lands within Masan Bay watershed is accompanied by the intensive use of chemical fertilizers (Fig. 6.4). In 2004 the annual usage of chemical fertilizers reached up 467 t/km2, and even in 2008 after considerable decrease, the annual usage of chemical fertilizers was about 224 t/km2. For the comparison the annual usage of chemical fertilizers for the agriculture at the Dokai Bay watershed (Japan) was 42 t/km2, and at the Jiaozhou Bay watershed (China) – 60-80 t/km2. The elevated level of the chemical fertilizers usage is inevitable source of additional runoff of the nutrients to the Masan Bay.

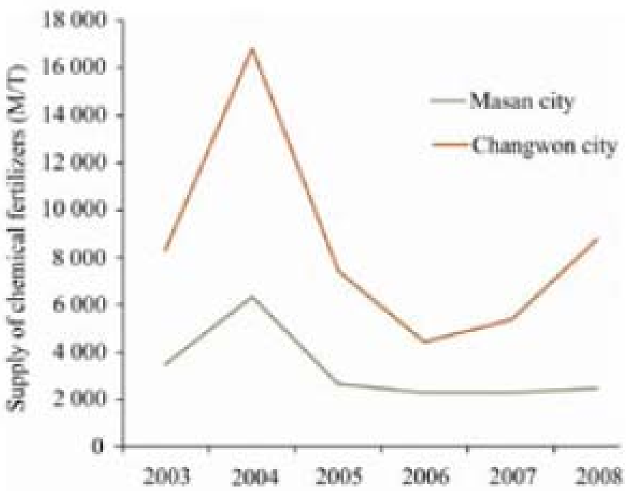


Figure 6.4. Supply of chemical fertilizers on the arable lands within Changwon and Masan cities.

The averaged chemical composition of the rivers inputting to Masan Bay (regular monitoring data on 2009) is presented in Table 6.1. The water quality characteristics are rather variable. The decreased dissolved oxygen concentration and increased COD values, as well as elevated level of TN and TP are observed in the Samho – the biggest river of the watershed (Table. 6.1). It unambiguously points the high anthropogenic press on the river water quality. At the same time weighted averages for all rivers at the Masan Bay watershed do not exceed the Korean water quality standards for river water.

Table 6.1. Chemical composition of river waters from Masan Bay watershed (2009 data)

area	river	Discharge	DO	pH	COD	NH_4	NO_3	TN	TP	PO_4	Si	TOC
		$m^3 d^{-1}$	mg/L		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Masan city, 92.3 km²	Sujeong	6,823	4.89	7.06	7.3	6.25	0.97	9.19	0.94	0.75	6.81	5.24
	Woosan	47,218	8.39	7.56	2.97	0.03	2.02	5.23	0.04	0.02	4.04	1.61
	Wolyong	4,987	7.29	7.57	12.66	6.51	3.37	14.52	2.04	0.64	5.37	3.93
	Janggun	7,400	7.42	7.30	7.83	3.36	3	10.8	0.61	0.42	4.89	2.1
	Cheoksan	9,117	3.99	7.15	15.65	9.5	1.4	15.7	1.93	0.62	3.67	4.83
	Kyubang	23,671	7.79	7.73	10.57	4.84	2.43	11.8	0.83	0.41	4.39	3.67
	Samho	105,889	3,88	7,19	23,57	0,02	1,21	14,5	1,62	0,62	3,79	4,59
	Palyoung	18,158	6.56	7.39	3.49	7.92	0.77	1.37	0.12	0.16	3.64	4.46
Changwon city, 126.3 km²	Namcheon	56,715	8.33	7.29	7.69	1.44	1.79	9.43	0.31	0.15	5.22	2.25
	Changwon	20,749	6.13	7.44	9.32	1.7	1.64	15.5	0.7	0.23	5.79	3.32
	Naedong	10,264	6.27	7.34	16.5	4.69	1.8	13.29	0.61	0.2	6.45	4.04
Jinhae city, 46.2 km²	Daecheon	31,012	6.54	7.39	7.26	3.18	3.68	11.4	0.45	0.22	7.32	2.41
	Seockdong	31,012	4.77	6.76	14.1	5.06	1.47	14.8	1.1	0.4	6.62	3.45
	Sinyicheon	31,012	5.86	7.31	15.1	2.73	1.91	13.2	0.56	0.28	6.69	2.6
	All rivers*	404,027	**6.7**	**7.30**	**12.9**	**2.36**	**1.80**	**11.5**	**0.84**	**0.35**	**5.02**	**3.33**

