Research on the Conservation of Northwest Pacific Marine Environments

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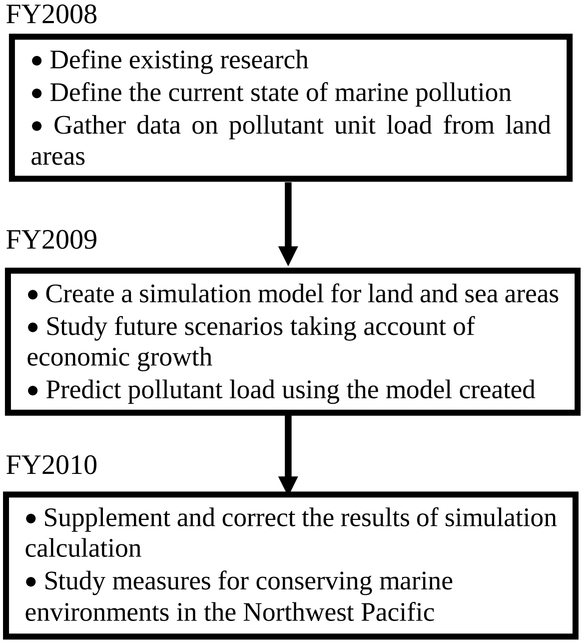
1. Introduction

Recent years have brought remarkable economic growth in the Northwest Pacific region, leading to industrial development and rapid population growth. At the same time, however, factory effluence and domestic wastewater have caused progressive water pollution, and a deterioration in marine environments symbolized by the occurrence of toxic red tide, among others, has become manifest in the Northwest Pacific (encompassing the Bohai Sea, Yellow Sea, East China Sea and the Sea of Japan). To address this problem, various efforts are underway in countries of the Northwest Pacific region to prevent water pollution in rivers and seas. However, while improvements to sewerage are yielding a degree of success in reducing pollution caused by urban effluence, there is still much to be desired, bearing in mind the scale of economy and speed of economic growth in these countries.

Given this situation, the Wastewater System Division of the National Institute for Land and Infrastructure Management (NILIM) of the Ministry of Land, Infrastructure, Transport and Tourism has, for three years since fiscal 2008, studied methods of conserving marine environments by reducing the discharge of pollutants from the mainland, mainly by developing sewer systems in the countries concerned, with a view to conserving marine environments in the Northwest Pacific. Fig. 1 shows the flow of this research over those three years, while Fig. 2 outlines the basin areas subject to study in this research. As shown in Fig. 2, “the Northwest Pacific” refers to the Bohai Sea, Yellow Sea, East China Sea and the Sea of Japan. Reducing pollutant emissions from countries facing these seas (Japan, China, South Korea and Russia) is expected to contribute greatly to conserving marine environments.

As for the flow of this research, the first process was a preparatory stage with the aim of defining the behavior of pollutants at sea and measures by the countries concerned (Japan, China, South Korea and Russia) to curb pollutant emissions from land areas. In addition, existing research was defined and data on land and sea areas in the countries concerned were gathered in fiscal 2008. Next, in fiscal 2009, we created a model of pollutant emissions from land areas in the countries concerned, i.e. Japan, China, South Korea and Russia (“Pollution Load Model”) using various data on topography, pollutant unit load, river flow rates, rainfall and others gathered in fiscal 2008 and 2009. On this basis, we established future scenarios up to the year 2030, taking account of economic growth (pollutant emissions) and the improvement of sewer systems, etc. (pollutant reduction). Moreover, volumes of pollutant discharge, calculated from the Pollution Load Model and future growth scenario thus created, were used as input values in a separately created Ocean Flow Model targeting the Bohai Sea, Yellow Sea, East China Sea and Sea of Japan. From this, we ascertained changes in the volume of pollutants at sea. In fiscal 2010, the final year of the project, we supplemented and corrected the results of simulation calculations conducted up to fiscal 2009, as well as studying measures for conserving marine environments in the Northwest Pacific, taking account of the finally calculated effects of measures to reduce pollutants.

The content of the research over the three years will now be described in the following sequence: 2. Results of data gathering on pollutant emissions from land areas and marine environments in the countries concerned, 3. Method of simulating land-based pollution loads and calculation results, 4. Method of simulating ocean flow and calculation results, 5. Outline of international symposia held over the last three years, 6. Outline of research partnership between the countries concerned, and 7. Summary.


FY2008

- Define existing research
- Define the current state of marine pollution
- Gather data on pollutant unit load from land areas

FY2009

- Create a simulation model for land and sea areas
- Study future scenarios taking account of economic growth
- Predict pollutant load using the model created

FY2010

- Supplement and correct the results of simulation calculation
- Study measures for conserving marine environments in the Northwest Pacific

Fig. 1 Flow of research

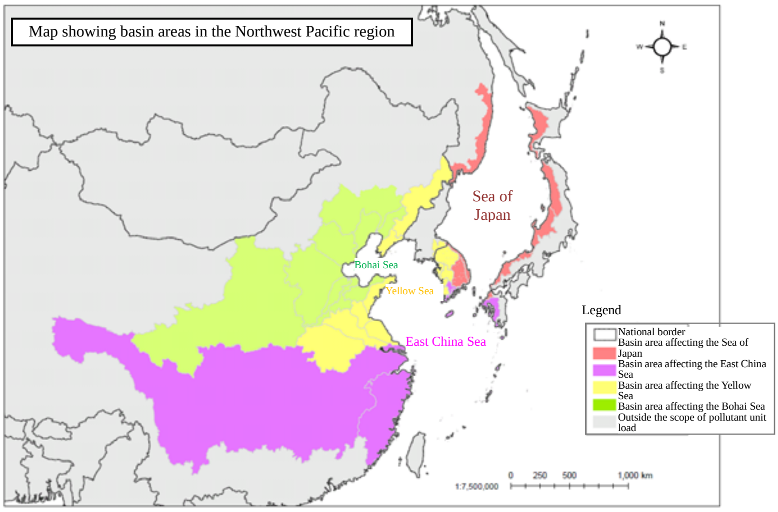


Fig. 2 Area covered by the research

2. Results of information gathering on marine environments and pollutant emissions from land areas in the countries concerned

2.1 Information on pollutant emissions from land areas in the countries concerned

As stated in the previous section, simulating the emission of land-based pollution in neighboring countries, ascertaining the current situation of pollutants discharged into the sea and predicting their future progression are important steps in this research. To create this Pollution Load Model, in fiscal 2008 we first gathered reference literature and other information on the level of establishment or designation of water environment standards, the status of wastewater regulation, the level of sewer system development, water resources, pollutant volumes, pollution analysis and water environment conservation measures in the countries concerned (Japan, China, South Korea and Russia). Although we succeeded in gathering basic reference material on each country, very little reference material and data could be gathered on Russia; even when data could be gathered, not all of the latest data had been made public.

Meanwhile, as data for actual use in the Pollution Load Model, we gathered topographical and land use data, population data, temperature and rainfall data, value of industrial production data, point source, nonpoint source and other pollutant unit loads, and monitoring data on water quality and water volume, etc., in major rivers. Basically, all of these data were gathered from materials published by the various countries. The data on China, for example, were gathered from the Chinese Statistical Yearbook, National Bureau of Statistics of the People's Republic of China1), and automatic monitoring data on water quality in China's principal river basins, Ministry of Environmental Protection 2), among others.

In some cases, however, attempts to gather reference materials and data, etc., yielded no suitable information. When it was not possible to gather survey data on pollutant unit load (e.g. unit load concerning nonpoint sources in forests, farmland, and built-up areas in China), we used average data from Japan, or otherwise substituted data from countries with similar data trends.

2.2 Information on marine environments in the countries concerned

The volume of pollutant discharge calculated using the "Land-based Pollution Load Model" built from data gathered in 2.1 was incorporated into the separately built "Ocean Flow Model" as an input value. Making calculations for the Ocean Flow Model enabled us to reproduce marine pollution and predict its future development. With a view to building an Ocean Flow Model, we mainly surveyed three types of information in fiscal 2008. These were ① survey information on Ocean Flow Models, ② information on surveys of the applicability of impact assessment models from neighboring countries, ③ information on surveys of marine environments in the Northwest Pacific.

2.2.1 Survey information on Ocean Flow Models

On investigating existing research and surveys on Ocean Flow Models, research results were seen in comparatively large quantities in the East China Sea near Japan, but there were few examples of calculation or observation in the Bohai Sea, the Yellow Sea area, or the East China Sea near China. Moreover, it also became clear that hardly any numerical simulations encompassing the whole area of the Bohai Sea, the Yellow Sea, the East China Sea and the Sea of Japan have been published. From this, to build the Ocean Flow Model for the whole of the Northwest Pacific, the most appropriate method was thought to be to divide sea areas at characteristic places like the Tsushima Strait, study a simulation model that matches the characteristics of both the East China Sea and the Sea of Japan, and continuously link the simulation research.

2.2.2 Information on surveys of the applicability of impact assessment models from neighboring countries

In parallel with the Ocean Flow Model, we also surveyed the applicability of impact assessment models of pollutant emissions from neighboring countries (“water pollution models”). As a result of the survey, the “low ecosystem model” was invariably being applied to impacts on sea areas when the load from land areas changed, under the Comprehensive Basin-wide Planning of Sewerage Systems (CBPSS) in Tokyo Bay3) and the 6th Total Pollutant Load Control4). The main reason for application is that, in sea areas with advanced eutrophication, when the load of nutrient salts (nitrogen (N) or phosphorus (P)) from land areas changes, it is known that, even when the COD load itself does not change, an impact on COD concentrations in sea areas is caused by changes in the production of phytoplankton. Taking these situations into account, it was considered desirable to opt for a “low ecosystem model” in this research, just as in CBPSS in Tokyo Bay3). With this, we could assess the environmental impact on Japan accompanying changes in load on sea areas due to economic activity in countries of the Northwest Pacific region as well as changes in the development level of sewer systems and other social infrastructure.

2.2.3 Information on surveys of marine environments in the Northwest Pacific

In parallel with the survey in the previous subsection, we also gathered information concerning existing studies on marine environments in the Northwest Pacific. In this survey, we gathered and organized data on water quality in countries along the coasts of the Northwest Pacific (Chinese Environmental Yearbook5), South Korea Statistical Yearbook6), survey reports on water quality in public water areas7), etc.), remote sensing data, and data on marine litter. From the data obtained, we were able to confirm, with respect to water quality data, the severity of pollution in Chinese coastal regions, as well as increased nitrogen concentrations in South Korean coastal regions. In Russian coastal regions, it became clear that, although the monitoring results of heavy metals are published, published figures for monitoring results on eutrophication substances are almost non-existent. In Japanese coastal regions, meanwhile, an increase in COD concentrations in the Tsushima sea area was recognized, and it was suggested from the gathered data that concentrations originating in the East China Sea could be rising.

On remote sensing data, as a result of gathering information, it was thought desirable to use the MODIS data provided by the Japan Aerospace Exploration Agency (JAXA)8). The reasons for this were that wide-region remote sensing data could be obtained, even in districts where other data were difficult to obtain, and the data obtainable through MODIS, notably those on water temperature and chlorophyll-a, would be very useful when calculating an Ocean Flow Model, as in this research. (Fig. 3, Fig. 4 (different MODIS data))

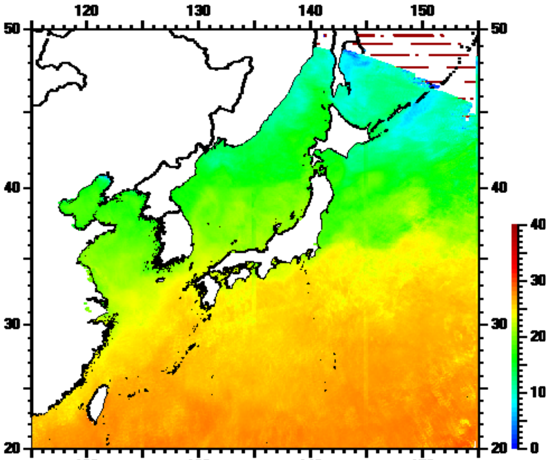


Fig. 3 Water temperature Oct. 2002 (℃)

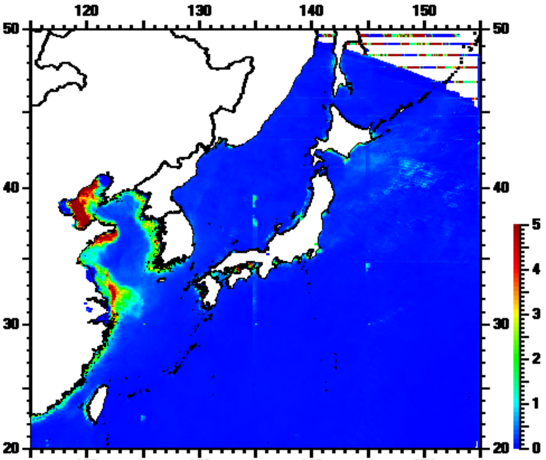


Fig. 4 Chlorophyll-a Oct. 2002 (μ g / l)

We also comprehensively gathered and organized information on the migration routes of giant jellyfish, the situation of marine litter, and sources of marine litter through reference to various data. In recent years, marine litter and other debris has been washed up on Japanese territory with increasing frequency, but we have also found, through simulation, that predictive calculations of the transit routes of jetsam are also possible.

3. Method of simulating land-based pollution and calculation results

3.1 Method of simulating land-based pollution

3.1.1 Basic rationale on constructing the Land-based Pollution Load Model

Using the information gathered in fiscal 2008, while supplementing missing information and making amendments, we constructed a Land-based Pollution Load Model for Japan, China, South Korea and Russia to ascertain the volume of pollutants released into the Northwest Pacific.

