NOWPAP POMRAC

Northwest Pacific Action Plan
Pollution Monitoring Regional Activity Centre

7 Radio St., Vladivostok 690041, Russian Federation
Tel.: 7-4232-313071, Fax: 7-4232-312833
Website: http://www.pomrac.dvo.ru
http://pomrac.nowpap.org

# REGIONAL OVERVIEW

## on River and Direct Inputs of Contaminants into the Marine and Coastal Environment in NOWPAP Region With Special Focus on the Land Based Sources of Pollution

**POMRAC, Vladivostok, Russian Federation**
**2009**
**POMRAC Technical Report No 7**

# List of Acronyms

| | |
|---|---|
| BOD | Biological oxygen demand |
| CEARAC | Special Monitoring and Coastal Environment Assessment Regional Activity Center |
| CEM | Center Environmental Monitoring , Federal Service on Hydrometeorology and Environmental Monitoring, Vladivostok, Russia |
| CNEMC | China National Environmental Monitoring Center |
| COD | Chemical oxygen demand |
| DO | Dissolved oxygen |
| EBM | Environmentally Based Management |
| EQS | Environment Quality Standard |
| FPM | Focal Points Meeting |
| GDP | Gross Domestic Product |
| GIWA | Global International Waters Assessment |
| HCH | Hexachlorcyclohexane compounds |
| HNS | Hazardous Noxious Substances |
| IC | Ion Chromatography |
| ICARM | Integrated Coastal and River Basins Management |
| IGM | Intergovernmental meeting(s) |
| IMO | International Maritime Organization |
| IUGG | International Union of Geodesy and Geophysics |
| LOICZ | Land Ocean Interaction Coastal Zone |
| MDL | Minimum detection limit |
| MEP | Ministry of Environmental Protection, China |
| MLTM | Ministry of Land, Transport and Maritime Affairs of Korea |
| MOE | Ministry of Environment of Korea |
| MOMAF | Ministry of Maritime Affairs and Fisheries of Korea |
| MOST | Ministry of Science and Technology of Korea |
| MPC | Maximum permissible concentration |
| NIER | National Institute of Environmental Research of Korea |
| NIES | National Institute Environmental Science, Japan |
| NFRDI | National Fisheries Research and Development Institute, Korea |
| NOWPAP | Action Plan for the Protection, Management and Development of the Marine and Coastal Environment of the Northwest Pacific Region |
| NPEC | Northwest Pacific Region Environmental Cooperation Centre, Toyama, Japan |
| PAHs | Polyaromatic hydrocarbons |
| PCBs | Polychlorbiphenyle compounds |
| PGI | Pacific Geographical Institute, Russian Federation |
| PHCs | Petroleum hydrocarbons |
| POI | Pacific Oceanographic Institute, Russian Federation |
| POMRAC | Pollution Monitoring Regional Activity Center |
| POPs | Stockholm Convention on Persistent Organic Pollutants |
| QA/QC | Quality Assurance/Quality Control |
| SEPA | State Environmental Protection Administration of China |
| SCOPE | Scientific Committee on Problems of the Environment |
| SCOR | Scientific Committee on Oceanic Research |
| SOMER | State of Marine Environment in the NOWPAP region |
| SS | Suspended Solids |
| TPLCS | Total Pollutant Load Control System |
| UNDP | United Nations Development Program |
| UNEP | United Nations Environment Program |
| YSLME | Yellow Sea Large Marine Ecosystem |
| WG | Working Group(s) |
| WQS | Water Quality Standard |

# Table of Contents

# 1. Executive Summary

Regional Overview of the River and Direct Inputs (POMRAC Technical Report #4, 2006), as a synthesis of the relevant National Reports, has given the assessment of the concentrations and fluxes of contaminants as well as features and peculiarities of the water quality monitoring systems of the NOWPAP member states with the baseline data for 2002. Existing and future activities related to ICARM (Integrated Coastal and River Basin Management) and EBM (Environmentally Based Management) need additional and updated information on the land-based sources of pollution. River and direct inputs of contaminants continue to be the main "channels" delivering the material to the coastal sea areas. This was the reason why POMRAC 6$^{th}$ Focal Points Meeting (held in Yantai, China, 17-19 June, 2008) has decided to modify the former title of activity "Regional Overview on Land-Based Sources of Pollution in the NOWPAP Region" on the "Regional Overview of River and Direct Inputs of Pollution in the NOWPAP region with special focus on land based sources". The corresponding changes in the overview structure have been done too.

This Overview, based primarily on the most recent available data for 2005-2007 presented by the experts from the NOWPAP member states, is summarizing the current status and trends of river water quality with emphasis on the land-based sources of pollution. Other NOWPAP publications (National Reports, 2005, Regional Overview, 2006, SOMER, 2008), research papers, and overviews prepared by other international projects such as UNDP YSLME and UNEP GIWA, are also used.

Natural environmental conditions and main socio-economic factors in the China, Japan, Korea, Russia within NOWPAP region are briefly described as part of the analysis of natural and anthropogenic factors affecting inputs of chemical substances to the sea. The total area of the river watersheds in the entire NOWPAP region is about 1,792,000 km$^2$ (excluding the Yangtze River basin), with a shoreline of about 30,000 km. Average river runoff is about 406.9 km$^3$/year excluding the Yangtze River, and 1,358 km$^3$/y with the Yangtze. Population in the study area is about 560 million and is very unevenly distributed. Population density ranges from 11 people/km$^2$ in Russia to 486 people/km$^2$ in Korea. The GDP per capita in the NOWPAP Region is also variable. GDP in Japan is USD 35,834 per capita (2005 data). The GDP in the ROK is USD 26,057 per capita (2007). GDP in the Russian part of NOWPAP region is USD 6,547 per capita (2007), and in the Chinese provinces within NOWPAP area the GDP is USD 3,864 per capita in 2007. In terms of absolute amount, GDP is highest in Korea (USD 1,263 Bln), followed by western prefectures of Japan (USD 1,215 Bln), north-eastern provinces of China (USD 676 Bln), and south-eastern regions of Russia (USD 9 Bln).

The legal basis for the monitoring of natural waters and effluents quality in the four NOWPAP countries is briefly described in this overview. The report also describes the existing monitoring networks, responsible agencies, methods used and water quality criteria. The main criteria of water quality in all NOWPAP countries are based on compliance with standards: EQS – environmental quality standards, WQS – water quality standards, MPC – maximum permissible concentration. Similarities and differences in standards, approaches, and methods used are also outlined.

The river water quality and pollution of the coastal areas due to influence of the land-based sources continue to be among the main ecological problems in the NOWPAP region (SOMER, 2008, GIWA, 2005, YSLME, 2008). Presented document summarizes the current status and trends of river water quality based on monitoring results for the last 5-7 years. Possible reasons of the existing trends are suggested and discussed. Discharge quantity for major rivers is calculated and hence the pollution load for the NOWPAP region can be estimated. The intensity of the pollution load is assessed for the different parts of NOWPAP coastal areas. The current status and historical trends for chemical substances in river water are also described and stability and even certain improvements in conditions noted. Other land-based sources of pollution in the NOWPAP region along with rivet discharge are characterized too.

# 2. Introduction

## 2.1. Goals of the Overview

The first goal of this Regional Overview is to present available information on the concentrations of some chemical substances in river water and effluents, and to assess input of contaminants into marine environments directly and via rivers at the regional level. In addition to a picture of river runoff for different parts of the NOWPAP region, this regional overview will present the available trends of chemical concentrations and fluxes for the last 5-7 years. We try also to present the data on the evaluation of inputs of different types of land based sources of pollution to the wastewater discharge.

The second goal of this Regional Overview is to assess the existing data on river and direct inputs of contaminants as a base for the environmental management within ICARM or EBM procedures and projects. This goal includes an overview of laws, a comparison of the main environmental standards, of the key features of monitoring programs and of the methods used. The aim of this part of the Overview is to assess the suitability of data on contaminant concentrations and inputs for the characteristic of the ecological issues in the coastal and off shore sea areas of NOWPAP region.