* weighted average

The annually averaged data on the sea water quality for the 3 monitoring points within inner part of Masan Bay (circles on Fig. 3.3) is presented on the Fig. 6.8. Salinity shows significant inter annual variability without any trend supposedly due to inter annual variation of atmospheric precipitation and river discharge. Dissolved oxygen shows weak increase trend during last 15 years, though significance of this trend is questionable. Similar weak trend but decrease takes place for the COD inter annual change. At the same time the decrease trend of the annually averaged nutrients (DIN, DIP, DSi) concentration is much more pronounced (Fig. 6.8). Part of this decline last 5 years can be explained by the elevated salinity level, which is connected in turn with decrease of river discharge. But such significant decrease trend of nutrients in the coastal sea area unambiguously reflects the reduction of nutrients runoff from the land-based sources last 15 years. The improvement of the technologies and enhanced efforts to wastewaters treatment is a main reason of this trend.

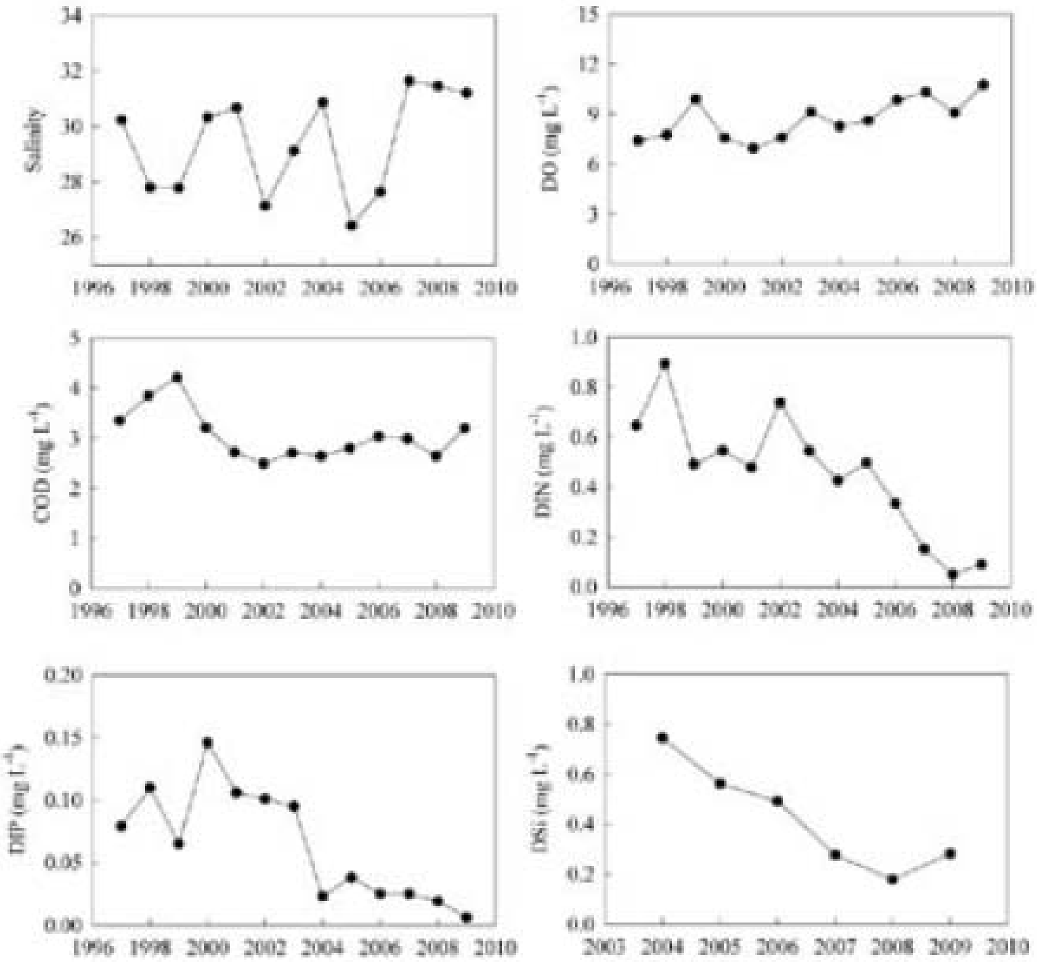


Figure 6.8. The change of annually averaged chemical characteristics in the Masan Bay

The coastal region including Masan Bay with neighboring Jinhae Bay and Haengam Bay was important spawning and breeding area due to ragged coast line and sufficient food supply. This coastal area provided 2/3 of oyster domestic production (Lee, Kim, 2008). After construction of industrial zone in Masan Bay area after 1970s the water quality has deteriorated seriously. The enhanced level of nutrients supply from the land-based sources and correspondent elevated level of nutrients concentration in Masan Bay have led to the eutrophication of this coastal area and adjoining Jinhae Bay as well. After 1980s algal blooms have been observed almost yearly, and sometimes with fish mortality and serious economical damage. The comprehensive assessment of eutrophication of Jinhae Bay is carried out in the integrated report on eutrophication assessment in the selected sea area in the NOWPAP region by NOWPAP CEARAC.