When constructing the Land-based Pollution Load Model, we focused on COD, nitrogen (N) and phosphorus (P) as target pollutants, taking account of the need to gather complete data for all countries. The method used to calculate pollutant load, with reference to the rationale of the Comprehensive Basin-wide Planning of Sewerage Systems9) in Japan, followed the “unit load method”, as shown in Fig. 5. As for the procedure for calculating the Pollution Load Model, as well as gathering the various data explained in the next subsection, we started by dividing into drainage system blocks, as shown in Fig. 6. After setting frame values (such as population), the load arising and the unit load for each block, we calculated the total generated load. After this, we made corrections for the rate of reduction due to measures and the volume of nonpoint sources. In China, we performed corrections taking account of the rate of loss due to the withdrawal of water for commercial farming, the delivered ratio of rainfall into rivers, etc., and in Russia, corrected the water quality of factory effluence, finally arriving at a calculation of the total delivered load to sea areas.

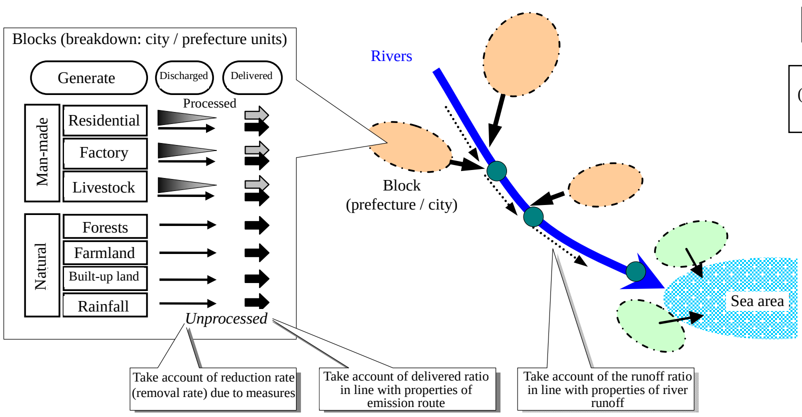


Fig. 5 Image of calculation of the Land-based Pollution Load Model

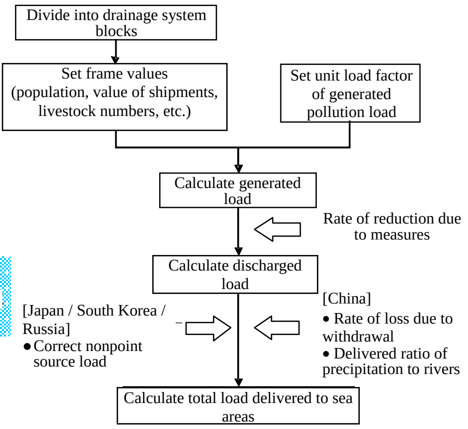


Fig. 6 Calculation flow of the Land-based Pollution Load Model

3.1.2 Various data used in the Land-based Pollution Load Model

To build the Land-based Pollution Load Model, since fiscal 2008 we have gathered data and reference materials on the level of establishment or designation of water environment standards, the status of wastewater regulation, the level of sewer system development, water resources, pollutant volumes and water environment conservation measures in the countries concerned (Japan, China, South Korea and Russia). Meanwhile, for topography, land use, population, industry, pollutant unit load, water quality in major rivers, flow volumes and other data necessary to build the Pollution Load Model, we have gathered data from published materials[5)6)7)], etc. When data on pollutant unit load could not be gathered from published materials, etc. (e.g. unit load data on overseas forests, farmland and built-up areas), we used Japan's Guidelines and Explanation of the Comprehensive Basin-wide Planning of Sewerage Systems [9)], among others, to substitute with data from countries assumed to have similar situations in terms of unit load.

3.1.3 On the segmentation of drainage system blocks

The segmentation of drainage system blocks was based on the basins of major rivers, with 7 sub-blocks for the Chang Jiang River and Yellow River basins in China. For regions close to coasts, meanwhile, we set drainage system blocks as direct discharge blocks, in which pollutants are directly discharged into sea areas (Fig. 7). We also set drainage system blocks for Japan, South Korea and Russia, with 10 blocks, 5 blocks and 4 blocks, respectively, for each of the sea areas of the Sea of Japan, the Yellow Sea and the East China Sea (Fig. 8).

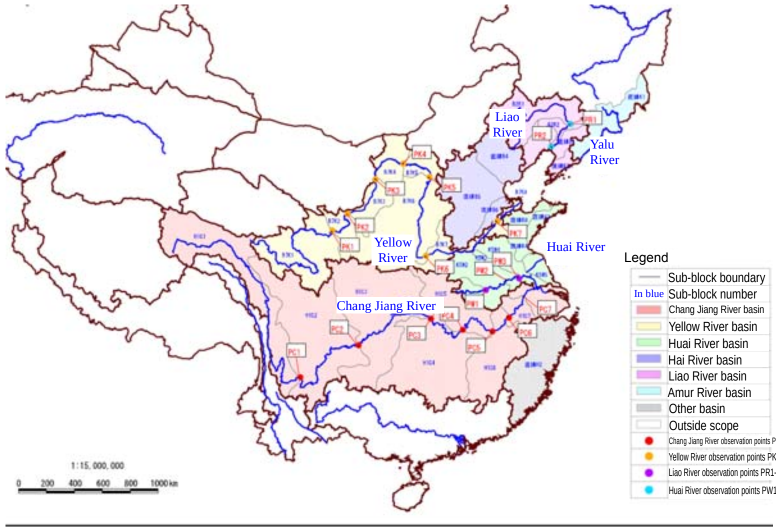


Fig. 7 Segmentation of basin blocks in China

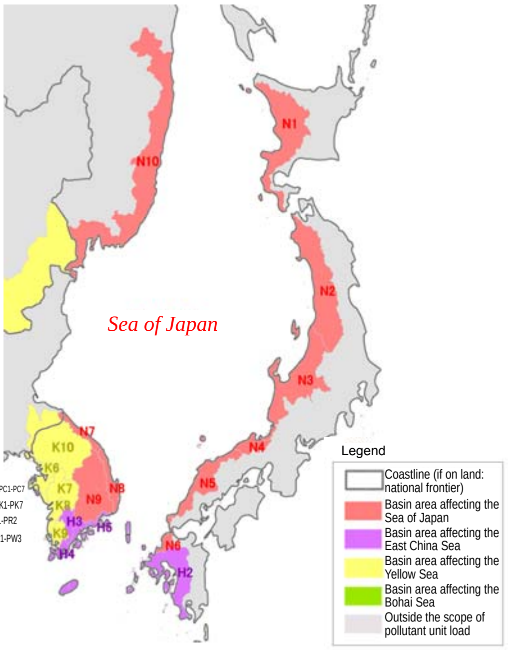


Fig. 8 Segmentation of basin blocks in Japan, South Korea and Russia

3.1.4 Unit loads used in the Land-based Pollution Load Model

As the unit loads used in the Land-based Pollution Load Model, for China we mainly used the values in the "Water Environment Restoration Pilot Project in Taihu Lake, People's Republic of China (JICA)" [10)], for Japan those of the "Guidelines and Explanation of the Comprehensive Basin-wide Planning of Sewerage Systems" [9)], and for South Korea those of the "Total Drainage System Pollution Management Technology Guidelines" [11)]. For Russia, since not enough data on unit loads could be obtained, we substituted figures from other countries (such as using the settings for China, which has the most similar per capita GDP values of the other three countries). The pollutant unit loads used in the constructed Pollution Load Model are tabulated below. (Table 1, Table 2, Table 3, Table 4)

Item	China, Russia					
Removal rate	Removal rate by standard			COD	T-N	T-P
	Sewers			80.0%	30.0%	60.0%
	Combined septic tanks			80.0%	42.0%	38.0%
	China’s removal rates were the same as those of Japan					
	Removal rate by advanced treatment			COD	T-N	T-P
	Sewers			90.0%	75.0%	85.0%
	Combined septic tanks			85.0%	67.0%	38.0%
	China’s removal rates were the same as those of Japan					
Pollutant unit load (generated load x (1 – removal rate))	Standard method			COD	T-N	T-P
	Urban areas	Released into sewers	Domestic wastewater A	5.6	7	0.4
	Urban areas	Directly discharged	Domestic wastewater B	16.5	25	0.5
	Rural areas	Combined septic tanks	Domestic wastewater C	4.0	5	0.5
	Rural areas	Directly discharged	Domestic wastewater D	12.5	2	0.4
	*If using the advanced treatment removal rate					
	Advanced treatment			COD	T-N	T-P
	Urban areas	Released into sewers	Domestic wastewater A	2.8	3	0.2
	Urban areas	Directly discharged	Domestic wastewater B	16.5	25	0.5
	Rural areas	Combined septic tanks	Domestic wastewater C	3.0	3	0.5
	Rural areas	Directly discharged	Domestic wastewater D	12.5	2	0.4

Item	Japan					
Removal rate	Removal rate by standard method			COD	T-N	T-P
	Sewers		④	80.0%	30.0%	60.0%
	Farm collection, etc.		⑤	81.5%	44.5%	51.5%
	Combined septic tanks		⑥	80.0%	42.0%	38.0%
	Separate	Human waste	⑦	53.5%	34.4%	30.0%
		Wastewater	⑧	0.0%	0.0%	0.0%
	Removal rate by advanced treatment			COD	T-N	T-P
	Sewers		④’	90.0%	75.0%	85.0%
	Farm collection, etc.		⑤’	90.0%	75.0%	85.0%
	Combined septic tanks		⑥’	85.0%	67.0%	38.0%
	Source for sewers: Design Guidelines (Part II) These state general removal rates for domestic wastewater using the standard activated sludge method, the middle values being adopted for this survey. For the T-N and T-P removal rates, we adopted the secondary processing averages for sewage indicated in “Advanced Processing Technology (1992)”. *Figures for treatment plants operating within the scope of the Design Guidelines Source for farm collection, combined septic tanks, etc.: CBPSS The removal rates for farm collection were based on the results of pollution volume and unit load surveys. The removal rates set for combined septic tanks adopted the values in the Plan for Conservation of Lake Water Quality (average values in 11 locations). The removal rates for separate septic tanks were based on the pollutant unit load set on the basis of survey materials, etc.					
Pollutant unit load (generated load x (1 – removal rate))	Standard method (scenarios 1, 2, 3)			COD	T-N	T-P
	Sewers		③×(1−④)	5.4	7.7	0.5
	Farm collection, etc.		③×(1−⑤)	5.0	6.1	0.6
	Combined septic tanks		③×(1−⑥)	5.4	6.4	0.8
	Separate	Human waste	①×(1-⑦)+②×(1-⑧)	21.7	7.9	1.0
	*If using the advanced treatment removal rate					
	Advanced treatment (scenarios 2', 3')			COD	T-N	T-P
	Sewers		③×(1−④’)	2.7	0.3	0.6
	Farm collection, etc.		③×(1−⑤’)	2.7	0.4	0.5
	Combined septic tanks		③×(1−⑥’)	4.1	0.4	0.4
	Vault toilets, etc.		①×(1-⑦)+②×(1-⑧)	21.7	7.9	1.0

Item	South Korea					
Removal rate	Removal rate by standard method			COD	T-N	T-P
	Sewers			80.0%	30.0%	60.0%
	Combined septic tanks			80.0%	42.0%	38.0%
	Separate	Human waste		53.5%	34.4%	30.0%
		Wastewater		0.0%	0.0%	0.0%
	Removal rate by advanced treatment			COD	T-N	T-P
	Sewers			90.0%	75.0%	85.0%
	Combined septic tanks			85.0%	67.0%	38.0%
	Although the South Korean standards for sewer facilities (Korea Water and Wastewater Works Association, 2005, Ministry of the Environment) do not specify removal rates, they were assumed to be same as those in Japan, since the standard activated sludge method is commonly used as a method of treatment in South Korea. For the population outside the sewerage area, the removal rates for “separate septic tanks” were adopted. The diffusion rate inside sewerage areas in South Korea includes combined septic tanks, etc., and cannot be divided. Therefore, the sewerage removal rate is applied.					
Pollutant unit load (generated load x (1 – removal rate))	Standard method (scenarios 1, 2, 3)			COD	T-N	T-P
	Urban areas	Released into sewers	Domestic wastewater A	5.4	7.4	0.5
	Urban areas	Untreated (separate)	Domestic wastewater B	21.7	7.7	0.9
	Rural areas	Combined septic tanks	Domestic wastewater C	5.4	7.5	0.9
	Rural areas	Untreated (separate)	Domestic wastewater D	21.7	9.4	1.1
	*If using the advanced treatment removal rate					
	Advanced treatment (scenarios 2', 3')			COD	T-N	T-P
	Urban areas	Released into sewers	Domestic wastewater A	2.7	2.7	0.2
	Urban areas	Untreated (separate)	Domestic wastewater B	21.7	7.7	0.9
	Rural areas	Combined septic tanks	Domestic wastewater C	4.1	4.3	0.9
	Rural areas	Untreated (separate)	Domestic wastewater D	21.7	9.4	1.1

Table 1 Setting of pollutant removal rates and generated pollutant unit loads in domestic wastewater in the countries concerned

Item	China, Russia				
Calculation method	To be calculated as [Factory-related pollution load = Frame value (Gross industrial output value) x Effluence unit load x Water quality of factory effluence]				
	Effluence meeting water quality standards: Factory effluence A Gross industrial output value x Factory effluence unit load x Factory effluence standards x Water quality standards achievement rate Effluence meeting water quality standards: Factory effluence B Gross industrial output value x Factory effluence unit load x Water quality of factory effluence x (1-Water quality standards achievement rate)				
Industrial effluence unit load (mg / L) or (g / day / million yen)	Water quality of factory effluence(mg/ L)		COD	T-N	T-P
	Effluence meeting water quality standards	Factory effluence A	66.7	25	0.3
	Effluence not meeting water quality standards	Factory effluence B	200.0	26	3.0
	Effluence meeting water quality standards: Factory effluence standards Set on the basis of the Grade 2 standard concentration in Chinese Environmental Standards (CODCr). The conversion to CODMn was assumed to be CODCr ÷ 3, based on JICA materials. Effluence not meeting water quality standards: Water quality of factory effluence Assumed to be 200mg / l based on JICA materials (Taihu Lake Project).				