## 2.2. General Background Information on NOWPAP

NOWPAP is a part of UNEP Regional Sea Program launched in 1972 with aim to support the coordinated efforts of countries to prevent the degradation of the shared sea areas. Now, more than 140 coastal countries are participating in 13 Regional Seas Programs established under UNEP auspices. Five partner programs are also operational. All Programs act through the "Action Plans" – comprehensive regional projects for the coordinated environmentally sound management efforts. Ideally the Action Plans should be underpinned by strong legal framework in the form of a regional Convention and associated Protocols on specific problems, but only some of Regional Sea Programs have such legal basement.

NOWPAP (*Action Plan for the Protection, Management and Development of the Marine and Coastal Environment of the Northwest Pacific Region*) is one of the action plans that cover the Northwest Pacific region. The natural and socio-economical conditions in this region are extremely diverse. The southern and eastern parts surrounding the Northwest Pacific are the most highly populated of the world and there are enormous pressures being placed on the environment. At the same time the northern part of region is less populated but is a subject of "hot spots" and transboundary influences. The countries of the region, the People's Republic of China, Japan, the Republic Korea and the Russian Federation have joined forces to participate in NOWPAP.

NOWPAP was adopted at the First Intergovernmental Meeting (IGM) in 1994, was followed by a series of meetings of experts and by National Focal Point Meetings that started as early as 1991. The overall goal of the NOWPAP is "the wise use, development and management of the coastal and marine environment so as to obtain the utmost long-term benefits for the human beings of the region, while protecting human health, ecological integrity and the region's sustainability for future generations".

The IGM, made up of senior representatives of the NOWPAP members, provides policy guidance and decision-making for NOWPAP. The plan incorporates seven priority projects that are implemented through a network of Regional Activity Centers (RACs) - CEARAC, DINRAC, MERRAC and POMRAC. The RACs play a central role in coordinating regional activities in specific fields of priority projects. NOWPAP's Regional Coordinating Unit (RCU), co-hosted by Japan and the Republic of Korea, oversees the implementation of the programmes and aspects of the regional action plans such as marine emergencies, information management and pollution monitoring. The opening of two RCU offices in Toyama Japan, and Busan Korea was agreed to at the 6th IGM in December 2000, and these two offices were established in November 2004. Besides coordination RCU plays a leading role in the implementation of new activities needed the joint efforts of all RACs, for example marine litter issues and some other problems.

At the beginning NOWPAP priority projects were:

NOWPAP 1: Establishment of a comprehensive database and information management system;
NOWPAP 2: Formation of a survey of national environmental legislation, objectives, strategies and policies;
NOWPAP 3: Establishment of a collaborative regional monitoring program;
NOWPAP 4: Development of effective measures for regional cooperation in marine pollution preparedness and response;
NOWPAP 5: Establishment of Regional Activity Centre (RAC) and the network among these centers;
NOWPAP 6: Promotion of public awareness of the marine, coastal, and associated freshwater environments;
NOWPAP 7: Assessment and management of land-based activities.

For the time being the activities are implemented as a numerous projects managed by one of the RACs according with their specialty.

CEARAC is hosted by the Northwest Pacific Region Environmental Cooperation Centre (NPEC) in Toyama, Japan. Its main activities are to monitor and assess harmful algal blooms, to develop new monitoring tools using remote sensing and to assess land-based sources of marine litter.

DINRAC is based in the Policy Research Centre for Environment & Economy of the Ministry of Environmental Protection (MEP) in Beijing, People's Republic of China. The objectives of DINRAC are to develop a region-wide data and information exchange network, to promote regional cooperation and exchange of information on the marine and coastal environment in the NOWPAP region and eventually to serve as a NOWPAP Clearinghouse.

MERRAC is established in the Maritime and Ocean Engineering Research Institute under Korea Ocean R&D Institute (MOERI/KORDI) in Daejeon, the Republic of Korea by the joint effort of UNEP and IMO to develop effective regional cooperative measures in response to marine pollution incidents including oil and hazardous and noxious substance (HNS) spills. MERRAC is also working on marine-based sources of marine litter.

POMRAC is located at the Pacific Geographical Institute (PGI) of the Far East Branch of the Russian Academy of Sciences in Vladivostok, Russian Federation. POMRAC is responsible for cooperative measures related to atmospheric deposition of contaminants and river and direct inputs of contaminants into the marine and coastal environment. In 2007, POMRAC started a new project on integrated coastal zone and river basin management and compiled the state of marine environment report.

Several activities have been implemented jointly by several RACs and RCU. First of the was Marine Litter Activity (MALITA). This activity has been completed successfully in 2007 due to the joint efforts made by RACs and RCU and strong support by the member states. The next stage of this activity is the NOWPAP Regional Action Plan on Marine Litter (RAP MALI) which is implemented since 2008. Another jointly implemented activity was Regional Overview of Legal Aspects of the Protection and Management of the Marine and Coastal Environment of the Northwest Pacific Region. This overview was updated by national experts and published in 2007. State of Marine Environment Report (SOMER). POMRAC in the collaboration with other RACs prepared SOMER – State of Marine Environment in the NOWPAP region – a comprehensive review of marine environmental problems in the region based on the analysis of data and information from different sources.

## 2.3. Geographic Scope of NOWPAP Region

According to an agreement between China, Japan, ROK, and Russia (1994) based on United Nation principals, the NOWPAP region includes marine, coastal and offshore basins at 33°-52°N and 121°-143°E (Fig. 1). Though the mouths of major Chinese rivers are technically outside of the NOWPAP region, an assessment of river impact on the quality of marine environments is impossible without accounting for the impact of such great Chinese rivers as the Yangtze and Yellow and Huaihe. For this reason, these rivers are assessed in our overview. The rivers discussed in this Regional Overview and key river features (watershed size and water discharge) are listed in Table 1. Major part of big rivers are depicted on Figure 1.

The terrestrial part of China occupies the lowland west coast of the Bohai Sea and the Yellow Sea where the mouths of the Yangtze, Huaihe, Huanhe, Haihe and Liaohe rivers are situated. In addition, two large hilly peninsulas, Liaodong and Shandong, with an average elevation of 500 m, are located between the Bohai Sea and the Yellow Sea. The major relief of Jiangsu province, Shandong province and Liaoning province are hilly and plain regions, while mountainous regions cover a big proportion in the other two provinces - Heilongjiang and Jilin. Besides, fresh water area of Jiangsu province is quite large with 17% of the whole province.

Land use in eastern China is very intensive. Vegetation rates in Liaoning Province, Heilongjiang Province and Jilin Province are 28.7%, 41.9% and 42.4%, respectively. In contrast to these provinces, vegetation rates in Shandong and Jiangsu Provinces are much lower: 21.5% and 10.6%, respectively. Protected areas in Liaoning, Shangdong and Heilongjiang Provinces cover 9.7%, 6.0% and 5.05% of the total area. The percentage of protected areas in Jiangsu and Jilin provinces is less. The major river basins of the region include Songhua River, Liaohe River, Haihe River, Yellow River, Huaihe River and Yangtze River, with overall annual input varied from 1,193 $km^3$ (2002) to 1,117 $km^3$ (2005), that is relatively stable. The Yangtze River provides 80-85% of this water discharge. When the Yangtze and Songhua Rivers are excluded, annual river input is about 177 $km^3$. All rivers have peak runoff in summer and minimum discharge in winter.