The averaged DIN level in Jinhae Bay after increase period from 1996 till 2000 has shown stable and substantial decrease trend from 0.4 mgN/l to 0.05-0.1 mg/l during last decade. This is coincided with inter annual trend in Masan Bay (Fig. 6.8), though initial concentrations of DIN in Masan Bay were 0.6-0.9 mgN/l that is twice compare with Jinhae Bay. Similar trend was observed for DIP in Jinhae Bay: increase up to 0.08 mgP/l in 2000 and decrease to 0.01-0.02 mgP/l in 2004-2008. And again such trend is coincided with inter annual change of DIP concentration in Masan Bay, with three fold elevated initial level in 2000 – 0.1-0.15 mgP/l (Fig. 6.8).

The registration of red tide events in Masan Bay and Jinhae Bay was carried out since 1979 by NFRDI at the 15 survey points. The number of events varied from 5 to 22 per year with peaks in 1986 and 1999 (Fig. 6.12). The period of 1980s had slightly elevated level of red tide events (10-21), but with diatoms as dominant species. First half of 1990s was characterized by diminish of red tide events (<10), but flagellats began to prevail. Second half of 1990s the number of red tides gradually increased up to 21 per year at flagellats dominance. Since 1999 decrease trend prevails.

Thus the number of red tide events varied without simple relationships with inter annual changes of nutrients level in water. Though some coinciding decrease trends of red tide events and averaged COD content takes place in Masan Bay during last decade (Fig. 6.13). At the same time there is firm trend of red tides size (coverage) increase from 1970s when they were observed within Masan Bay only till 1990s and 2000s when red tides covered all east part of coastal area between mainland and Geoje Is.

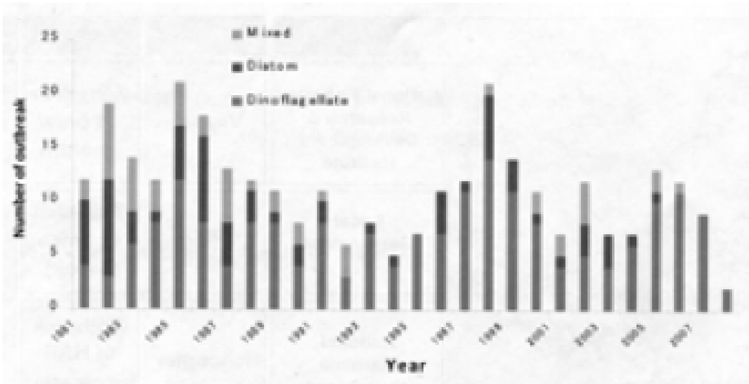


Figure 6.12. The number of red tide events in Jinhae Bay since 1981 (Park, Lee, 2011)