Item	Japan				
Calculation method	To be calculated as [Industrial shipments value x Pollution unit load].				
	Outside the service start area Industrial shipments value x Factory effluence pollution unit load A Inside the service start area Industrial shipments value x Factory effluence pollution unit load B x (1-sewer removal rate)				
Industrial effluence unit load (mg / L) or (g / day / million yen)	Pollution unit load per shipment value (g / day / million yen)		COD	T-N	T-P
	Outside the service start area	Factory effluence A	20～120	10～50	2～8
	Inside the service start area	Factory effluence B	280～510	20～90	2～13
	For Japan, pollution unit load inside and outside the sewer service start area is set per prefecture Outside the service start area Set based on more stringent prefectural standards on effluence Inside the service start area Set based on sewer abatement standards The water quality shown above is assumed from the volume of effluence and the pollutant load.				

Item	South Korea			
Calculation method	To be calculated as [Factory-related pollution load = Frame value (Gross industrial output value) x Effluence unit load x Water quality of factory effluence]			
Industrial effluence unit load (mg / L) or (g / day / million yen)	Water quality of factory effluence (mg / L)	COD	T-N	T-P
	Unpolluted river regions (less than 2000m³ / day)	50	30.0	4.0
	A regions (less than 2000m³ / day)	90	60.0	8.0
	B regions (less than 2000m³ / day)	130	60.0	8.0
	Regions subject to special orders (less than 2000m³ / day)	40	60.0	8.0
	Effluence regulation values in South Korea are determined in accordance with regional divisions (unpolluted river regions, A regions, B regions, Regions subject to special orders), and these regional divisions reflect units of administrative areas. In this survey, we surveyed and set representative regional divisions for each administrative area.			

Table 2 Methods of calculating factory effluence load and the water quality of factory effluence

Item	China, Russia				Japan				South Korea			
Calculation method	To be calculated as [Livestock-related pollution load = Frame value (livestock numbers) x Pollution unit load x Discharge rate]											
Frame value	For China, we surveyed the following frame values (livestock). Large pasturing livestock (cattle, horses), pigs, sheep				For Japan, we surveyed the following frame values (livestock). Cattle, pigs				For South Korea, we surveyed the following frame values (livestock). Dairy cattle, beef cattle, horses, pigs, deer, poultry			
Pollution unit load (g / head / day)		COD	T-N	T-P		COD	T-N	T-P		COD	T-N	T-P
	Livestock A (large pasturing livestock)	65.06	108.77	0.30	Cattle	530	290	50	Dairy Cattle	530.0	161.8	56.7
	Livestock B (pigs)	8.38	14.06	3.00	Pigs	130	40	25	Beef Cattle	530.0	116.8	36.1
	Livestock C (sheep)	3.28	6.25	25.00	Source: Survey Guidelines and Explanation of the CBPSS In the “Comprehensive Plan”, these are set on the basis of materials from the Livestock Bureau, MAFF, among others.				Horses	530.0	77.6	24.0
	Source: Water Environment Restoration Pilot Project in Taihu Lake, PRC (JICA) In the Water Environment Restoration Pilot Project in Taihu Lake, PRC (JICA), unit load was set on the basis of Chinese data.								Pigs	130.0	27.7	12.2
									Deer	10.0	5.8	0.9
									Poultry	3.0	1.1	0.4
									Source: Total Drainage System Pollution Control Guidelines (National Office of Environmental Research) For COD, Japan’s unit load was adopted			
Discharge rate		COD	T-N	T-P		COD	T-N	T-P		COD	T-N	T-P
	Livestock A (large pasturing livestock)	2.9%	4.2%	1.3%	Cattle	2.9%	4.2%	1.3%	Dairy Cattle	2.9%	4.2%	1.3%
	Livestock B (pigs)	3.8%	6.0%	3.7%	Pigs	3.8%	6.0%	3.7%	Beef Cattle	2.9%	4.2%	1.3%
	Livestock C (sheep)	3.8%	6.0%	3.7%	Source: CBPSS For the discharge rate, the Plan for Conservation of Lake Water Quality (cattle: average value for 13 locations, pigs: average value for 12 locations) was adopted				Horses	1.0%	1.9%	2.9%
	China’s discharge rate was taken to be the same as Japan’s (using pigs for sheep)								Pigs	3.8%	6.0%	3.7%
									Deer	1.0%	1.9%	2.9%
									Poultry	10.0%	10.0%	1.3%
									Source: CBPSS Japan’s discharge rate adopted (using horses for deer)			

Table 3 Livestock effluence unit load and discharge rates

Item	China, Russia				Japan				South Korea			
Calculation method	To be calculated as [Nonpoint pollution load = Frame value (land use area) x Generated pollution unit load]											
Frame value	For China, we surveyed the following frame values (land use area). Forests, paddy fields, dry fields, built-up areas				For Japan, we surveyed the following frame values (land use area). Forests, paddy fields, dry fields, built-up areas				For South Korea, we surveyed the following frame values (land use area). Forests, paddy fields, dry fields, built-up areas			
Discharged pollution unit load (kg / ha / year)		COD	T-N	T-P		COD	T-N	T-P		COD	T-N	T-P
	Forests	20.7	4.2	0.17	Forests	20.7	4.2	0.17	Forests	41.4	8.0	0.50
	Paddy Fields	42.9	11.0	1.30	Paddy Fields	42.9	11.0	1.30	Paddy Fields	128.7	34.5	0.90
	Dry Fields	19.1	32.2	0.36	Dry Fields	19.1	32.2	0.36	Dry Fields	19.1	23.9	2.20
	Built-Up Areas	51.1	12.1	0.81	Built-Up Areas	51.1	12.1	0.81	Built-Up Areas	204.4	50.0	7.70
	China’s unit load was taken to be the same as Japan’s.				Source: CBPSS Adopted the Plan for Conservation of Lake Water Quality (average of 11 locations)				Source: Total Drainage System Pollution Control Guidelines (National Office of Environmental Research) For COD, see the next section			

Table 4 Nonpoint source pollutant unit load

3.1.5 Method of calculating load using Land-based Pollution Load Model calculations, and method of calculating corrections

With the constructed Pollution Load Model, we calculated discharged load by multiplying the frame values (population, etc.) of the various discharge sources by the unit load factor of each discharge source, in accordance with the unit load factor calculation method. We then calculated the total discharged load by adding together the discharged loads from each discharge source (e.g. point source, factory-related, etc.). For example, when calculating man-made load, the process was

[Point source load] = [Population (divided into urban and rural areas)] x [Unit load factor].

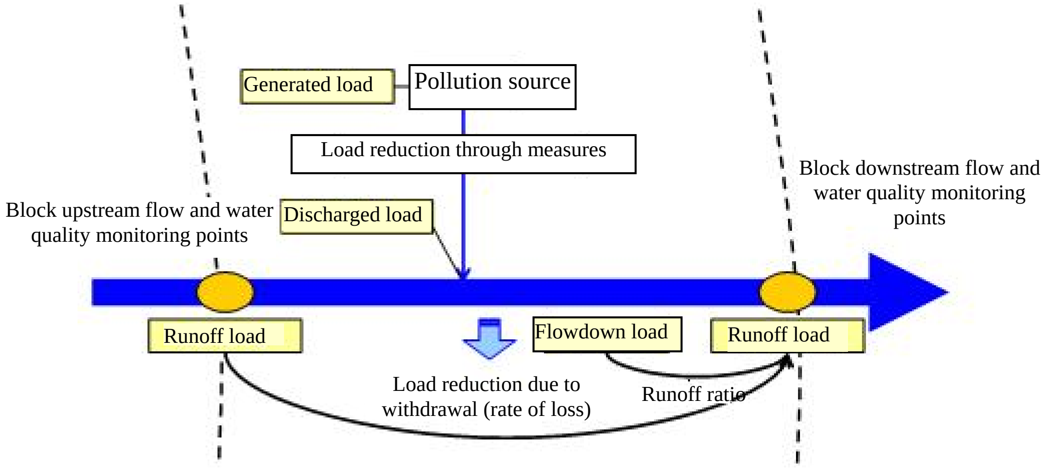
For nonpoint sources, for example in the case of forests, the calculation took the form

[Nonpoint source volume (forests)] = [Land use area (forests)] x [Unit load factor].

As the rationale on annual delivered load from land to sea areas, meanwhile, in Japan, South Korea and Russia, we calculated the annual delivered load to sea areas as if the entire load discharged to land areas runs off to sea areas throughout the year, following the rationale of examples that deal with Japan’s enclosed sea areas. In other words, annual delivered ratio = 1.0. In China, on the other hand, basin areas are vast, and meteorological conditions, water use situations and other factors differ from those in other countries. Therefore, we did not apply the hypothetical annual delivered ratio = 1.0 set for Japan, South Korea and Russia, but took account of the rate of loss of pollution load through river withdrawal for agricultural and other uses, and the runoff ratio of rainfall to rivers, when calculating delivered load to sea areas (Fig. 9, Fig. 10).

The estimated annual delivered load was used for analysis of the Ocean Flow Model (discussed later). When doing so, however, the annual delivered load needed to be redistributed for each season. In this research, we calculated seasonal delivered load by multiplying annual delivered load by the ratio of seasonal rainfall to annual rainfall in the target area (Fig. 10, Fig. 11).

As other corrective calculations, in Japan, South Korea and Russia, we made corrective calculations for nonpoint source pollutant volume according to annual rainfall in each basin. When making corrective calculations, we used the following correlation equation between the runoff ratio from nonpoint sources (forests, paddy fields, dry fields, built-up areas) and annual rainfall volume, created in this research (Fig. 12).



- Generated load: Load generated from pollution sources (man-made, nonpoint)
- Discharged load: Of the generated load, load actually discharged
- Flowdown load: Load taking account of loss rate   Discharged load x (1 – loss rate)
- Runoff load: Load reaching water quality datum points (= observed load)
- Runoff ratio: (Upstream block runoff load + Target block flowdown load) ÷ Block downstream observed value

Fig. 9 Rationale on load calculations

[Rationale on annual delivered load]

○ Japan, South Korea and Russia:

Annual delivered load = Annual discharged load x Delivered ratio (1.0)

○ China:

Annual delivered load = Annual discharged load x {1 – (Load loss rate due to withdrawal upstream of observation point (e.g. use of surface water for agriculture)) x Precipitation runoff to rivers

[Rationale on seasonal delivered load]

Seasonal delivered load = Annual delivered load x Seasonal rainfall / Annual rainfall

Fig. 10 Rationale on annual delivered ratio and seasonal delivered load

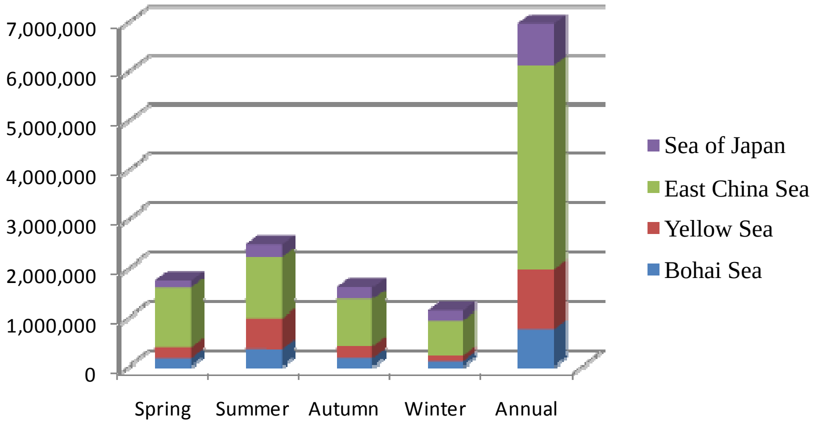


Fig. 11 Rationale on seasonal delivered load

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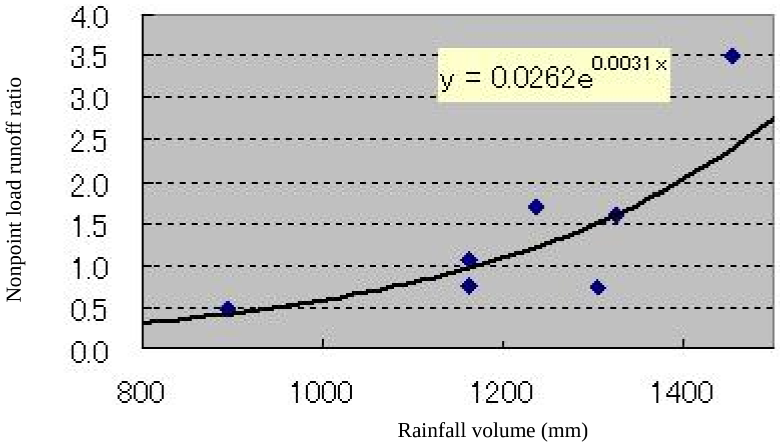


{$y = 0.0262e^{0.0031x}$ (x = basin annual rainfall volume (mm), y = nonpoint load runoff ratio)}
(correlation coefficient $R^2 = 0.681$)