Western Japan is rather mountainous, with elevations up to 3,000 m in central Honshu Island and up to 1,800 m in the south of Kyushu Island. Despite relatively high population and intensive agriculture, forests and wildlife parks cover 71.4% and 13.9%, respectively of the prefectures facing the NOWPAP marine region. Eight large rivers exist among the numerous rivers on the west coast of Japan: Teshio and Ishikari at the Hokkaido Is., Yoneshiro, Omono, Mogami, Agano, Shinano and Jintsu at the Honsyu Is. These rivers had a total annual (2005) discharge of about 70 $km^3$, whereas total input from all west coast Japanese first class rivers reached up to 126 $km^3$

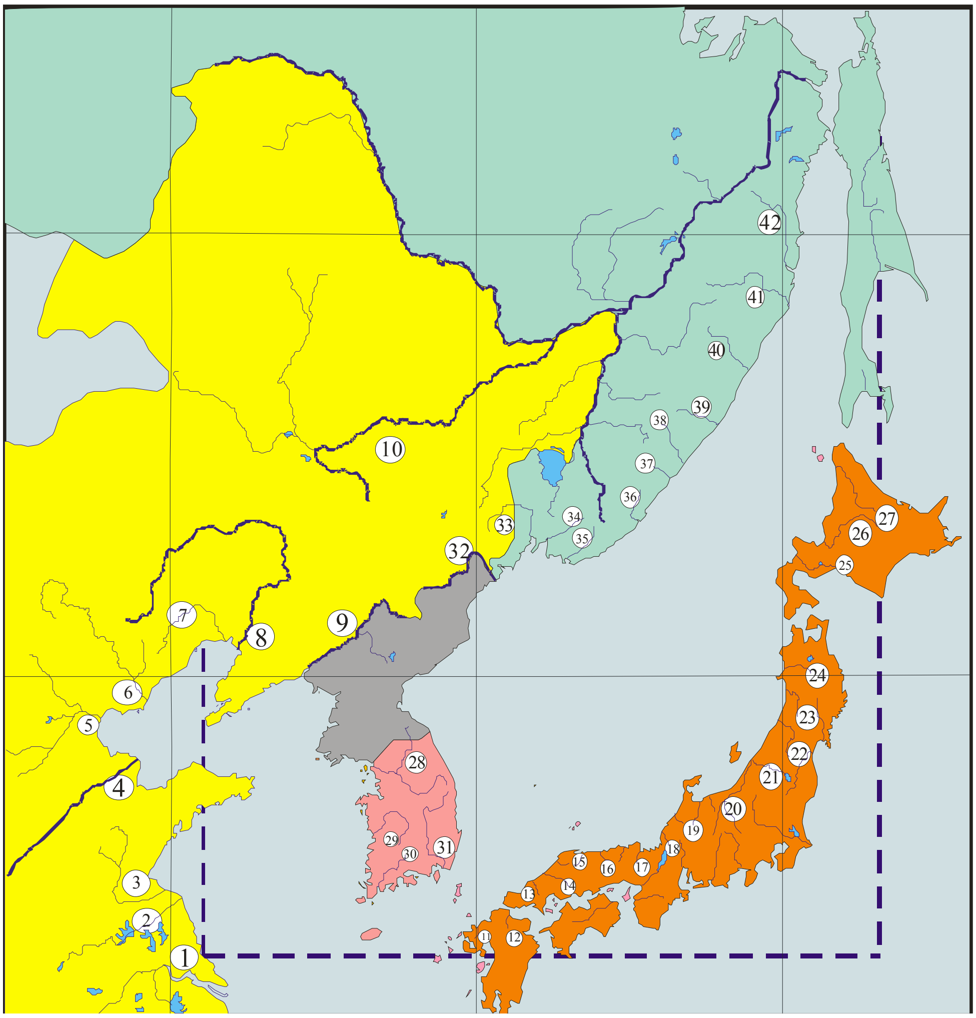



Figure 1. NOWPAP Region (within dashed line) with Rivers Keyed to Table 2.1

The southern part of the Korean peninsula is mostly hilly and mountainous terrain with average elevation about 400-600 m. The principal range is the T'aebaek-sanmaek that extends in a generally north-south direction parallel to the east coast. The country's highest peak is located on the island of Cheju, is Halla-san (1,950 m). The next highest peak Chiri-san (1,915 m) is situated at the south part of Korean peninsula between Busan and Kwangju. Mixed deciduous and coniferous forests cover about three-quarters of the peninsula. Large part of these forests is man-made. Protected areas make up about 7 % of South Korea and include more than a dozen national parks. Less than one-fifth of the total area occupied by plains and these are concentrated in the west along the coast; the coastal plains in the east and south are very narrow. Apart from the east coast, South Korea has a highly rugged coastline characterized by high tidal ranges, especially at the west coast where tides reach up 5 m and well developed tidal mudflats are situated. The main five rivers include: Han River, Guem River, Yongsan River, Somjin River and Nakdong River with total annual input varied from 31 km$^3$ (2001) to 93 km$^3$ (2003), that is very significant.

The Russian territory of NOWPAP includes Primorskii Krai, parts of southeastern Khabarovskii Krai, and parts of southwest Sakhalin Island. About 80% of Primorskii Krai and the adjoining part of Khabarovskii Krai are occupied by the mountain ridges belonging to the Sikhote Alin mountain system. Average elevation is 600 meters, with the highest peaks reaching 1,855 meters. Southwestern Sakhalin Island has low mountains and hills. Almost 80% of the territory is covered by forest and an additional 8.1% is occupied by wildlife reserves. The main rivers are the Tumannaya (Tumen), Razdolnaya (Suifun), Partizanskaya (Suchan), Samarga, Koppi, Botchi, Tumnin with a total annual input about 27 km$^3$ (2002). Total annual input of all rivers in the Russian portion of the NOWPAP was about 43 km$^3$ (2002).

Monsoon is a key climatic feature of the entire NOWPAP region, accompanied by the strong seasonal variation, but there are obvious climatic differences due to more than 2,000 km south to north stretch. The climate of Jiangsu Province and Shandong Province in China belongs to the warm temperate zone with moist continental monsoon features. In summer these provinces are often hit by typhoons. Annual precipitation in Jiangsu Province is about 1,000 mm, while Shandong Province gets 550~950 mm.

The northern three Provinces (Liaoning, Jilin, Heilongjiang) belong to the temperate continental monsoon climate zone that has cloudy spring and hot, rainy summer. Winter lasts longer than in other Chinese provinces. Annual precipitation in Liaoning Province, 600~1,100 mm and is most abundant of these three Provinces.

The climate of the Japanese west coast situated within NOWPAP area is characterized by heavy snowfall brought on by humid northwest winter monsoons. Despite rather high annual average temperatures that increase from 8.4° C on the western Hokkaido coast to 13.7° C in Toyama, maximum snow cover reaches 69-118 cm. Annual precipitation increases from 1,218 mm at Otaru (Hokkaido) to 2,133 mm at Toyama (middle Honshu) and then decreases to 1,632 mm at Fukuoka. Summers in Japan, as in China, bring typhoons.

Table 2.1 Major Rivers entering to sea areas within NOWPAP Region

| N* | River | Province, region, sub-region, | Watershed square, $10^3$ км$^2$ | Coast length, km | Discharge, m$^3$/s |
|---|---|---|---|---|---|
| | **China (2002)** | | **4,000(1,634[1])** | **10,054** | |
| 1 | Yangtze | Jiangsu | 1,809 | | 30,166 |
| 2 | Huaihe | Jiangsu/Shandong | 269 | 2,498 | 1,972 |
| 3 | Yihe | Shandong | nd | | nd |
| 4 | Yellow | Shandong | 752 | | 2,087 |
| 5 | Haihe | Hebei/Tianjin | 264 | 1728 | 723 |
| 6 | Luanhe** | Liaoning | 44 | | 144.3 |
| 7 | Dalinghe** | Liaoning | 14.4 | | 117.6 |
| 8 | Daliaohe | Liaoning | 229 | 1828 | 469 |
| 9 | Yalu** | Liaoning/Jilin | 61.9 | | 1200 |
| 10 | Songhua | Jilin/Heilongjiang | 557 | | 2416 |
| | **Japan (2005)** | | **89.5** | **11,610** | **3,995.2** |