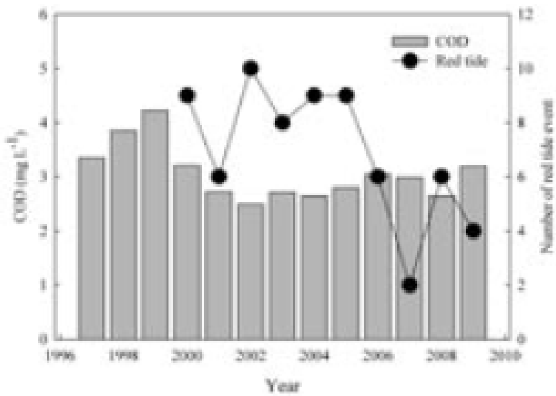


Figure 6.13. The relationship between red tides occurrence and COD level in Masan Bay during last 15 years.

4. Water environment in Russian Far East

(1) Water environment in Peter the Great Bay

(Source: 'REGIONAL OVERVIEW Case studies of river and direct inputs of *contaminants with focus on the anthropogenic and natural changes in the selected areas of the NOWPAP region POMRAC Technical Report #10', NOWPAP POMRAC, 2011)*

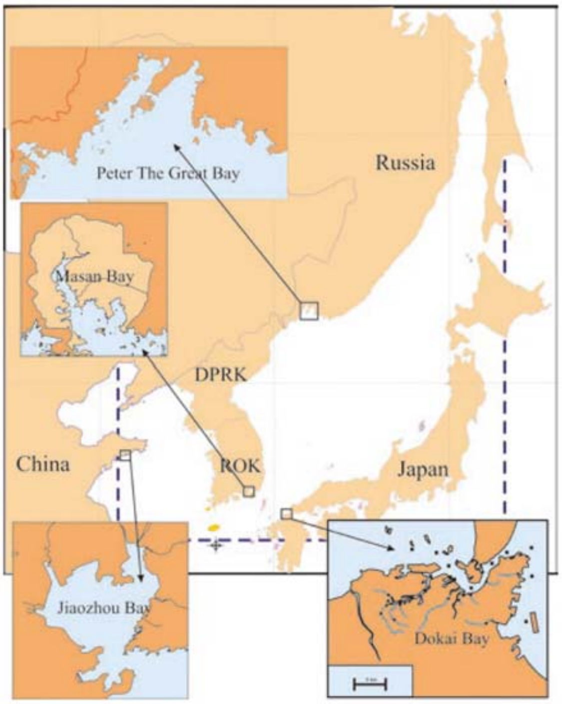


Figure 1.1. Location of the selected case study areas within NOWPAP region.

Figure 3.4. The sketch map of Peter the Great Bay

Peter the Great Bay watershed area is the most populated and developed part of the Primorskyi Kray, and Russian Far East as a whole. The contribution of the Peter the Great Bay watershed to the population of Primorskyi Kray reaches up 70% nowadays (Table 7.1), though 45-50 years ago this contribution was 50-55% (Fig. 7.1a). The urban population strongly dominates for the area studied, and Vladivostok with 605000 comprises more than half of all urban population (Fig. 7.1b). Other major cities include Ussuryisk – 152700, Artem – 111200, Nakhodka – 167600, Fokino – 33800, Bolshoi Kamen – 47400, Partizansk – 49600. Such structure of population takes place during last 30 years. 50 years ago the contribution of Vladivostok city was significantly lower (Fig. 7.1b). The population density at the Peter the Great Bay watershed is 5 times higher than for the Primorsky Kray as a whole (Table 7.1). The main reason is high contribution of urban population, the population density at the Khasan, Razdolnaya and Shkotovsky-Partizansky sub-areas off the cities is close to the average level observed for the Primorsky Kray as a whole (Fig. 7.1c). The dynamic of population within Peter the Great Bay watershed is similar to the Primorsky Kray also: increase to the nineteenth of XX century and decrease after that (Fig. 7.1a). The population density has decreased as well (Fig. 7.1c).