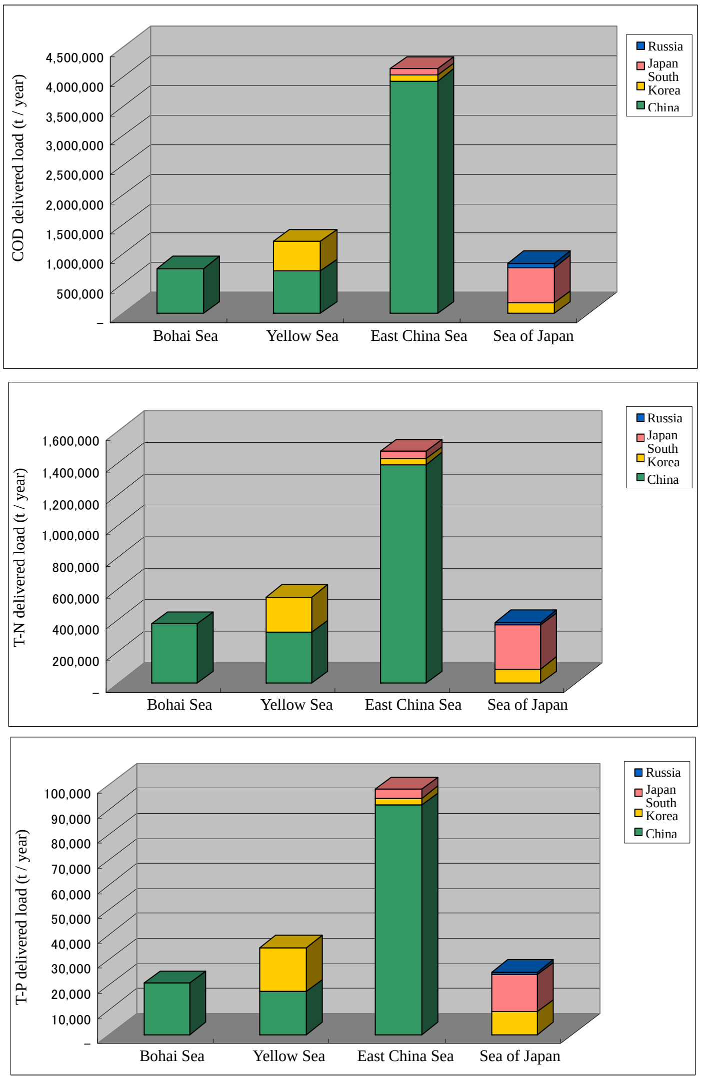
Fig. 12 Relationship between nonpoint source load runoff ratio and rainfall volume

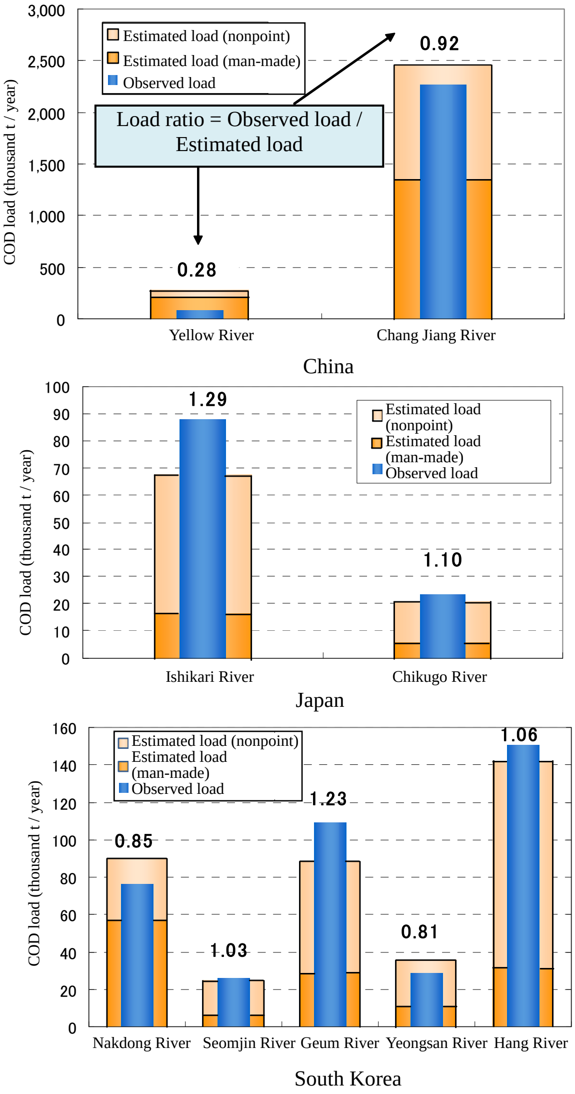
3.2 Result of calculation of pollutant volume using the Land-based Pollution Load Model

Using the calculation method and corrective calculations outlined above, we calculated land-based pollution loads in Japan, China, South Korea and Russia in the base year (2005) and tabulated the delivered load for each sea area, as shown in Fig. 13.

Meanwhile, in China, South Korea and Japan, where observation point data on the flow rate and water quality (COD concentrations) of major rivers are published throughout the year, we compared the observed load at most-downstream observation points (flow rate x water quality (COD)) with the delivered pollutant volume at the same most-downstream points, as calculated with the Pollution Load Model. Fig. 14 shows the results of the comparison.

The estimated load ratio, defined as [Load ratio] = [Observed value] / [Estimated value], ranged from around 0.8 (0.81) to 1.3 (1.29) for the Chang Jiang River and all rivers in Japan and South Korea. The exception was the Yellow River, with a load ratio of 0.28. The ratio between observed and estimated values for the Yellow River showed a nearly four-fold discrepancy, even after corrective calculations. Although the Chinese calculation results took account of loss rates due to withdrawals from rivers and corrective calculations of nonpoint sources, the specificity of basin characteristics are thought to have been the main cause of this.





(left) Fig. 13 Volumes of pollutant discharge by sea area in the base year (2005)
(right) Fig. 14 Ratio between observed and estimated load by river (COD)

3.3 Setting future scenarios taking account of economic growth, etc., and pollutant emission volumes in the future scenarios

3.3.1 Setting future scenarios taking account of economic growth, etc.

To ascertain the future volume of pollutant discharge in each country, we established future scenarios taking account of economic growth (increase in pollutant emissions) and development of sewer systems, etc. (reduction of pollutants), as shown in Table 5.

Taking 2005 as the base year, we set the target year of the future scenarios at 2030. Meanwhile, we adopted the figures given in World Statistics (Statistics Bureau, Ministry of Internal Affairs and Communications)12) and GDP figures forecast by the Japan Center for Economic Research 13) as future values of the various frame values (such as population and gross industrial output). As for China's population and the GDP of China and South Korea, we assumed significant increases until 2030.

We also assumed that values for livestock numbers, land use area and other nonpoint sources in future would be the same as in the base year (2005).

Future scenarios	Scenario content	Urban areas		Rural areas	
		Standard method	Advanced treatment	Standard method	Advanced treatment
Scenario 1	**Current status maintained**	-	-	-	-
Scenario 2	**If measures for sewers, etc. (standard method) are deployed in urban areas** (Coverage by the standard method to be expanded to 100% by FY2030) (Regulations on factory effluence achieved at the same time)	○	-	-	-
Scenario 2'	**If measures for sewers, etc. (advanced treatment) are deployed in urban areas**	-	○	-	-
Scenario 3	**If measures for sewers, etc., are deployed in urban and rural areas** **(**Wastewater treatment coverage in urban and rural areas to be expanded to 100% by FY2030**)**	○	-	○	-
Scenario 3'	**If measures for sewers, etc. (advanced treatment) are deployed in urban and rural areas**	-	○	-	○

Table 5 Future scenarios taking account of economic growth, etc.

Table 6 expresses the diffusion rates of sewer systems and others in each future scenario in Japan, China, South Korea and Russia as of 2030. “Advanced treatment” in Table 6 indicates the diffusion of sewer systems and others capable of advanced treatment. Advanced treatment in rural areas assumes the development of advanced treatment for farm village effluence in Japan, and the development of combined septic tanks capable of advanced treatment in other countries.

In connection with measures for factory effluence, meanwhile, we assumed a high satisfaction rate of factory effluence regulations in all countries, with most factories lying within sewer system areas. We therefore thought it possible to reduce load along with improvements to the sewer system diffusion ratio, and as such, decided not to set a scenario accompanying progress in measures. We also decided not to take account of the reduction of nonpoint sources and measures to reduce pollutants in sea areas.

		Scenario 1	Scenario 2	Scenario 2'	Scenario 3	Scenario 3'
China	Urban areas	63%	100%	(Advanced treatment) 100%	100%	(Advanced treatment) 100%
	Rural areas	0%	0%	0%	100%	(Advanced treatment) 100%
Japan	Urban areas	81%	100%	(Advanced treatment) 100%	100%	(Advanced treatment) 100%
	Rural areas	61%	61%	61%	100%	(Advanced treatment) 100%
South Korea	Urban areas	95%	100%	(Advanced treatment) 100%	100%	(Advanced treatment) 100%
	Rural areas	0%	0%	0%	100%	(Advanced treatment) 100%
Russia	Urban areas	15%	100%	(Advanced treatment) 100%	100%	(Advanced treatment) 100%
	Rural areas	15%	15%	15%	100%	(Advanced treatment) 100%

Table 6 Diffusion ratios of sewer systems, etc., in each country and future scenario

3.3.2 Pollutant emission volumes taking account of future scenarios

The volume of pollutant discharge (COD, T-N, T-P) in each country at present and in future scenarios, as calculated using the Pollution Load Model, is as shown in Fig. 15 through Fig. 18. The calculation results in each scenario are those of 2030.

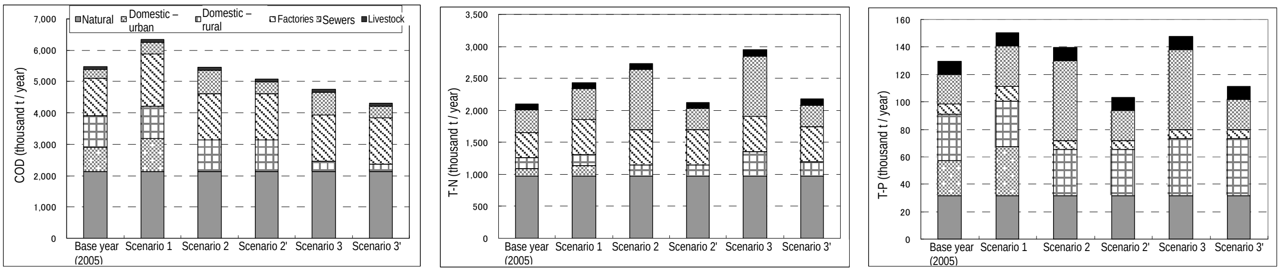


Fig. 15 Pollutant volume (COD, T-N, T-P) in China at present and in each scenario (bar graph: from below, nonpoint sources – livestock)

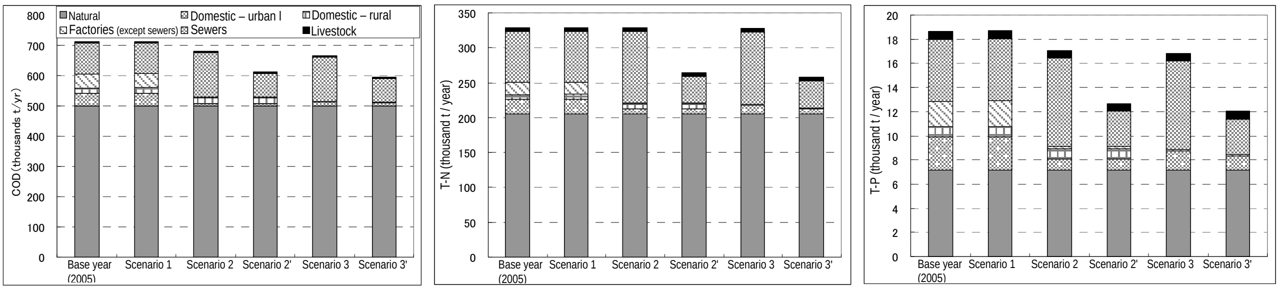


Fig. 16 Pollutant volume (COD, T-N, T-P) in Japan at present and in each scenario (bar graph: from below, nonpoint sources – livestock)

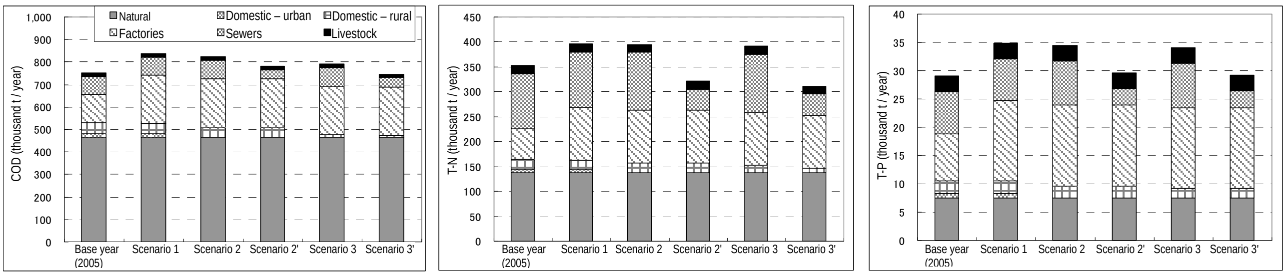


Fig. 17 Pollutant volume (COD, T-N, T-P) in South Korea at present and in each scenario (bar graph: from below, nonpoint sources – livestock)

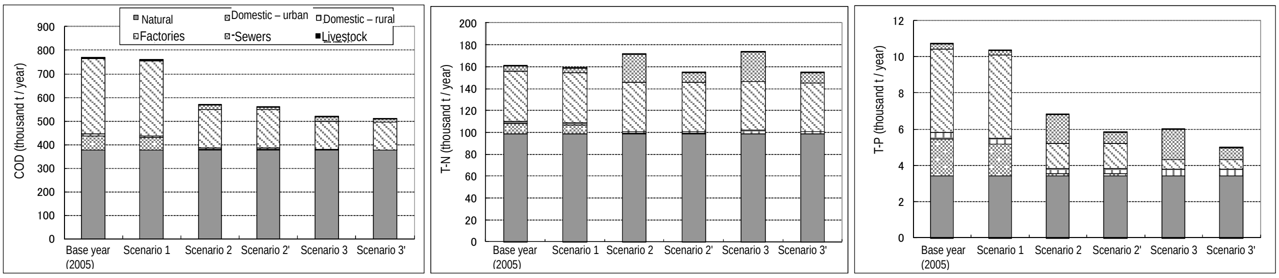


Fig. 18 Pollutant volume (COD, T-N, T-P) in Russia at present and in each scenario (bar graph: from below, nonpoint sources – livestock)

In each country, the introduction of advanced treatment will make it possible to inhibit increases in T-N and T-P. In China and South Korea, in particular, it will be possible to inhibit increases in T-N, T-P compared to the present situation, in spite of population increase and economic growth.