| | | | | | |
|---|---|---|---|---|---|
| 27 | Teshio & Rumoi | Hokkaido | 5.9 | 1,486*** | 201.79 |
| 26 | Ishikari River | Hokkaido | 14.3 | | 466.6 |
| 25 | Shiribetsu River | Hokkaido | 1.6 | | 75.01 |
| | Shiribeshitoshibetsu | Hokkaido | 0.7 | | 27.02 |
| | Iwaki River | Touhoku | 2.5 | 1,158 | 99.83 |
| 24 | Yoneshiro River | Touhoku | 4.1 | | 213.36 |
| 23 | Omono River | Touhoku | 4.7 | | 275.84 |
| | Koyoshi River | Touhoku | 1.2 | | 62.36 |
| 22 | Mogami River | Touhoku | 7.0 | | 406.34 |
| | Aka River | Touhoku | 0.9 | | 78.42 |
| | Ara River | Hokuriku (N) | 1.2 | 585 | 117.31 |
| 21 | Agano River | Hokuriku (N) | 7.7 | | 454.69 |
| 20 | Shinano River | Hokuriku (N) | 11.9 | | 393.06 |
| | Seki River | Hokuriku (N) | 1.1 | | 50.48 |
| | Hime River | Hokuriku (N) | 0.7 | | 60.53 |
| | Kurobe River | Hokuriku (S) | 0.7 | 117 | 97.9 |
| | Joganji River | Hokuriku (S) | 0.4 | | 14.8 |
| 19 | Jintsu River | Hokuriku (S) | 2.7 | | 161.0 |
| | Sho & Oyabe | Hokuriku (S) | 1.9 | | 107.6 |
| | Tedori & Kakehashi | Kiriki | 1.2 | 2,072 | 100.1 |
| 18 | Kuzuryuu River | Kiriki | 2.9 | | 105.21 |
| 17 | Yura River | Kiriki | 1.9 | | 13.18 |
| 16 | Maruyama River | Kiriki | 1.3 | | 37.17 |
| | Chiyo River | Chugoku/Kyusyu | 1.2 | 1,904 | 30.55 |
| | Tenjin & Hino | Chugoku/Kyusyu | 1.4 | | 55.07 |
| 15 | Hii River | Chugoku/Kyusyu | 2.1 | | 45.4 |
| 14 | Gono River | Chugoku/Kyusyu | 3.9 | | 120.79 |
| 13 | Takatsu River | Chugoku/Kyusyu | 1.1 | | 40.71 |
| 12 | Onga River | Chugoku/Kyusyu | 1.0 | | 16.47 |
| 11 | Matsuura River | Chugoku/Kyusyu | 0.4 | | 3.92 |
| | **Korea (2005)** | | **68.1** | **6,050** | |
| 28 | Han River | Gyeonggi | 26.0 (34.0)[1] | 310 | 887 |
| 29 | Geum River | Chungnam, Jeonbuk | 9.9 | 963 | 250 |
| 30 | Youngsan River | Jeonnam | 3.4 | 2,103 | 45 |
| | Seomjin River | Jeonnam | 4.9 | | 102 |
| 31 | Nakdong River | Gyeongbuk, | 23.9 | 1,668 | 365 |
| | **Russia (2002)** | | **103.9** | **3,092** | |
| 32 | Tumen | Jilin/Heilongjiang | 33.2 | | 287 |
| | Tsukanovka etc.[2] | Primorskii-1 | 1.5 | 376 | 25.4 |
| 33 | Razdolnaya | Primorskii-2 | 16.8 | 113 | 71.9 |
| 34 | Artyomovka etc.[3] | Primorskii-3 | 2.6 | 295 | 15.7 |
| 35 | Partizanskaya | Primorskii-3 | 4.1 | | 42.0 |
| | Margaritovka etc.[4] | Primorskii-4 | 5.7 | 404 | 66.9 |
| 36 | Avvakumovka | Primorskii-4 | 3.2 | | 31.9 |
| | Zerkalnaya | Primorskii-4 | 1.9 | | 17.5 |
| 37 | Rudnaya | Primorskii-5 | 1.1 | 18 | 14.5 |
| 38 | Serebryanka etc.[5] | Primorskii-6 | 8.6 | 1,119 | 94.2 |
| 39 | Maksimovka | Primorskii-6 | 2.2 | | 32.1 |
| 40 | Samarga etc.[6] | Primorskii-6 | 12.1 | | 155.9 |
| 41 | Koppi | Primorskii-6 | 7.3 | | 68.5 |
| 42 | Tumnin | Primorskii-6 | 22.4 | | 252 |
| | Rivers from SW of Sakhalin Is. | Sakhalin-SW | 5.3 | 767 | 105.7 |

* - Number of river on Figure 1; ** - Data from Zhang et al.,1998; *** - Coastline within NOWPAP region; [1] – Including watershed in PDRK; 2 – Including Amba, Barabash and Narva Rivers; 3 – Including Shkotovka and Suhodol Rivers; 4 – Including Kievka,Chernaya and Milogradovka Rivers; 5 – Including Gigit, Kema, and Amgu Rivers; 6 – Including Svetlaya, Peya, Kabanya and Edinka Rivers.

The climate in Korea is similar to the temperate climate of the Japanese and Chinese coasts. Average January temperatures range from -7°C to +1°C and average July temperatures range from 22°C to 29°C in Seoul. Rainfall is concentrated in the summer months of June through September. The river runoff is maximum in summer also. The southern coast gets late summer typhoons that bring strong winds and heavy rains. Average annual precipitation in Seoul is 1,370 millimeters and in Busan - 1,470 mm.

Cold dry winters and moderate warm humid summers are typical for the Primorskii Krai – Russian mainland part of NOWPAP region. There is clear shift of air temperature decrease in winter and increase in summer in moving away from the coast to the west even for the distance 30-50 km. The average temperature in coastal zone is – 10-12°C in winter, and +16°C in summer. Annual precipitation decreases from about 800 mm at the sea coast to 650 mm near the Khanka Lake 200 km away the sea. 80-95% of annual precipitation comes in the April to October period, and major part of river runoff takes place in summer.

Climate of southwestern part of Sakhalin Is. is more soft with average temperature - 6°C in January, and +19°C in August. Annual precipitation varied between 750 mm and 990 mm for the different place, that is close to Primorskii Krai, but distribution through the year is more even, and distinct snow accumulation is observed around the whole island. The bi-modal distribution of Sakhalin's river discharge takes place due to this reason.

## 2.4. General Information on Inputs of Pollutants from Land Based Sources

Most of the material entering the marine ecosystems is of terrestrial origin, and thus can be described as from land based sources. Three general terrestrial patterns are identified: 1) atmospheric; 2) via rivers; 3) direct flow into the sea via dumping, sewages and storm water runoff. Atmospheric pollutants include material that are dropped with rain and snow; these have been reviewed in Regional Overview of WG1 (POMRAC Technical Report #3, 2007) and continue to be analyzed in Regional Overview on Atmospheric Deposition Models in NOWPAP Region which is under preparation.

The difference between river input and direct input is obvious in theory but in practice only dumping and sometimes sewage can be assessed separately because most storm waters are difficult to account for and a large portion of the sewage flows through the rivers. Typical sources of river water pollution in all NOWPAP countries are domestic wastewater, industrial and agricultural wastewater, and natural loads. There are two types of discharge of wastewaters: point and non-point. Point sources include constantly existing streams and sewage outlets where the direct measurements of the discharge are possible. The non-point sources include temporary streams, farmland and urban surface runoff, livestock production. Quantitative assessment of this part of input is a difficult task, though some successful models are suggested already (Lai Siyun et al., 2004).

The main part of the pollutant loads from all sources flow into the sea via rivers running through urban and rural areas, industrial areas, and agricultural regions, and to evaluate the input of different types of sources to the river runoff is a challenge. The current features of water pollution sources in different NOWPAP countries are outlined in sections of this overview. The frequently observed distinct changes of the chemical composition of the rivers upstream and downstream allow suggest the land based human activities on the watersheds as a main reason of deterioration of river water quality. Therefore to describe the relationship between land-based sources of pollution and characteristics of water quality seems to be very useful for the arrangement of proper environmental management. Another approach to distinguish the natural and anthropogenic contribution in the fluxes of matter entering to the sea is to compare the data on the different industrial and agricultural emissions with the river run off. Although one should take into account that river water composition could be already altered by the human activity.

Many of China's rivers carry contaminated water into marine and coastal environments. Most, but not all wastewater sources are well treated before release. Many national and local laws and regulations exist to manage and control pollution from discharging sources. There are two basic environmental and effluent quality standards to protect the environment and to reduce pollution volumes; discrepancies in these standards are being addressed. There are environmental standards for surface water, ground water, marine water, and for special usage water as well. The main parameters that are regulated include chemical oxygen demand (COD), biochemical oxygen demand (BOD), and ammonia nitrogen ($NH_4$-N) in fresh water, and COD, oils, inorganic nitrogen (IN), and active phosphate ($PO_4$) in marine water.