Table 7.1. Socio-Economic characteristics of different sub-areas within Peter the Great Bay watershed in 2009

Sub-area	Square, $*10^3$ km^2	Population $*10^3$ person	Population density, per./km^2	Industry, $*10^6$ USD	Agriculture, $*10^6$ USD	GDP $*10^6$ USD	GDP per capita, USD
1	4.13	27	6.5	26.5	5.9	106.5	3916
2	9.42	135.1	14.3	134.1	100.3	420.4	1951
3	7.00	55.1	7.9	237.9	31.0	376.0	6823
4	0.56	605.1	1080.5	2384.5	9.4	6599.8	10835
5	2.74	562.9	205.4	1133.3	197.8	3176.2	7359
6	23.85	1385.2	62.9	3916.3	344.2	10678.8	7709
7	164.67	1984	13.7				

Note: southwestern sub-area (1) includes Khasanskyi district; Razdolnaya area (2) includes Oktober, Mikhailovskyi, Ussuryiskyi, Nadesdinskyi districts; northeastern sub-area (3) includes Shkotovskyi and Partizanskyi districts; (4) – Vladivostok; other cities (5) include Ussuryisk, Artem, Fokino, Bolshoy Kamen, Nakhodka and Partizansk; (6) – all watershed of Peter the Great Bay; (7) – all Primorskyi Krai.

Chemical oxygen demand (COD) parameter in many Russian rivers is significantly higher than in Japanese rivers and even in Korean ones. COD reflects the amount of substances (organic mainly) could be oxidized by chemicals ($KMnO_4$ or $K_2Cr_2O_7$). The use of stronger oxidant $K_2Cr_2O_7$ for the determination of COD in Russia is a first reason of difference. Among Russian rivers the low COD is observed in the most pristine small mountainous streams of southwestern subarea. The high COD exceeding MPC (maximum permissible concentration) take place in Razdolnaya River and severely polluted streams like Knevichanka river, draining Arteom city and inputting to the low reach of Arteomovka river (Table 7.2)

Table 7.2 Some chemical characteristic (mg/l) of major rivers at the Peter the Great watershed (2001-2007 averaged data)

River	COD_{Cr}	BOD_5	N_{NH4^+}	N_{NO3^-}	$P_{PO4^{3-}}$	PHs	v-phenols	SS
Tumen	18.8	1.93	0.24	0.63	0.017	0.02	0.003	86.5
Rivers of south – western part*	3.4	1.5	0.08	0.20	0.003	0.02	0.001	6.0
Razdolnaya	21.2	11.6	0.87	0.20	0.071	0.11	0.003	29.2
Knevichanka	26.1	6.1	2.25	0.22	0.24	0.06	0.002	29.9
Artemovka	10.7	2.14	0.14	0.09	0.010	0.05	0.001	9.6
Partizanskaya	10.8	2.53	0.05	0.12	0.009	0.05	0.0003	12.1
MPC	**15.0**	**2.0**	**0.40**	**9.1**	**0.05**	**0.05**	**0.001**	-

* - Tsukanovka, Brusya, Narva, Barabashevka, Amba; Nutrients are determined in the filtered (0.45 mkm)

The BOD shows distinct decrease trend in the rather polluted Razdolnaya River, but in other polluted stream – Knevichanka River BOD increase 1.5-2 times last years. Less polluted rivers do not show any clear trend for BOD (Fig. 7.4).