Viewing China in isolation, in scenario 3 and 3', it has been suggested that COD discharge can be reduced to below the present level, and that an increase in the sewerage diffusion ratio will be effective in reducing COD. As for T-N and T-P, the result was that the discharge volume in scenario 3 would be greater than those of scenario 1 and 2. The main cause of this is that, while the discharge pollutant volume will increase because not all human waste will be collected due to the diffusion of flush toilets in rural areas (based on the unit load factor used this time), the removal rate of T-N and T-P in septic tanks will be only 42% and 38%, respectively.

Meanwhile, from the results of Pollution Load Models calculated for individual future scenarios, it was suggested that an effective measure for reducing load in Japan and South Korea would be to promote advanced sewage treatment as well as nonpoint source pollutant measures, etc., while in Russia it would be to promote the development of wastewater treatment facilities in urban areas, respectively.

4. Method of constructing the Ocean Flow Model and calculation results

4.1 Creation of the "water quality model" and "hydrodynamic model"

As mentioned above, we also constructed a separate Ocean Flow Model to reproduce and predict future changes in marine pollution on the Northwest Pacific, using the calculated volume of land-based pollution loads. In this research, we have built two different types of Ocean Flow Model, namely a water quality model and a hydrodynamic model. Based on information gathered in fiscal 2008, we decided to adopt a "low ecosystem model" for the water quality model, in that it can appropriately express changes in load delivered to sea areas due to economic activity and sewer systems or other social infrastructure in the respective countries. Increased reproduction of phytoplankton due to photosynthesis is also included in the model.

Fig. 19 shows a conceptual diagram of the low ecosystem model.

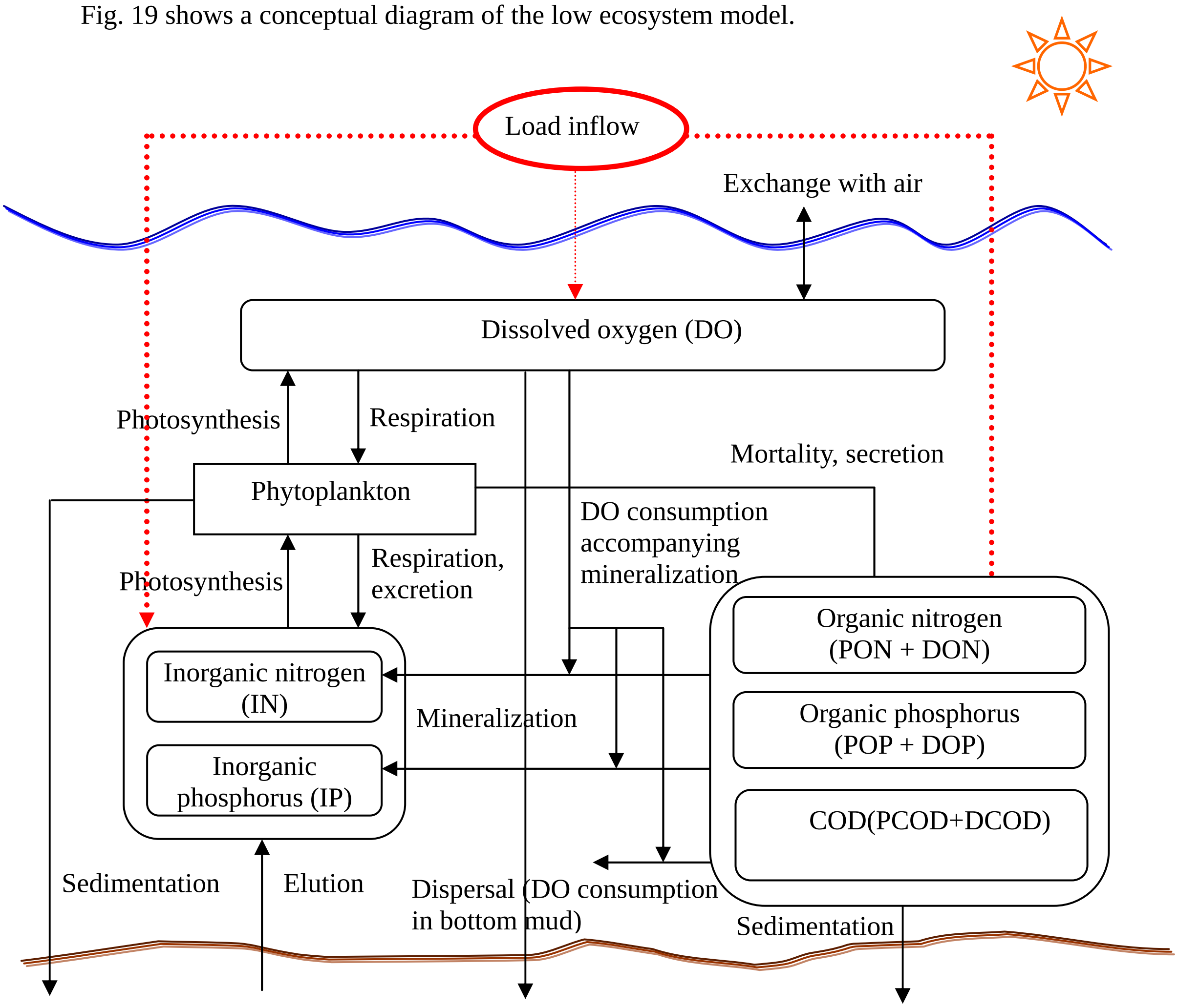


Fig. 19 Concept diagram of the water quality model (low ecosystem model)

For the hydrodynamic model, we decided to select a model that could take into account the following four elements, bearing in mind the characteristics and flow mechanisms of the sea areas targeted by this research (Bohai Sea, Yellow Sea, East China Sea, Sea of Japan).

① Tidal current (induced by raising and lowering of water level by tides)

② Density current (induced by density difference between freshwater (low) and seawater (high))

③ Wind-driven current (induced by ocean surface winds)

④ Ocean current (large-scale circulation of seawater, such as the Kuroshio or the Oyashio)

In bay areas such as Japan's representative Tokyo Bay, Osaka Bay and Ise Bay, tidal current, density current, wind-driven current and others play an important role in the long-term propagation of water quality. On the other hand, the sea areas targeted by this research are far greater in spatial scale than these domestic bays. As a result, compared to the role of tidal current, the principal hydrodynamic factors used were ocean current caused by the Kuroshio, density current caused by the introduction of freshwater from the Chang Jiang River, and wind-driven current.

From the above, we decided to use the model with coordinates converted vertically, researched and developed by Mellor, et al. (2002)[14)] and Ezer and Mellor (2004)[15)], as a hydrodynamic model that can take into account the effect of density current, wind driven current and ocean current.

While detailed explanation will be omitted here, the grid partitioning arising vertically when coordinates are converted is similar to that shown in Fig. 20.

The same vertical coordinate conversion model is used in the water quality model mentioned above.

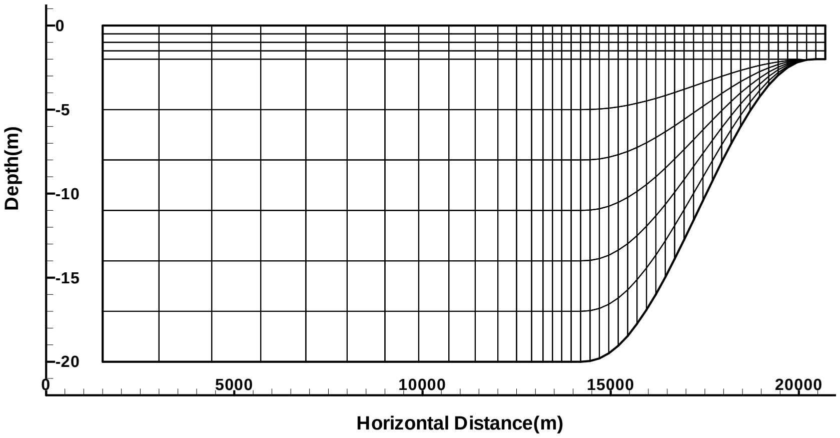


Fig. 20 Example of vertical grid partitioning in a general vertical coordinate model

Meanwhile, the intervals in the horizontal grid were set at 40km, over the range shown in Fig. 21. In the vertical direction, the σ (sigma) coordinate system was used, dividing vertically into a total of 20 layers from the sea surface downwards. (Fig. 23)

The boundary conditions used with the hydrodynamic model were ocean current velocity, water level, salinity and water temperature. We used the ocean assimilation data supplied by the company Forecast Ocean Plus (FO) [16)] as boundary conditions.

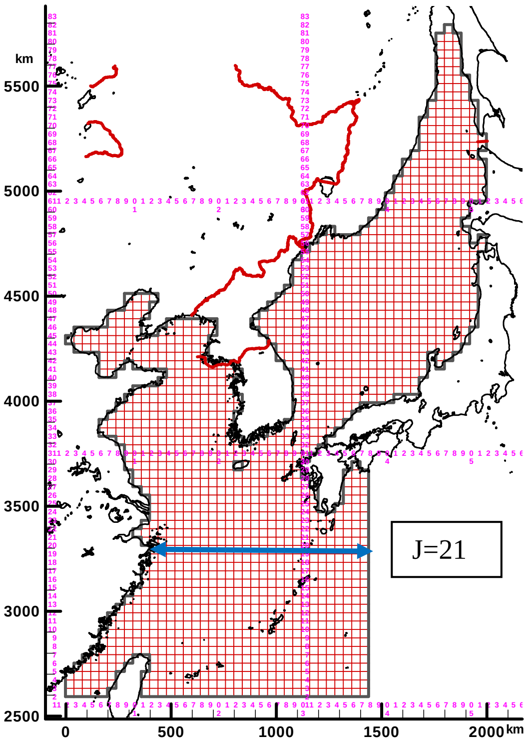


Fig. 21 Horizontal grid partitioning adopted for the hydrodynamic model

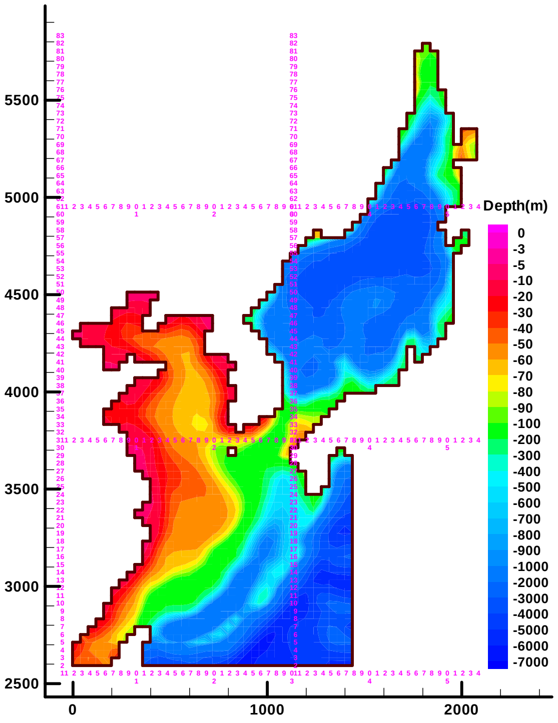


Fig. 22 Water depth data used in the calculations

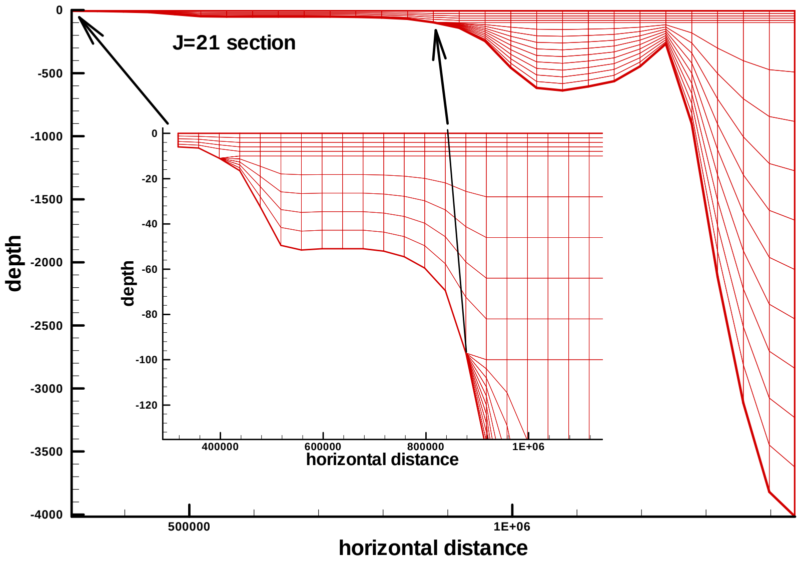


Fig. 23 Vertical grid partitioning adopted in the hydrodynamic model (shows position J21 in Fig. 21)

4.2 Hydrodynamic and water quality calculations used in the constructed model

Fig. 24 (right) shows the water temperature actually calculated using the constructed hydrodynamic calculation model. On comparing the monthly average values for 2005 obtained from a satellite (MODIS data obtained from JAXA) with the average of the calculation results, the characteristics of the calculation results and the satellite data can be said to resemble each other in general. Again, in the water quality calculations, we compared chlorophyll-a with satellite data (MODIS). Since the satellite data included data such as agitation of colored dissolved organic matter derived from rivers and bottom mud, their consistency in relation to concentrations of chlorophyll a deteriorates particularly in summer, when rainfall and river flow rates increase. This sometimes made it difficult to make direct comparisons of concentration with the calculation results. Besides this, however, it could be said that the calculation results generally reflected the characteristics of the satellite data (Fig. 25)