In 2007 year, the total quantity of waste waters discharged in the five provinces relevant to the NOWPAP area: Jiangsu, Shandong, Liaoning, Jilin and Heilongjiang was 12.68 bln. tons, including 6.09 bln. tons of industrial wastewaters and 6.60 bln. tons of municipal sewages. The quantity of COD was 3.13 million tons with 1.15 million tons in industrial wastewaters and 1.98 million tons in the municipal ones. The total quantity of ammonia was 303,000 tons, among them the industry ammonia was 60,000 tons, and the sewage ammonia was 241,000 tons. The quantity of waste water, COD, and ammonia in 2005 were all slightly (6-15%) higher than that in 2001. In 2007 the amount of waste water continue to rise on 1.5% annually, but quantity of COD and ammonia decreased down to the level of 2001-2002.

The very big amount of the wastewaters and wastes generated in China leads to the serious ecological issues in the coastal sea areas and in the rivers themselves and needs attention from the society.

In Japan domestic wastewater is classified in two categories, human sewage (sometimes called night soil) and gray water, wastewater from kitchens, laundries, and bathrooms, excluding human sewage. The human sewage or night soil is 100% treated. However, as of 2007, 87% of the gray water discharge is treated nationally, thus the remaining percentage of the gray water is discharged untreated. Domestic wastewater load is on the decline since sewage systems are becoming more wide spread and because the nation is converting to a combined processing johkasou* (septic tank) from the single processing johkasou.

Industrial wastewater discharge in Japan is regulated by the Water Pollution Control Law, the basis for national effluent standards. Prefectures are authorized to establish more stringent standards to regulate wastewater discharged from factories and business establishments into public water bodies. The standards are applied to factories and business, with the "Specified Facilities" defined by cabinet orders.

In Japan the concept of natural load includes the load of naturally occurring substances flushed into rivers or the sea from forest, agricultural area and urban areas, and from the atmosphere as a result of rainwater or snowmelt runoff. Controlling natural loads from non-point sources is difficult. The government is studying potentially effective control measures. The government has developed a new type of drainage support system and the creation of management plans for the aquatic environment to reduce the pollution load from non-point sources.

Discharge to the sea is regulated in Japan by the Agreement Concerning the Prevention of Seawater Pollution by the Dumping of Waste and Other Things (London Convention 1972). The Japanese legal system allows waste discharge to the sea only in designated areas of the sea and only after the articles and standards prescribed by Waste Management and Public Cleansing Law and Law Concerning the Prevention of Seawater Pollution and Maritime Disasters are applied. A protocol to rescind the amendment of the London Convention of 1972 was adopted in 1996 (1996 Protocol). In the protocol, the list (Reverse List) of wastes that can be discharged into the sea was replaced by the present list of prohibited substances. The 1996 Protocol entered into force in 2006. The Japanese government ratified the Protocol in 2007, and the Protocol entered into force in the same year in Japan.

The total amount of the waste waters generated in Korea slightly increased from 2.89 bln tons in 2001 to 2.92 bln tons in 2005. At the same period the total amount of discharged waste waters decreased from 0.93 bln. tons/year to 0.86 bln. tons/year. In 2006 these positive trends have been changed: the amount of generated waste waters increase significantly up to 3.35 bln.tons in 2007 with consequent increase of discharged waste waters up to 1.05 bln. tons/year. Wastewater in Korea is divided into industrial, livestock, and domestic. The latter accounts for 85% of the total volume of wastewater, industrial wastewater is 14%, and livestock is only 1% of all wastewater. The role of different sources can change depending on substances considered. In the case of BOD load, for example, industrial wastewater input increases to 39% and livestock - 15%, while the role of domestic wastewater decreases to 46%. The domestic sewage treatment rate varies from 59-66% in the agricultural Jeonnam, Gyeongbuk and Chungnam Provinces to 99% in Seoul and Busan, with the national average at 81,4% (2006). It should be noted that in 2001 the average rate of population provided by the sewage systems was 65%. Industrial and livestock wastewater is subject of treatment also.

The absolute amount of the wastewaters generated in the part of Russia relevant to NOWPAP area varies from 1.17 to 1.00 million tons/day (0.43 bln. tons in 2002 and 0.36 bln. tons in 2007). Thus the distinct trend of decrease was observed last five years. This volume of wastewaters looks not so big in the according with relatively low absolute population in the part of Russia under consideration. But amount of waste waters generated by capita reaches up in the Primorye region 266 tons/person.year that is twice comparing with Korea and China. It means that local hot spots are likely possible at the Russian part of NOWPAP area despite the low population density. Domestic wastewater runoff in Russia is assessed by water supply data without distinction between night soil and gray water. The annual discharge of domestic wastewater in Primorskii Krai in 2007 was about 0.132 bln. tons, and about 41% of this amount is discharged untreated and 19% is only partially treated. The annual discharge of industrial wastewater in Primorskii Krai in 2007 was about 0.25 bln. tons, with 94% of this volume discharged untreated. Fortunately, 93% of this untreated industrial wastewater is cooling water from electric power stations that release pretty low levels of contamination. Information on direct input of contaminants in Russia is gathered from official data on municipal and industrial waste volumes and on expert assessment of storm waters runoff.

Information on river input and chemical substances concentration in river water used for the current overview come from observation points located much closer to river mouths and without special attention to processes in the estuaries and mixing zones, though author realizes that estuarine processes are extremely important from the point of view influence of river runoff on the coastal sea areas.

## Sources Used to Develop this Regional Overview:

Regional Overview on River and Direct Inputs of Contaminants into the Marine and Coastal Environment in the NOWPAP Region. NOWPAP POMRAC Technical report # 4, 2006.
State of the Marine Environment in the NOWPAP Region. NOWPAP POMRAC, 2007.
Data from China on River and Direct Inputs of Contaminants in the NOWPAP Region (prepared by Ms. Mingcui Wang, CNEMC)
Data from Japan on River and Direct Inputs of Contaminants Into the Marine and Coastal Environment in the NOWPAP Region (prepared by Dr. Akira Harashima, NIES)
Data from Korea (ROK) on River and Direct Inputs of Contaminants Into the Marine and Coastal Environment in the NOWPAP Region (prepared by Dr. Jae Seong Lee, NFRDI)
Data from Russian Federation on River and Direct Inputs of Contaminants Into the Marine and Coastal Environment in the NOWPAP Region (prepared by Vladimir M. Shulkin, PGI FEBRAS, and Galina I. Semykyna, CEM)
Information sources used to prepare the Regional Overview are cited here, as well as other sources such as scientific papers and open official statistics with proper citation.

# 3. Social and Economic Situation

In **China** five provinces are relevant to the NOWPAP area. There are Heilongjiang, Jilin, Liaoning, Shandong and Jiangsu.

The GDP of Heilongjiang province in 2007 was USD 101.2 Bln, which had increased by 14.5% than last year. The total added industrial value of Heilongjiang Province was USD 38.5 Bln, Heilongjiang Province is abundant in green food, which is the major industry in this region.

The GDP of Jilin Province by the end of 2007 was USD 75.7 Bln, which had increased by 24% than last year. The total added industrial value of Jilin Province was USD 19.5 Bln, The preponderant industry of Jilin Province is resources exploitation and manufacturing industry, including petrol and natural gas exploitation, tobacco manufacturing, black metal smelt, and transportation devices manufacturing ,etc.

The GDP of Liaoning province in 2007 was USD 157.9 Bln, which had increased by 19.5% than last year. The total added industrial value of Liaoning Province was USD 49.8 Bln. The major industries of Liaoning Province are metallurgy industry, oil and petrifaction industry and electronics manufacturing industry, etc.

The GDP of Shandong province in 2007 was USD 372.0 Bln, which had increased by 17.9% than last year. The total added industrial value of Shandong Province was USD 136.7 Bln. The main industry includes petroleum and natural gas exploitation industry, food manufacturing industry, textile industry, chemical materials manufacturing industry, non-metal mineral manufacturing industry, and wiring manufacturing industry, whose production value account for the 54.8% of the whole.

The GDP of Jiangsu province in 2005 was USD 368.8 Bln, which had increased by 19.3% than last year. The total added industrial value of Jiangsu Province was USD 133.4 Bln. The added production value of heavy industry is beyond that of light industry, focused on textile industry, electronics industry, chemicals manufacturing industry, etc.