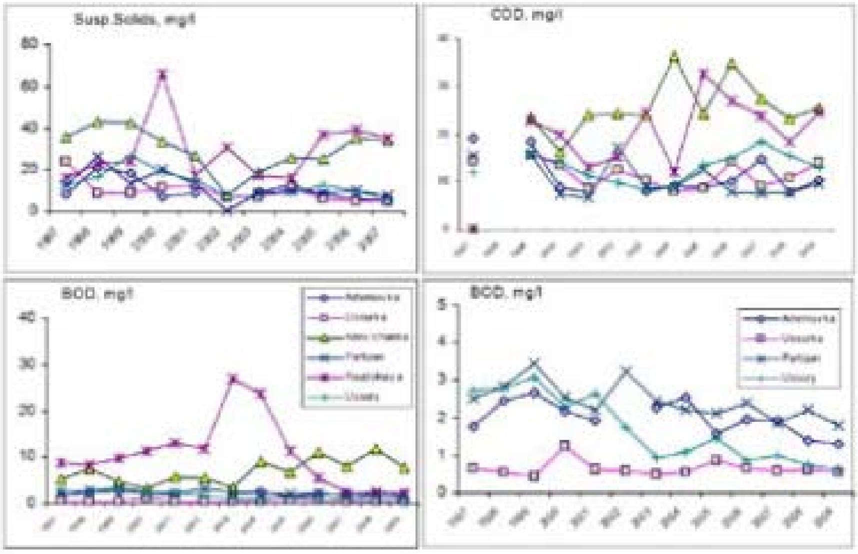


Figure 7.4. Annually averaged concentration of suspended solids, COD and BOD in the Artemovka and Razdolnaya rivers of the Peter the Great Bay basin, and two big rivers of the Amur River basin: Ussury and Ussurka.

Annual means of phosphate show trend of increase during last 5-6 years in the polluted rivers, and that is more important, in the less contaminated ones (Fig. 7.5c, 7.5d). Increased level in the pristine Russian rivers continue to be lower than in many Korean and Japanese rivers, but trend itself is alerted. The somewhat similar trend of rising is observed for the concentration of ammonia nitrogen and DIN (sum of ammonia and nitrate nitrogen) in the contaminated Razdolnaya and polluted Knevichanka rivers at least, but in the more clean rivers there was stabilization or even decrease of ammonia nitrogen and DIN concentration last 5-6 years (Fig. 7.5).

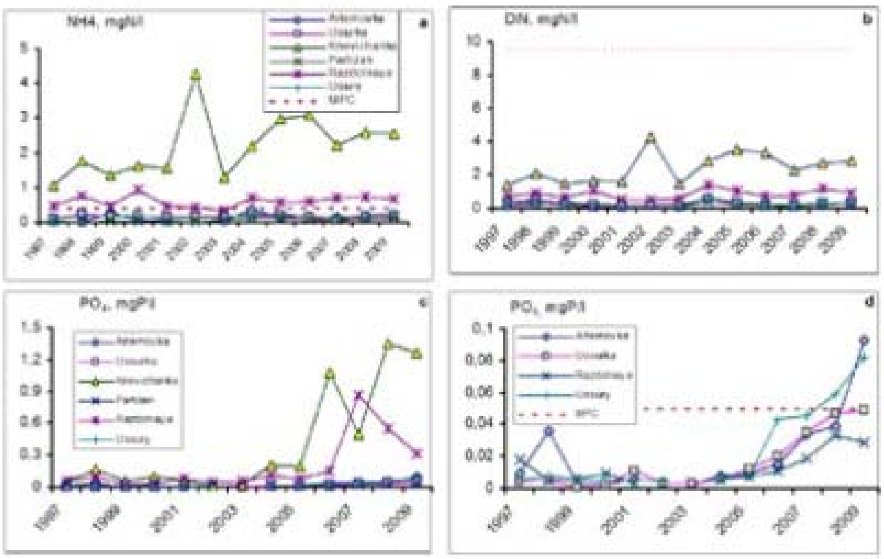


Figure 7.5. Annually averaged concentration of ammonia nitrogen (a), dissolved inorganic nitrogen (b) and phosphate (c, d) in the Artemovka and Razdolnaya rivers of the Peter the Great Bay basin, and two big rivers of the Amur River basin: Ussury and Ussurka.