Satellite data (MODIS)	Calculation results

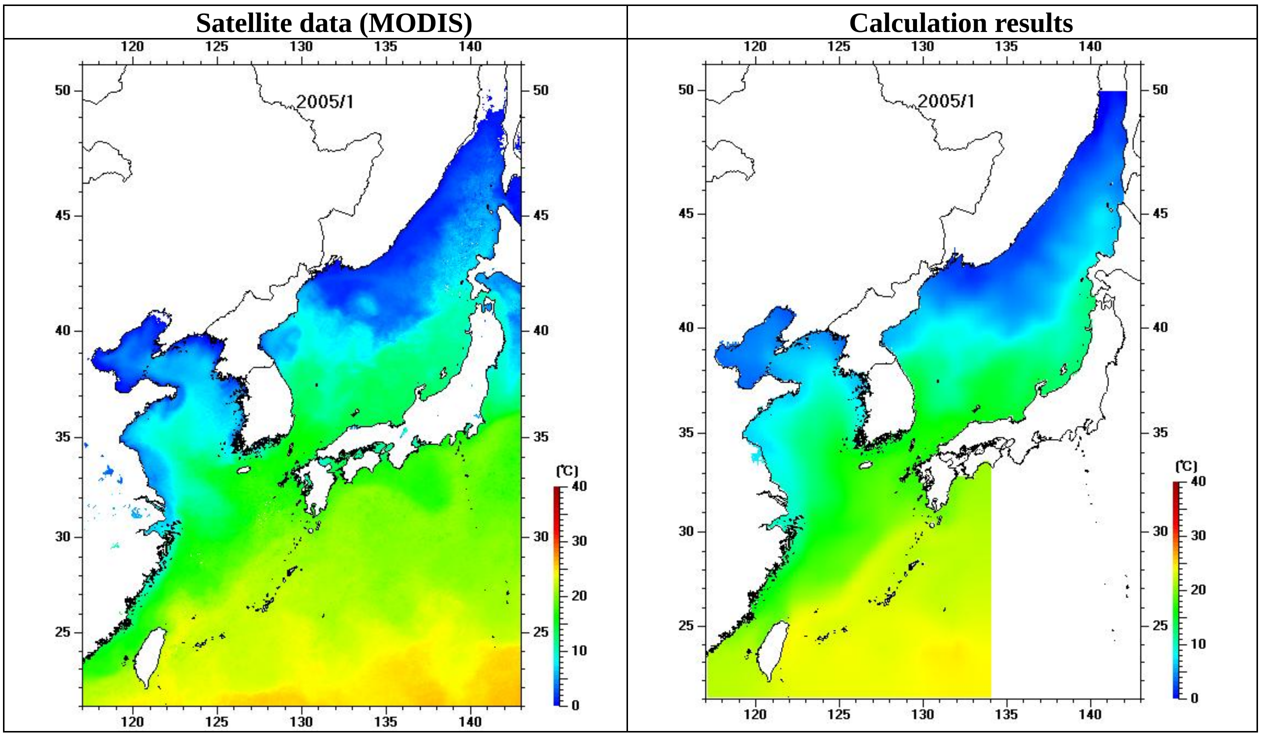


Fig. 24 Example of comparison between satellite data and estimated values using the model (water temperature) (January 2005)

Satellite data (JAXA MODIS)	Calculation results

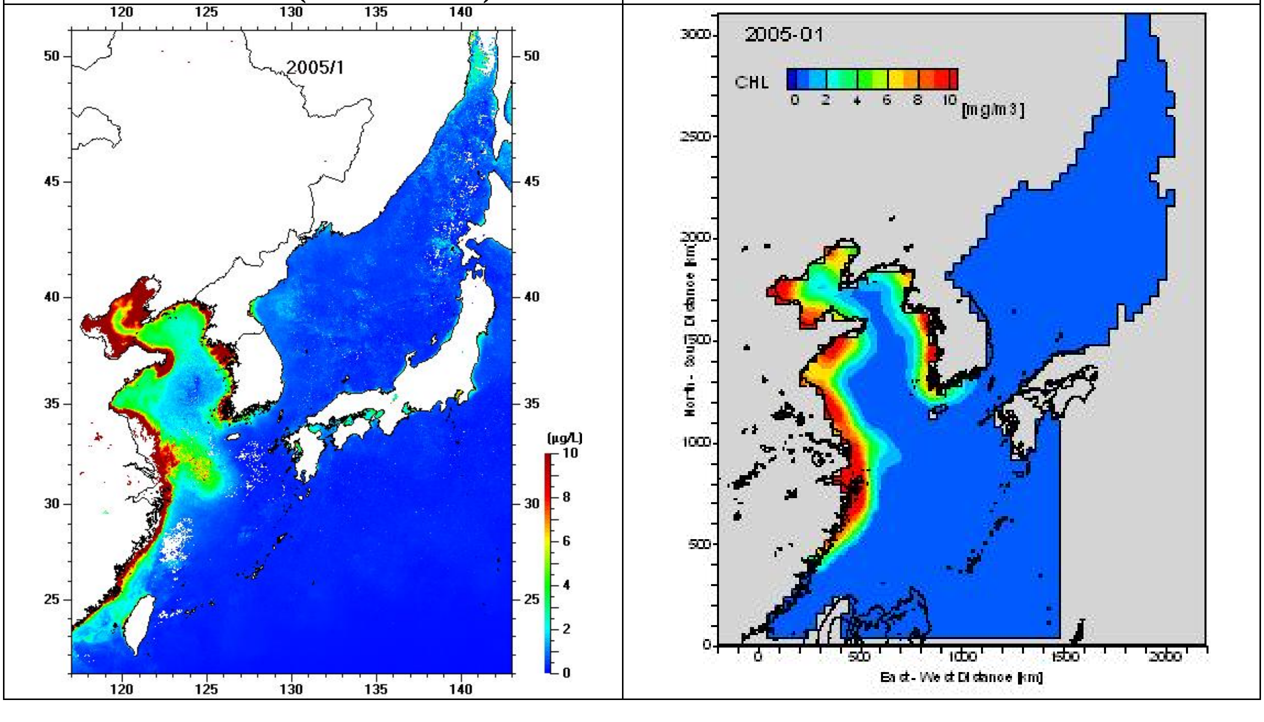


Fig. 25 Example of comparison between satellite data and estimated values using the model (chlorophyll-a) (January 2005)

4.3 Changes in marine pollutant volume in line with the volume of pollutant discharge from land areas based on future scenarios

When reproducing marine pollution, we added the volume of land-based pollution loads calculated in the previous section as input values in the horizontal grid near the estuaries of major rivers, or in major urban areas in coastal regions, and then made calculations for hydrodynamic and water quality models. For future scenarios (for economic growth and development of sewer systems, etc.), similarly, we made calculations using the 5 future scenarios explained above.

To evaluate changes in load from land areas, we summarized changes in water quality concentrations at the estuaries of principal rivers in each country. The pickup points for concentration were the nine locations shown in Fig. 26.

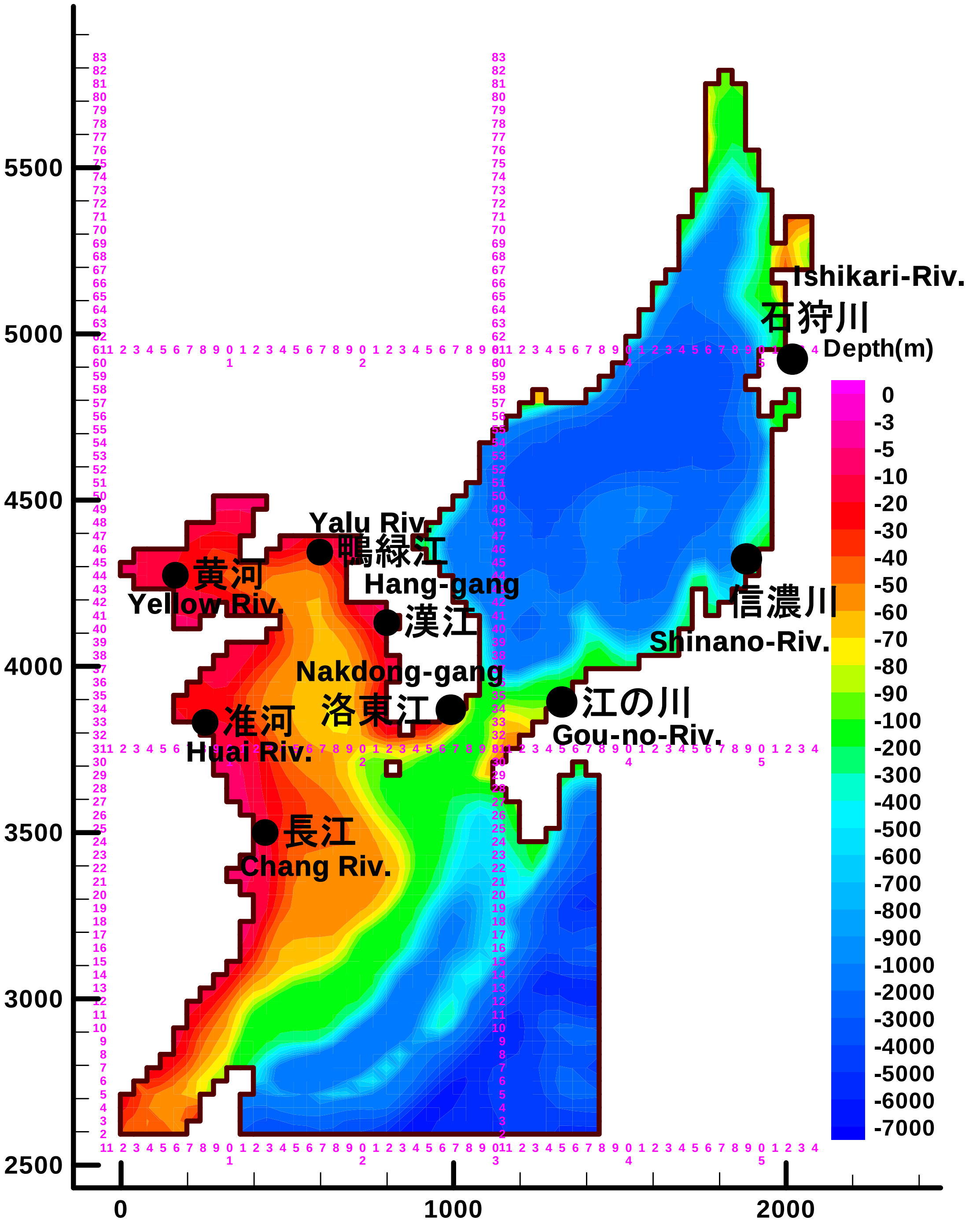


Fig. 26 Locations for comparison of concentrations to evaluate scenarios

At the points shown in Fig. 26, Fig. 27 shows changes in annual average concentrations in coastal regions used to calculate each scenario in 2030. In the chart, “-01” indicates the results for the surface layer (the uppermost of the 20 segmented vertical layers) and “-05” those of the 5th layer (of the 20 segmented vertical layers, the 5th from the top) (around 10m deep).

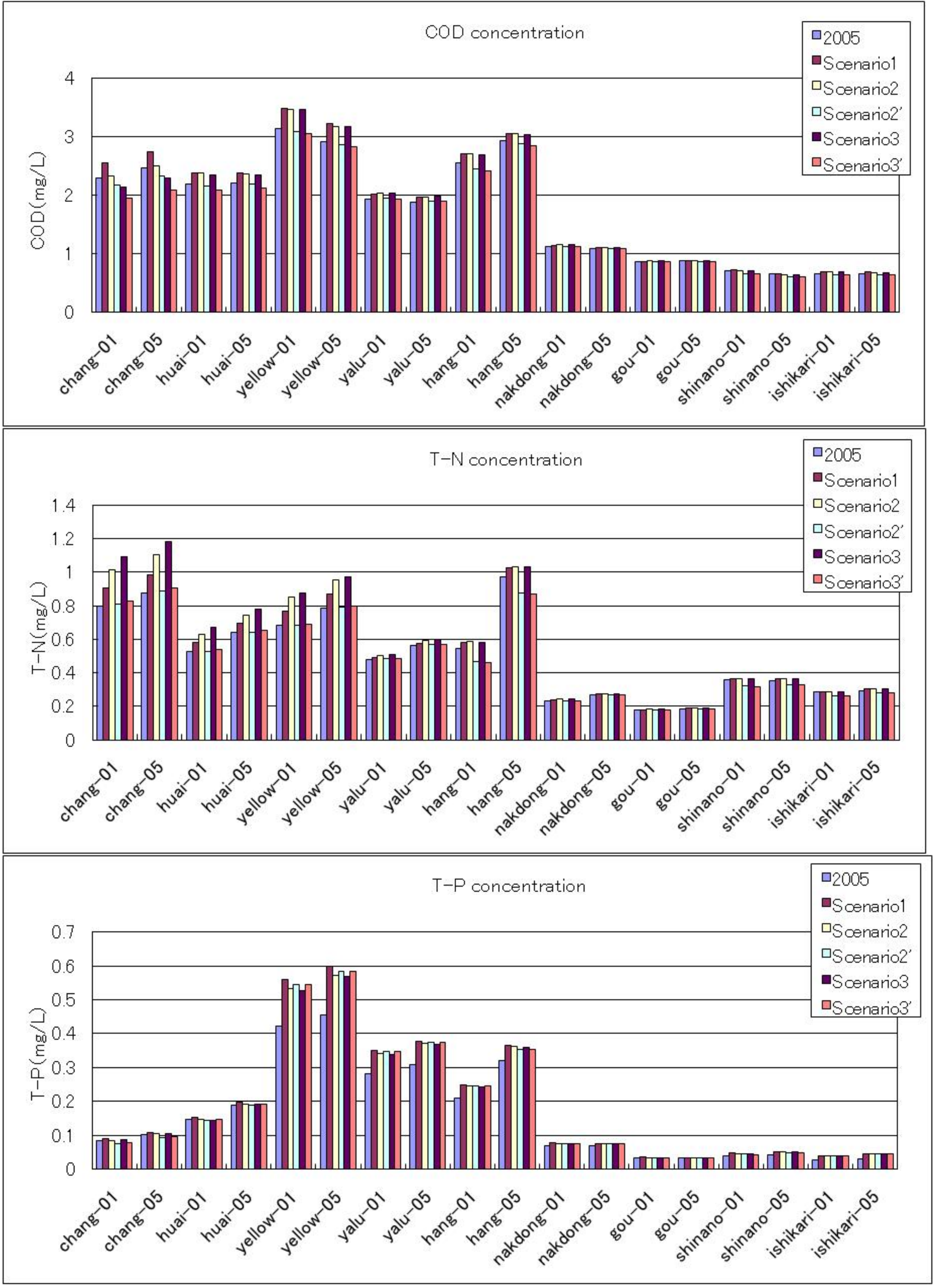


Fig. 27 Changes in concentration in coastal regions used to calculate each scenario in 2030 (annual averages) (COD, T-N, T-P)

Figs. 28 to 30 show the distribution of water quality concentrations (COD) in layer 1 (the surface layer) used to calculate each scenario in 2005 and 2030. When comparing scenario 1 with scenario 2' and scenario 3' in Figs. 28, 29 and 30, for example, we see that the effects of measures in different scenarios are particularly pronounced in the Bohai Sea area.