The social and economic information of the related main territorial objects in the year of 2007 is listed in Table 3.1. It should be noticed that only the parts of the provinces are situated within the NOWPAP Region. The exact data divided within the Region are not available unless carrying on more investigations and works in further. The social and economic information of the related main territorial objects in the year of 2008 has not been published in public.

The trend of GDP per capita in the 2001-2007 period is presented at Fig.2. Obviously significant growth of the economic activity takes place despite the almost stable population.

Table 3.1. Geographical Characteristics and Economic Conditions
in Chinese Provinces Relating to NOWPAP (2007)

| **Province** | **Area, $10^3$ km$^2$** | **Population (million)** | **Population density (per/km$^2$)** | **GDP, $10^6$ USD** | **GDP per capita, USD/person** |
|---|---|---|---|---|---|
| Jiangsu | 100 | 76.25 | 762 | 368,823 | 4,837 |
| Shandong | 150 | 93.67 | 624 | 372,043 | 3,972 |
| Liaoning | 150 | 42.98 | 286 | 157,946 | 3,675 |
| Jilin | 180 | 27.30 | 152 | 75,720 | 2,774 |
| Heilongjiang | 460 | 38.24 | 83 | 101,228 | 2,647 |
| Subtotal/average | **1,040** | **278.44** | **268** | **1,075,760** | **3,864** |

Socio-economic characteristics for **Japanese** prefectures in the NOWPAP region are listed in Table 3.2. The population in these prefectures in 2007 was 33,917,000 or 26.55% of Japan's total population. Average population density in 2007 was 316 people per km$^2$, which is below the national average of 351 people per km$^2$ in the same year.

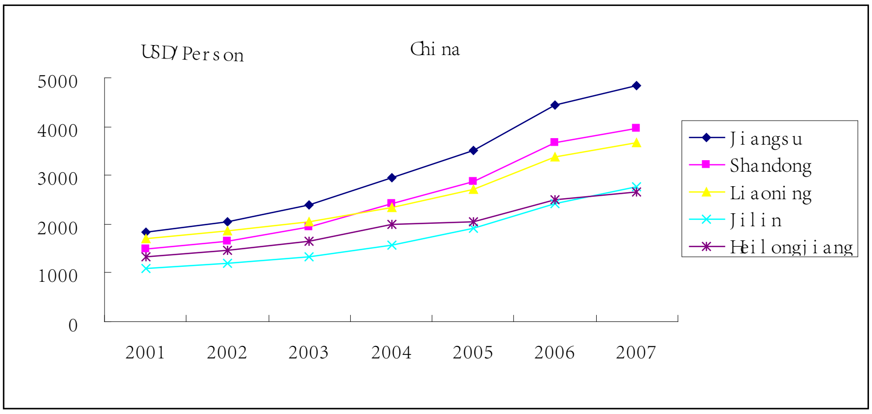



Figure 2. The change of GDP per capita in the provinces of China relevant to the NOWPAP area

In terms of annual changes, over the 6 years from 2001 to 2007, the population density in the study region decreases by 2.2%, on the other hand, the national population density increased by 0.4%. Over the same period, all prefectures in the region studied except Hyogo and Fukuoka Prefectures showed a decrease in the population density from -5.3% to -0.4%, while the population density in Hyogo and Fukuoka prefectures showed less than 0.5% increase.

Cities with populations over one million are Sapporo City (1,823,000 people), Fukuoka (1,302,500 people), and Kitakyushu (999,800 people). Cities with populations between 300,000 to 500,000 people include Niigata, Kanazawa, Asahikawa, Nagano, Toyama, Akita, Yamagata, Fukui, and Shimonoseki, these in declining order. 7,181,198 people (20% of total) live in such big cities.

Table 3.2. Socio-Economic Characteristics of Japanese Prefectures in the NOWPAP Region (2007)

| **Prefecture** | **Region** | **Area, km$^2$** | **Population (1000 peoples)** | **Population density (per km$^2$)** | **GDP $10^6$ USD*** | **GDP, USD per capita*** |
|---|---|---|---|---|---|---|
| Hokkaido | Hokkaido | 83 456 | 5, 570 | 67 | 197, 416 | 35,077 |
| Aomori | Touhoku | 8 918 | 1 ,407 | 158 | 42,748 | 29,748 |
| Akita | | 11 434 | 1, 121 | 98 | 36, 947 | 32,240 |
| Yamagata | | 6 652 | 1, 198 | 180 | 41, 152 | 33,842 |
| Niigata | Hokuriku(N) | 10 789 | 2 ,405 | 223 | 93, 731 | 38,557 |
| Toyama | Hokuriku(S) | 2 046 | 1, 106 | 541 | 46, 807 | 42,093 |
| Ishikawa | | 4 185 | 1 ,170 | 280 | 46, 129 | 39,292 |
| Fukui | | 4 189 | 816 | 195 | 33, 584 | 40,856 |
| Nagano | Chubu | 13 105 | 2, 180 | 166 | 81, 993 | 37,337 |
| Kyoto | Kiriki | 4 613 | 2, 635 | 571 | 100, 297 | 37,877 |
| Hyogo | | 8 396 | 5 ,589 | 666 | 188, 572 | 33,728 |
| Tottori | Chugoku | 3 507 | 600 | 171 | 20 ,057 | 33,043 |
| Shimane | | 6 708 | 731 | 109 | 24,967 | 33,648 |
| Yamaguchi | | 6 113 | 1, 474 | 241 | 59,463 | 39,828 |
| Fukuoka | | 4 844 | 5, 056 | 1 044 | 180, 840 | 35,810 |
| Saga | | 2 440 | 859 | 352 | 29,355 | 33,897 |
| **Subtotal** | | 181 396 | **33,917** | **Av.316** | **1,224,058** | **35,834** |

*for 2005, enumerated 1 USD= 100 JPY

In 2002 the number of people employed in the service area is 29.2%, in trade - 28.7%, in finance - 3.8%, in government - 3.6%. The total service industry accounts for 65.3% of all employees. The amount of employees in manufacturing is 17.6%, in construction - 9.8%, in transport - 6%, and only 0.7% work in agriculture / forestry and fishing. So the number of employees in primary industries is 0.5%, the number in secondary industries - about 30%, and the number in tertiary industries - about 70%. These figures clearly indicate that most employees are concentrated in the tertiary industries. By 2007 the structure of employees in Japan does not change significantly.

An especially large percentage of employees work in service industries and wholesale food and beverage trade, each of which accounts for 29.3% of all employment, with both industries accounting for about 60% of total employment. Moreover, the number of employees in primary and secondary industries has been decreasing since 1991, whereas the number of employees in tertiary industries has tended to increase. The distribution of employees in different kinds of businesses within Prefectures in the NOWPAP region is similar to rest of Japan, that is main part of employees work in tertiary industries.

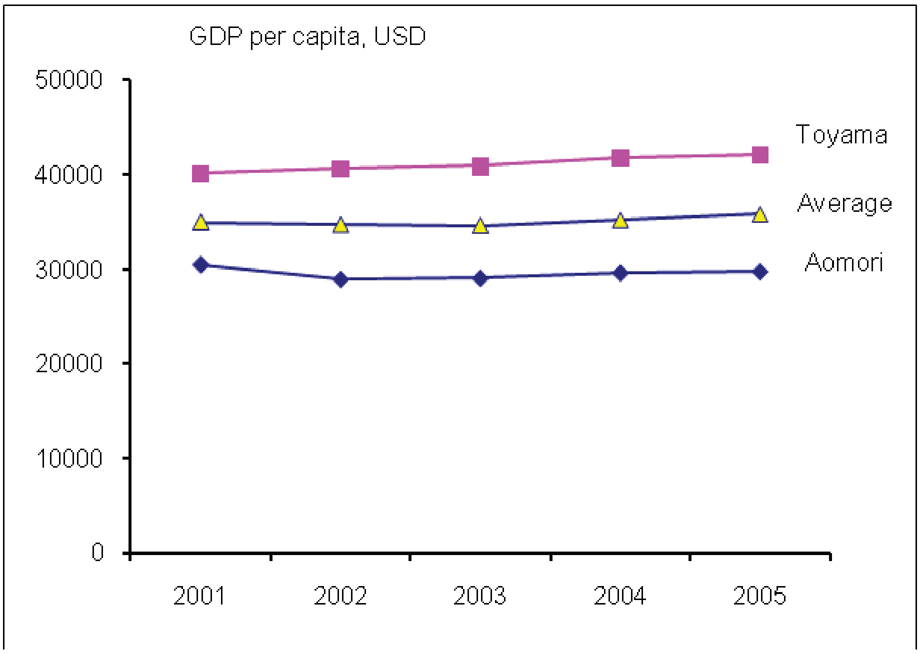



Figure 3. The change of GDP in the prefectures with maximum and minimum GDP per capita, and average for the prefectures relevant to the NOWPAP area

The trend of population and GDP per capita (Fig. 3) indicates clearly the mature character of economy in the Japanese provinces faced to the NOWPAP area as well as in whole Japan.