The concentration of pollutants in the wastewater outputs and especially in the storm waters is very variable, and all assessments are inevitably rather approximate. Such estimates (Gavrilevsky et al., 1998) for Vladivostok area by the chemical parameters often used as water quality indices are presented in Table 7.5. These data coupled with fresh water runoff data (Table 7.4) and information on the chemical composition of river discharge (Table 7.2) allow to evaluate the contribution of rivers, storm waters and wastewaters runoffs to the total input of water and some chemical substances to the Peter the Great Bay (Fig. 7.8).

Table 7.4. The elements of fresh water runoff from the Peter the Great Bay watershed

	Watershed square, km^2	Runoff, km^3/y	Specific discharge, l/s/km^2
River runoff			
Tumen River	33200	9.05	8.6
Tsukanovka	170	0.12	10.4
Brusya	160	0.04	12.4
Narva	332	0.13	12.4
Barabashevka	576	0.32	17.6
Amba	242	0.19	13.4
Razdolnaya	16800	2.46	4.6
Artemovka	1460	0.29	3.1
Shkotovka	714	0.22	8.9
Suhodol	443	0.14	10.4
Partizanskaya	4140	1.32	10.1
Accounted watershed*	25037	5.23	6.6
Non counted watershed*	6498	1.89	9.2
All watershed*	31535	7.12	7.2
Storm water runoff			
all urban area	237	0.171**	22.9
Vladivostok only	171	0.055***	10.2
Direct wastewater discharge			
Vladivostok		0.11-0.14****	
Vladivostok		0.41-0.44*****	
Nakhodka		0.02	

* - estimations for Peter The Great Bay as a whole are carried out without Tumen river runoff; ** - assessment based on the atmospheric precipitation without evapotranspiration;
*** - from Gavrilevsky et al., 1998; **** - without sea water cooling the electricity and heat generation stations in Vladivostok; ***** - total discharge of industrial and municipal wastewaters from Vladivostok

Table 7.5. Concentrations (mg/l) of Substances in the Wastewaters and Storm Waters of Vladivostok (Gavrilevski et al., 1998)

	BOD_5	NH_4	PO_4	Sufr*	PHs**	Phenols	SS
Wastewater	32.6	4.2	1.9	0.11	0.92	0.015	39.2
Storm Water wastes	17.8	3.5	0.25	0.17	1.09	0.011	85.9

*- surfactants (detergents); ** - PHs petroleum hydrocarbons

These assessments are rather rough due to high seasonal and spatial variability of the volume and chemical composition of the end-members. But such estimations show clearly insignificant contribution of storm and wastewaters in terms of water volume input. The contribution of storm and wastewaters increases up to 15% for the degradable organic substances load (BOD), and up to 40-46% for the NH4- and petroleum hydrocarbons (PHC). The contribution of storm and especially wastewaters to the phosphorus load exceeds the contribution of river runoff.