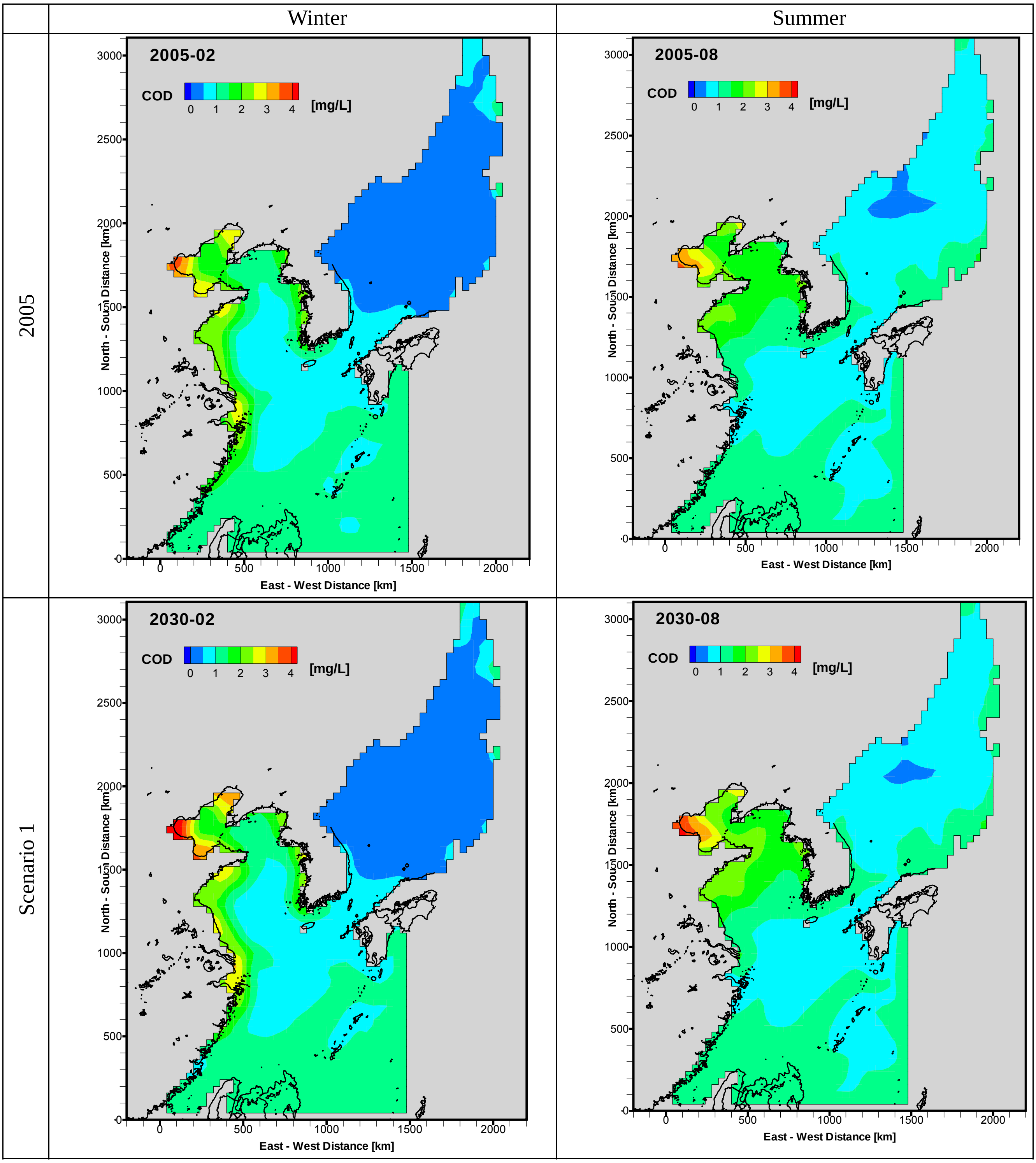


Fig. 28 Distribution of water quality concentration (layer 1) (2005, 2030 scenario 1, COD)

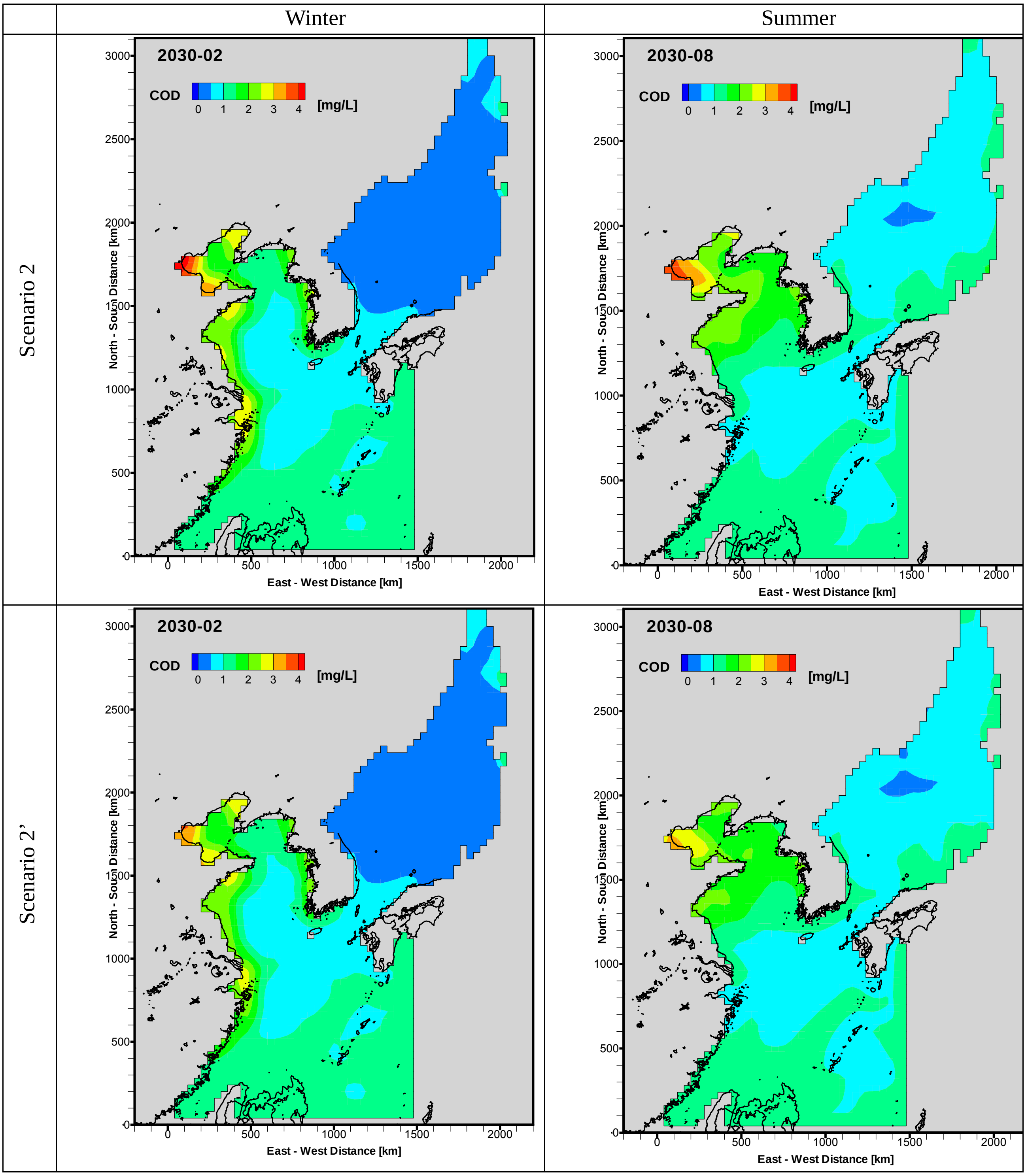


Fig. 29 Distribution of water quality concentration (layer 1) (2030 scenario 2, scenario 2', COD)

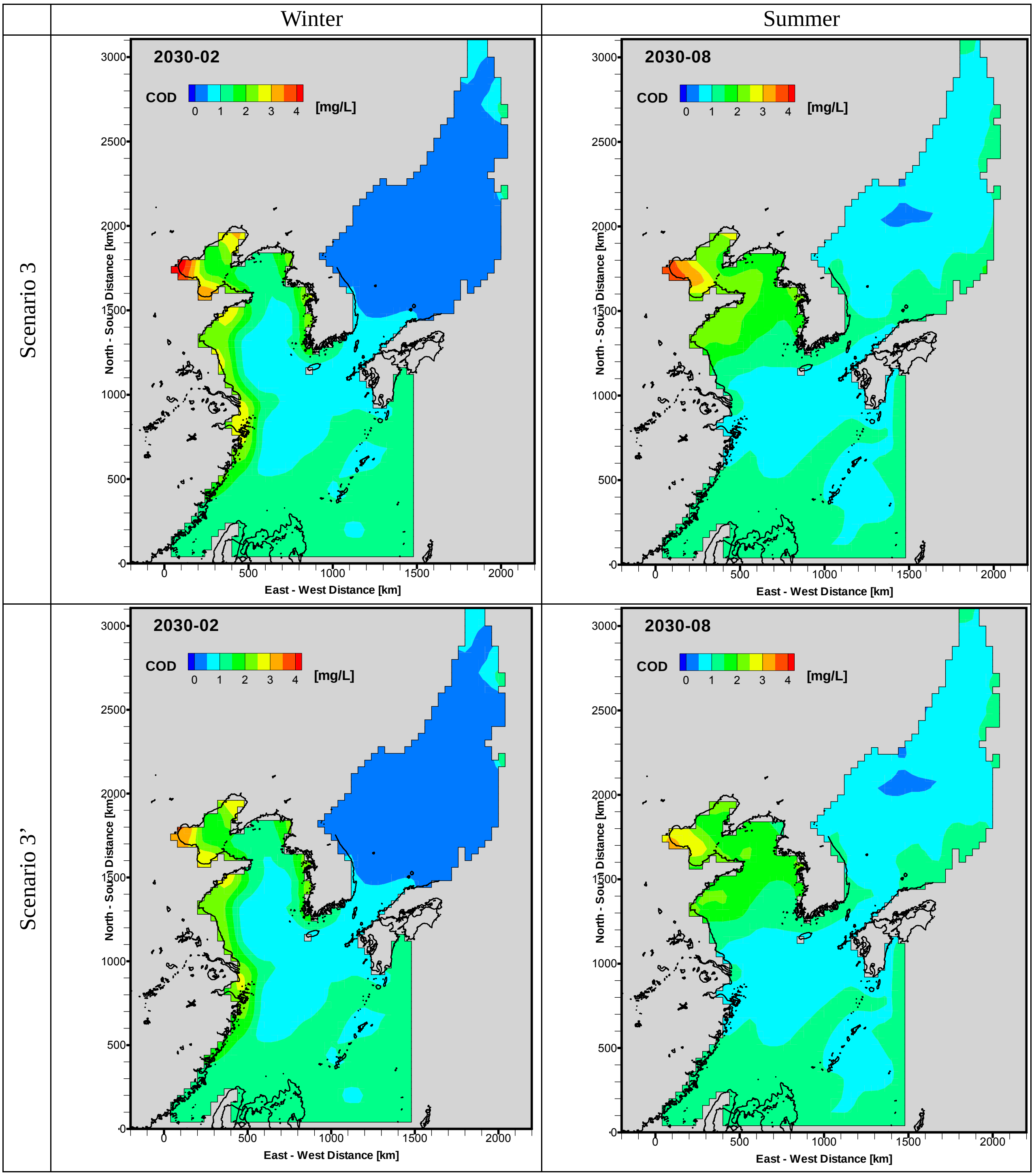


Fig. 30 Distribution of water quality concentration (layer 1) (2030 scenario 3, scenario 3', COD)

The Ocean Flow Model calculations involve various analyses besides those given in Fig. 27 through Fig. 30. The results of study on the Ocean Flow Model are outlined below.

① Coastal parts of China and South Korea where load is particularly large are susceptible to the impact of pollutant inflow, and a pronounced trend for deterioration in water quality was seen. Meanwhile, in scenarios involving advanced measures, a tendency was seen for the deterioration of water quality in coastal areas to be reduced, particularly in the case of COD.

② Because we constructed a model taking account of internal production by phytoplankton in sea areas (low ecosystem model), even when the COD load is reduced as a result of developing sewer systems and other measures for conserving the water quality environment, the effects do not appear clearly in sea areas. Depending on the load balance between nitrogen and phosphorus, internal production became activated, and COD concentrations rose in sea areas in some cases.

③ Because we took account of internal production in sea areas, a big difference was seen in COD concentrations between scenarios in spring-summer, when phytoplankton production is lively, while in winter the difference in water quality concentrations between scenarios showed a smaller tendency.

④ Even within the same country, depending on factors such as the state of upstream land use, the level of urbanization and the state sea areas in which river estuaries are located, the water quality environment and its mechanism will differ between rivers and estuaries. As a result, even when the pollutant volume is reduced in the same way, there are different trends in changes of water quality concentrations in estuaries. Consequently, the status of each river needs to be taken into account when studying water quality conservation measures.