**Korea's** population in 2007 stood at 48.46 million. Population density is very high in the cities. The seven largest cities (Seoul – 10.3 million peoples, Busan – 3.5 million peoples, Daegu – 2.5 million peoples, Incheon – 2.6 million peoples, Gwangju – 1.5 million peoples, Daejeon – 1.5 million peoples and Ulsan – 1.1 million peoples) accounted for almost half the population of the state. As a result the averaged population density in Korea reaches up 486 person/km$^2$ that is highest among the NOWPAP states. The 3% population growth rate of the 1960s declined sharply to 2% in the 1970s due to improved social and financial living standards, changed social perspective on population issues, and campaigns to control the growing population. The rate has dropped further to below 1% since 1985. Last 5-7 years the population of Korea continue to be almost stable (population growth was 0.3-0.4% per year).

The social-economical features of Korea provinces and largest cities in 2007 are presented on the Table 3.3.

Table 3.3. Socio-Economic Characteristics of Korean big cities and provinces in 2007

| **Province** | **Square, km2** | **Population mln. people** | **Population density in 2007 (people/km2)** | **GDP, $10^6$ USD** | **GDP, per capita, USD** |
|---|---|---|---|---|---|
| Seoul | 605 | 10.03 | 16,564 | 701,674 | 69,958 |
| Busan | 766 | 3.53 | 4,604 | 159,855 | 45,285 |
| Daegu | 884 | 2.47 | 2,794 | 39,361 | 15,936 |
| Incheon | 1,008 | 2.61 | 2,593 | 22,714 | 8,703 |
| Gwangju | 501 | 1.45 | 2,883 | 33,86 | 23,352 |
| Daejeon | 540 | 1.49 | 2,755 | 15,45 | 10,369 |
| Ulsan | 1,057 | 1.08 | 1,021 | 15,835 | 14,662 |
| Gyeonggi P. | 10,123 | 11.04 | 1,090 | 35,696 | 3,233 |
| Gangwon P. | 16,613 | 1.47 | 89 | 19,43 | 13,218 |
| Chungbuk P. | 7,432 | 1.48 | 200 | 21,996 | 14,862 |
| Chungnam P. | 8,600 | 1.94 | 225 | 41,884 | 21,590 |
| Jeonbuk P. | 12,121 | 1.77 | 220 | 21,539 | 12,169 |
| Jeonnam P. | 19,026 | 1.81 | 149 | 33,148 | 18,314 |
| Gyeongbuk P. | 10,524 | 2.64 | 138 | 45,473 | 17,225 |
| Gyeongnam P. | 10,531 | 3.13 | 297 | 48,586 | 15,523 |
| Jeju P. | 1,848 | 0.55 | 295 | 6,207 | 11,285 |
| Total | 99,720 | 48.46 | 486 | 1,262,708 | **26,057** |

The trends of GDP per capita for the most developed Seoul and Busan cities, and for the least developed Jeju province, and for whole ROK as well during the period 2001-2007 are presented at Fig. 4.

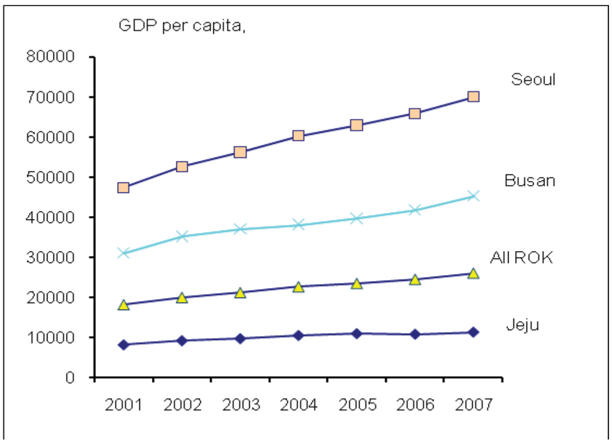



Figure 4. The change of GDP in the areas with maximum and minimum GDP per capita, and average for all Korea

Obviously the Korean economy continues to grow up last years. The number of employees working in primary industries comprised about 0.3% of the total; secondary industries, about 28%, and tertiary industries, about 71% in 2004. The manufacture and wholesale-retail business of foods and beverages accounted for 23% and 28%, respectively, of the total in employment.

Korean agriculture and fishing industries currently face great challenges and account for a very low, 1% of all employees.

Socio-economic features of **Russian** coastal subregions in the NOWPAP area are presented in Table 3.4. These subregions called in Russia "raion" (districts) belong to the three administrative regions: Primorskii Krai (subregions 1 – 5 and part of 6 with overall population 1.177 million people), Khabarovskii Krai (part of region 6 with 0.046 million people), and south-western districts of Sakhalinskaya Oblast (region 7 – 0.190 million people).

Table 3.4. Socio-Economic Characteristics of Russian Coastal Sub-regions within the NOWPAP area in 2007

| Sub-regions | Square, *$10^3$ km$^2$ | Population *$10^3$ person | Population density, per./km$^2$ | Agriculture, *$10^6$ USD | Industry, *$10^6$ USD | GDP *$10^6$ USD | GDP per capita, USD |
|---|---|---|---|---|---|---|---|
| 1 | 4.13 | 36.2 | 8.8 | 3.8 | 25.8 | 950.9 | 3027 |
| 2 | 2.66 | 757 | 284.6 | 33.0 | 1612.3 | 5159.1 | 7789 |
| 3 | 7.51 | 264.1 | 35.2 | 22.2 | 282.3 | 875.4 | 4228 |
| 4 | 15.32 | 57 | 3.7 | 5.8 | 28.9 | 120.9 | 2424 |
| 5 | 5.34 | 48.3 | 9.1 | 3.6 | 130.5 | 250.8 | 5935 |
| 6 | 42.7 | 60.1 | 1.4 | 8.1 | 118.6 | 246.9 | 4696 |
| 7 | 43.7 | 189.8 | 4.3 | 35.6 | 664.6 | 1241.4 | 7475 |
| Total | **121.36** | **1412.5** | **11.6** | **112.1** | **2862.9** | **7990.4** | **6547** |

The sub-regions include: 1 – Khasanski Raion; 2 – Nadezhdinskii Raion plus Vladivostok and Artem, 3 – Shkotovskii and Partizanskii Raions plus Nakhodka and Fokino, 4 – Lazovskii, Olginskii and Kavalerovskii Raions, 5 – Dalnegorskii Raion, 6 - Terneiskii and part of Sovgavanskii Raions, 7 – Southwestern Raions of Sakhalin Island.

Population of districts within NOWPAP area is 60.4%, 7.8%, and 28.1% of total population of Primorskii Krai, Khabarovskii Krai and Sakhalinskaya Oblast, respectively. This means that Primorskii Krai, compared to other large administrative regions (Khabarovskii Krai and Sakhalinskaya Oblast), plays the key role in the economy represented in the Russian part of the NOWPAP region.

The major cities in Primorskii Krai are Vladivostok – 613,400, Artem – 111,500, Nakhodka – 174,600, Fokino – 35,400, Bolshoi Kamen – 39,300, Partizansk – 51,500, Dalnegorsk – 49,400.

Industrial employees (industrial enterprises, transport, construction) account for about 58.5% of all employees; only 3.7% work in agriculture and forestry.

The relative input of agriculture and industry (with construction) production to the GDP is consistent with this distribution of employees. The role of agriculture input varies depending of district from 2 to 20% of industry and construction input, but does not exceed 4% for the region as a whole (Table 3.4).