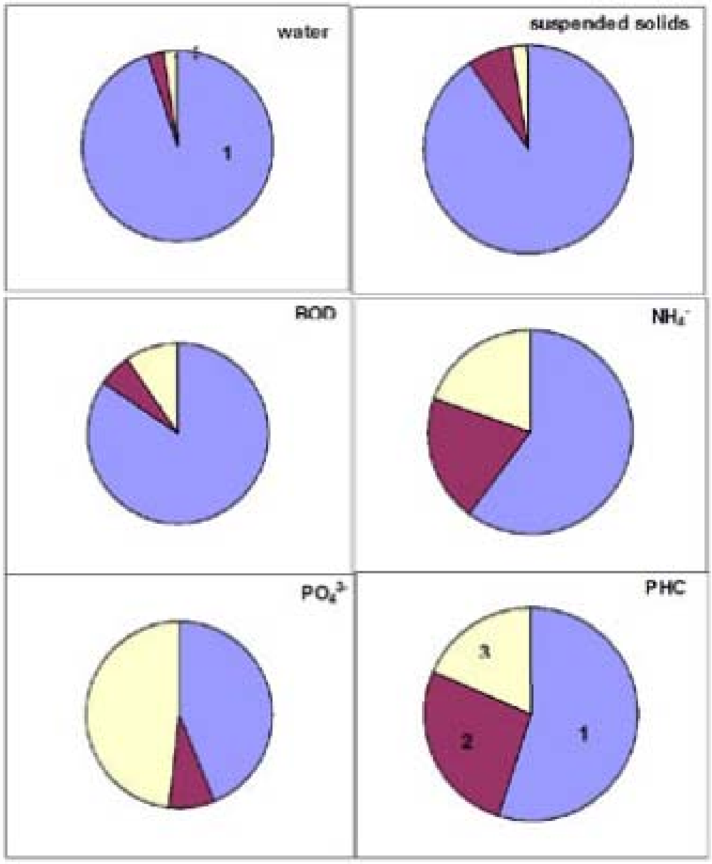


Figure 7.8. The contribution of river runoff (1), storm waters (2) and waste waters (3) for the inputs of water, suspended solids, BOD, ammonia nitrogen, phosphate and petroleum hydrocarbons (PHC) to the Peter the Great Bay area as a whole.

The eutrophication as a phenomenon is characterized by the chlorophyll "a" concentration 8-25 ug/L and TP concentration 35-100 ug/L. At the chlorophyll"a" content >25 ug/L the water status is classified as hypertrophic (Treatise in Geochemistry, 2005). According these criterions only some inner parts of Peter the Great Bay could be identified as eutrophic. This eutrophicated status is observed during the rather restricted periods (1-2 weeks) at the phytoplankton blooms. Most frequently bloom events in Amursky Bay are registered in July and August (Fig. 7.18) (Orlova et al., CEARAC Report, 2005). The duration of blooms is around one week. Only blooms caused by *Noctiluca scintillans* and *Oxyrrhis marina* lasted more than 20 days. The area occupied by red tides varies extremely depending on oceanographic, meteorological, and biological conditions. The red tides area rarely exceeds 1 km2. Only *Noctiluca scintillans* blooms spread areas that exceeded 10-20 km2.

Thus, for the time being the eutrophication itself is not a problem for the Peter the Great Bay as a whole. At the same time there are some signs of excessive inputs of nutrients to the inner parts of Peter the Great Bay. As a result the phytioplankton blooms have been observed in the inner part of Peter the Great Bay, namely in the Amursky Bay. The late summer depletion of DO takes place in the bottom layer of Amursky Bay as a consequence of phytoplankton destruction. This feature can be indicated as a symptom of local eutrophication and was studied in current CEARAC report. Moreover the toxin producing species of phytoplankton are observed within Peter the Great Bay, and the absence of damage is explained by the low level of aquaculture development for the moment.

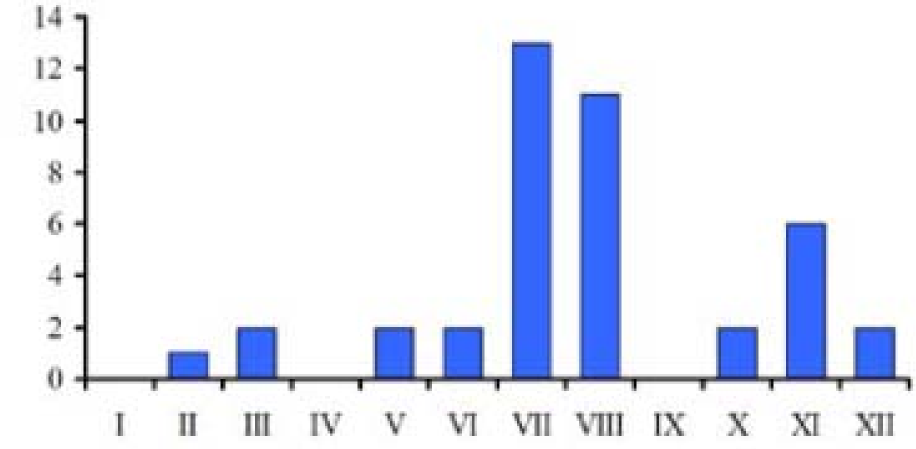


Figure 7.18. The seasonal distribution of "red tides" (phytoplankton bloom) events in Amursky Bay during the 1991-2007 period (Orlova et al., from CEARAC Report, 2005).