As can be seen from the results of the Ocean Flow Model, this survey has made it clear that cases such as scenario 3', which adopt more advanced water quality conservation measures, inhibit the deterioration in water quality in the Northwest Pacific more than scenario 1, which maintains current water quality conservation measures.

However, the problem for the Ocean Flow Model, which predicts the impact of increases or decreases in the volume of land-based pollution loads on the water quality environment of the Northwest Pacific, is that it was difficult to gather data on water quality for verification of the target year in calculations to ascertain the current status.

5. Outline of international symposia held over the last three years

In promoting this research, we have confirmed the relevance of our methods of constructing the Land-based Pollution Load Model and the Ocean Flow Model through regular exchanges of views with researchers from Japan, China, South Korea and Russia on the details of the methods, etc. At the same time, we have also taken the opportunity to gather information such as pollutant emissions in other countries, amend our model calculation method based on the views of overseas academics, and so on.

The principal researchers and others from Japan, China and South Korea involved in this research are, specifically, Professor Tetsuya Kusuda of Graduate school, The University of Kitakyushu (Japan), former Senior Researcher Kim Kap-Soo of the Seoul Development Institute (South Korea), Associate Professor Du Pengfei of Tsinghua University (China), Professor Li Guangming of Tongji University (China), and Dr Vladimir Shulkin, Head of the Geochemical Laboratory in the Pacific Geographical Institute (Russia).

Once a year in each of fiscal 2008, fiscal 2009 and fiscal 2010, we invited these researchers and others to Japan for an international conference, when we discussed each country’s measures against land-based pollution loads, etc., and exchanged views. At these international conferences, we also received numerous useful comments on our methods of proceeding with this research.

In fiscal 2008, we held an international conference in the Clock Tower Centennial Hall of Kyoto University, which jointly hosted the event. This first conference was attended by about 120 people. In fiscal 2009, the venue for the conference was moved to the Shiba Park Hotel in Tokyo. And in fiscal 2010, the final conference was held in the Tokyo Bay Ariake Washington Hotel.

Fig. 31 and Fig. 32 show scenes from the most recent conference held in the Tokyo Bay Ariake Washington Hotel on February 9th, 2011.

At the conference venue on February 9th, 2011, we presented an outline of our survey results over the three years of our research to the assembled academics. Specifically, we explained the method of constructing a model of pollutant emissions from land areas in the countries concerned and the calculation results, the method of constructing ocean flow simulation and the calculation results, and others from the Japanese perspective. At the conference venue, we pointed out to the overseas academics that our survey methods and calculation results had been amended since the previous fiscal year, and received comments that, within the range of data obtained in the survey, they were appropriate analytical methods and calculation results.

Fig. 31 Scene from the "International Conference: Research on the Conservation of the Northwest Pacific Marine Environment" on Feb. 9th, 2011

Fig. 32 Participants in the "International Conference: Research on the Conservation of the Northwest Pacific Marine Environment" on Feb. 9th, 2011

6. Outline of research partnership between the countries concerned

In this research, we used the Land-based Pollution Load Model and the Ocean Flow Model to predict the volume and behavior of pollutants flowing into the Northwest Pacific, and obtained the required outcome. However, something that was always a problem when conducting surveys was gathering and ensuring the reliability of monitoring data on the quality and flow of water, essential elements for analysis.

Each country has different methods of gathering monitoring and other data on water quality, and different times for doing so. This made it very difficult to use data uniformly for analysis in the four countries of Japan, China, South Korea and Russia.

To promote the conservation of marine environments in the Northwest Pacific using the methods developed in this research, it will of course be important for the four countries of Japan, China, South Korea and Russia to continuously gather monitoring data on water flow and water quality, but also for each of the four countries to share their respective monitoring data. This has also been pointed out by the overseas academics attending our international conferences.

Based on this problem awareness, at the international conference held on Feb. 9th, 2011, we discussed the idea of continuously sharing water quality monitoring data on the Northwest Pacific possessed by each country, as a concrete plan of action for a research partnership aimed at the conservation of marine environments in the Northwest Pacific between fellow researchers in Japan, China, South Korea and Russia. We gained the approval of the invited academics of this principle, leading to the signing of the agreement shown in Fig. 35 (Fig. 33, Fig. 34).

The text set out in the agreement is as follows.

RESEARCH PARTNERSHIP
ON
CONSERVATION OF THE NORTHWEST PACIFIC MARINE ENVIRONMENT

Tokyo, 9th February, 2011

So far, we have held an international symposium in 2009 and international workshops in 2010 and 2011, and have worked to accumulate knowledge on the conservation of marine environments in the Northwest Pacific.

As a result of this research, we shared analytical tools for conserving marine environments in the Northwest Pacific by implementing the Ocean Flow Model based on estimation of land-based pollution loads from each country and future predictions. Furthermore, we have clarified the effects of measures to reduce pollutants in different future scenarios by utilizing these tools.

In future, for the conservation of marine environments in the Northwest Pacific, we will continuously carry out survey research, while continuing exchanges of information on water quality data in the Northwest Pacific, etc., until the end of March 2014.

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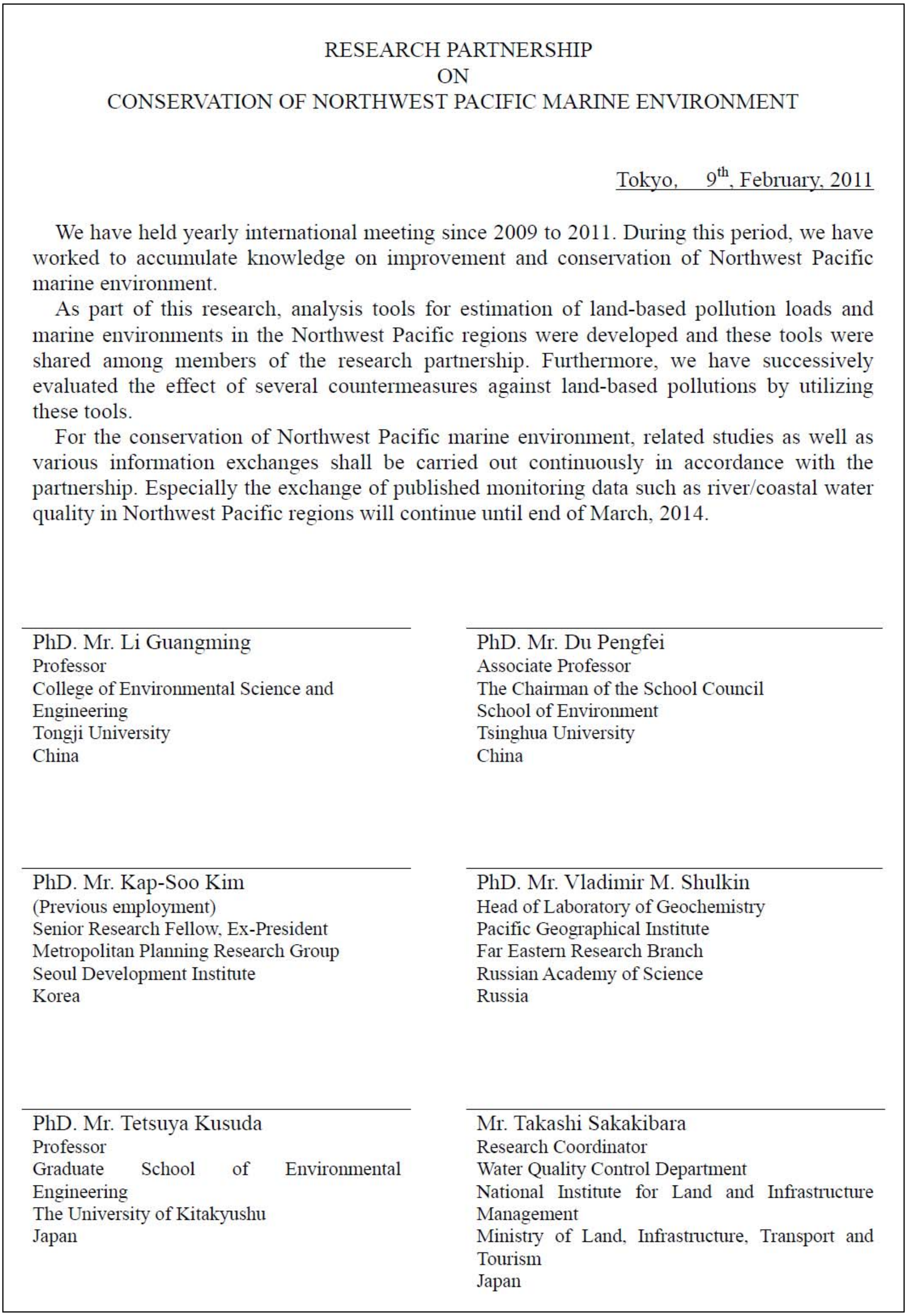
(South Korea) Kim Kap-Soo, Seoul Development Institute
(Russia) Vladimir Shulkin, Geochemical Laboratory in the Pacific Geographical Institute
(Japan) Tetsuya Kusuda, Graduate school, The University of Kitakyushu
(Japan) Takashi Sakakaibara, National Institute for Land and Infrastructure Management (NILIM), Ministry of Land, Infrastructure, Transport and Tourism

Fig. 33 Signing the Agreement Document

Fig. 34 Signing the Agreement Document



RESEARCH PARTNERSHIP
ON
CONSERVATION OF NORTHWEST PACIFIC MARINE ENVIRONMENT

Tokyo, 9th, February, 2011

We have held yearly international meeting since 2009 to 2011. During this period, we have worked to accumulate knowledge on improvement and conservation of Northwest Pacific marine environment.

As part of this research, analysis tools for estimation of land-based pollution loads and marine environments in the Northwest Pacific regions were developed and these tools were shared among members of the research partnership. Furthermore, we have successively evaluated the effect of several countermeasures against land-based pollutions by utilizing these tools.

For the conservation of Northwest Pacific marine environment, related studies as well as various information exchanges shall be carried out continuously in accordance with the partnership. Especially the exchange of published monitoring data such as river/coastal water quality in Northwest Pacific regions will continue until end of March, 2014.

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Fig. 35 Copy of the Agreement on Research Partnerships without signatures

7. Summary

As has already been stated up to the previous section, to study methods of conserving marine environments in the Northwest Pacific, we have attempted to ascertain pollutant emissions from land areas in Japan, China, South Korea and Russia, predict their future increases or decreases, and predict the behavior of pollutants at sea in the Northwest Pacific. For land-based pollution simulation, we constructed a calculation model based on the rationale used in Japan's Comprehensive Basin-wide Planning of Sewerage Systems (CBPSS)9), and made calculations while using the data gathered. Meanwhile, we investigated various reference materials and others concerning future predictions of GDP, etc., set scenarios for economic growth (pollutant increase) and development of sewer systems, etc. (reduction of pollutants), and attempted to ascertain future increases or decreases in pollutants by the year 2030. In the Northwest Pacific Ocean Flow Model, moreover, we specifically constructed a hydrodynamic model and a water quality model (low ecosystem model), and attempted to predict the behavior of pollutants at sea based on the calculation results of the Land-based Pollution Load Model.

As a result, we demonstrated that, if each country were to take appropriate steps such as developing sewer systems, a reduction in pollutants could be expected in the Northwest Pacific, particularly in the Bohai Sea and other enclosed sea areas or the coastal regions of each country. Meanwhile, in a prediction of water quality in the Northwest Pacific using the Ocean Flow Model, we found that deterioration in water quality can be inhibited by reducing pollutants.

Again, researchers from Japan, China, South Korea and Russia shared the perception that it is important to enhance water quality monitoring data on major rivers and the Northwest Pacific Ocean possessed by each country, and for each country to share those data, with a view to ascertaining the improvement of marine environments in the Northwest Pacific Ocean and promoting pollutant emission countermeasures.

In response to this problem awareness, in an international conference held with invited researchers from Japan, China, South Korea and Russia on Feb. 9th, 2011, we prepared an agreement stating that "In future, we will continuously carry out survey research on the Northwest Pacific, while continuing exchanges of information on water quality data, etc., between our four countries." (Fig. 32, Fig. 33, Fig. 34).

In future, we aim to enhance information and others related to water quality monitoring data and the pollutant unit load in each country by holding exchanges of information with the other countries. We will actively provide the obtained data to research institutes and others that need them. By enhancing water quality monitoring data, etc., it should become possible to identify issues related to conserving marine environments in the Northwest Pacific, and to prepare draft environmental conservation measures in greater detail than in the study undertaken in this research.

Based on the survey results accumulated in this research and the research partnerships forged between Japan, China, South Korea and Russia, we intend to continue lobbying from Japan through frameworks such as JICA and the Global Centre for Urban Sanitation (GCUS) , so that measures to reduce pollutants may be steadily implemented by countries in the Northwest Pacific.

Acknowledgement

In conducting this research, we were fortunate to receive assistance from a large number of sources, not only in Japan but also in China, South Korea and Russia. In particular, Professor Tetsuya Kusuda of Graduate school, The University of Kitakyushu, Professor Li Guangming of Tongji University, Associate Professor Du Pengfei of Tsinghua University, former Senior Researcher Kim Kap-Soo of the Seoul Development Institute, and Dr Vladimir Shulkin, Head of the Geochemical Laboratory in the Pacific Geographical Institute (Russia), took part in our international workshops over three years from 2008 and provided tremendous assistance. We also received many useful opinions from members of the "Review Subcommittee for Promoting Joint Research by Japan, China, South Korea and Russia on Environmental Problems of the Northwest Pacific", set up within the Committee of Environmental Engineering of the Japan Society of Civil Engineers. Besides the parties cited above, we have received information in the form of hearings, etc., from many academics both within Japan and overseas. We would like to express our gratitude to all of these parties, as well as the relevant personnel in Nippon Jogesuido Sekkei Co., Ltd. and IDEA Consultants , Inc., who shared in implementing this research.

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