Service sector employment (service, medicine, education, science, officials) is about 41.5%. At the same time the input of tertiary production accounts for 66% of GDP of the region (Table 3.4).

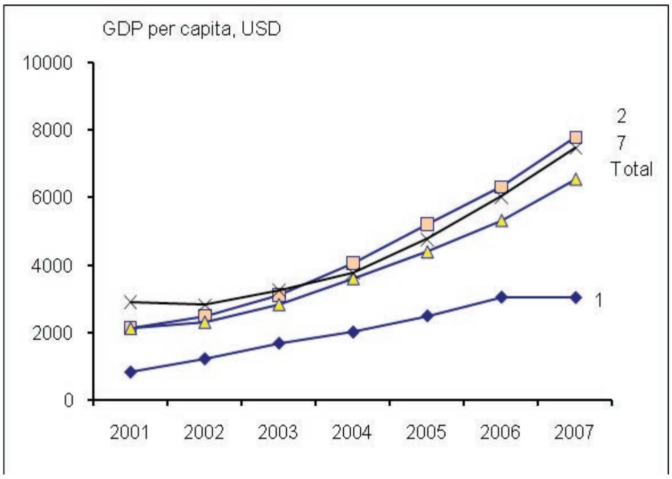



Figure 5. The change of GDP per capita in the areas with maximum and minimum level of development, and average for the sub regions of Russia relevant to the NOWPAP area. Numbers are correspondent to Table 3.4

The main areas of industrial production in Primorskii Krai include energy production and delivery, coal and ore mining, machinery, chemicals, timber industry, textiles, construction and food production. The mining and chemical industries are concentrated in Dalnegorskii District (sub-region 5). The Artem - Vladivostok area (sub-region 2) and Nakhodka (sub-region 3) are the major food and machinery producers. Terneiskii District (sub-region 6) specializes on wood manufacturing. The south-western districts of Sakhalin specialize on the transport services, oil and gas production. The percentage of people employed in goods manufacture has decreased to 52.5% during last 5 years.

The trend of GDP per capita for last 7 years shows significant growth, especially in Vladivostok's agglomeration and in the south-western districts of Sakhalin. The growth of GDP is less pronounced for some other districts (Fig. 5). For all Russian areas within NOWPAP region the declining of population was observed during last years with averaged rate – 0.63% per year.

# 4. Monitoring and Assessment Activities in NOWPAP Member Countries

## 4.1. Overview of National and International Policies and Laws

**China**. National and international laws and regulations relating to the monitoring and prevention of the environment pollution in China are listed in Table 4.1.

Table 4.1 Main Laws and Regulations Related to the Contamination of Environment

| Type | Name and Published Year of Document | Approved by |
|---|---|---|
| Law | Law of Fishery (1986) | People's representative Committee of China |
| | Law of Reservation for Wild Animals (1988) | |
| | Law of Environmental Protection (1989) | |
| | Law of Water and Soil Conservation (1991) | |
| | Law of Prevention on Environmental Pollution by Solid Wastes (1995) | |
| | Law of Water Pollution Prevention (1996) | |
| | Law of Mines Resources (1996) | |
| | Law of Marine Environmental Protection (1999) | |
| | Law of Water (2002) | |
| | Law of Promotion on Clean Production (2002) | |
| | Law of Environmental Influences Assessment (2003) | |
| Legislation | Managing Guidelines to Protecting on Propagation of Aquaculture Resources (1979) | State Council of China |
| | Managing Guidelines to Prevention Marine from Shipping (1983) | |
| | Managing Guidelines to Keep Contamination and Damage from Coastal Construction and Engineering (1990) | |
| | Managing Guidelines to Keep Contamination and Damage from Pollutants in Terrestrial Sources (1990) | |
| | Rules on Implementation of the Law of Prevention of Terrestrial Wild Animals (1992) | |
| | Technical Guidelines on Environmental Impacts Assessment (1993) | |
| | Rules on Implementation of the Law of Prevention of Water and Soil (1993) | |
| | Rules on Implementation of the Law of Prevention of Aquicolous Wild Animals (1993) | |
| | Guidelines on Natural Preservation Zones (1994) | |
| | Guidelines on Preservation of wild Plants (1996) | |
| | Management Ordinance of Environmental Protection on Projects (1998) | |
| | Detailed Rules on Implementation of the Law of Prevention of Water Pollution (2000) | |
| | Implementation Guidelines on Law of Forests (2000) | |
| Standard | Sanitary Standard for Drinking Water (1985) | National or Ministries |
| | Water Quality Standard for Fisheries (1989) | |
| | Quality Standard for Agricultural Irrigation (1992) | |
| | Wastewater and Sludge Disposal Standard for Municipal WTP (1993) | |
| | Integrated Wastewater Discharge Standard (1996) | |
| | Sea Water Quality Standard (1997) | |
| | Discharge Standard for Municipal Wastewater (1999) | |
| | Environment Quality Standard for Surface Water (2002) | |
| | Standard for Pollution Control of Sewage Marine Disposal Engineering (2000) | |

In some provinces, additional local laws were constituted and implemented, such as "Guidelines of ocean using and managing in Shandong province", which was constituted and issued in 2004.

According to "Law of Environmental Protection", Chaper I, Article 7, the envrionmental protection should be carried out by several departments & ministries:

State Environmental Protection Administration (Ministry of Environmental Protection from 2009): responsible for the whole surface waters (i.e. lakes, reservoirs, and rivers), underground waters, coastal and near shores seawaters, and the waste water discharge sources as well. The monitoring items are water qualities, biology, sediments and discharge volumes. This duty is designated by the National laws and regulations, such as Environmental Protection Law and Water Pollution Prevention Law.

The monitoring stations, at every administrative level, have carried the routine monitory tasks, and additional jobs those to meet the supervisory requirements by any kinds uses.

Ministry of Water Resources: responsible for the water resources, through the whole water moving process, from the generation, the influx, the flowing to the allocation for using. The main monitoring items are the water quantities and hydrological characters. The duty is based on the National Water Law.

The measurement stations, divided into each grade of drainage or river basins, take the regulation surveys, and any additional tasks.

Monitoring of the Land Sources of Pollution. From 2008 according to the demand of SEPA we begun the monitoring of the major enterprises in China, including the important factories emitted waste gas and wastewater, and municipal wastewater treatment plants controlled by government. Monitored items for the wastewaters include: pH, COD, $NH_4$_N and flux. Waste-gas includes $SO_2$ and flux; At the monitoring of the wastewater treatment plants the monitored items are coincides with the municipal standards for wastewater treatment plant.

The monitoring reports for the important factoriers controlled by government is reported by CNEMC seasonaly.

Monitoring of sources of direct inputs of contaminants

From 2007, CNEMC started plans for the monitoring of the direct inputs of contaminants around China coastal. The number of 2007 monitored is 610, of 2008 is 646, and of 534 is regular monitoring. The number of the direct inputs of contaminants sources in NOWPAP region (includes Liaoning, Jiangsu and Shandong province) is 116 in all, of them, Liaoning accounts 42, Shandong accounts 51 and Jiangsu accounts 23. Monitoring frequences vary from monthly to twice per year.

National Marine Administration: responsible for the surveys of far shore water qualities at four marine areas. The job is defined in the State Law of Marine Environmental Protections. Major items in the surveys include hydraulics, physics, chemicals, biologics and sediments. The duty is accorded with the Law of Marine Environmental Protection mainly.

Chapter I, Article 7 of the Environmental Protection Law directs the State Council to empower several departments and ministries to carry out environmental protection activities.

Articles 3 and 4 of the Law of the People's Republic of China on the Prevention and Control of Water Pollution (Amended 5/15/1996) establish departments under the State Council and local people's governments to supervise and manage the prevention and control of water pollution.

Article 19 requires urban sewage be disposed of in a centralized way through the sewage treatment facilities.

The Regulation on Environmental Monitoring of the People's Republic of China puts the China National Monitoring Center at the top of the environmental monitoring network. Monitoring stations at each administrative level carry out routine monitory tasks and additional tasks mandated by supervisory requirements.

**Japan.** The system of Japanese statutes governing the discharge of pollutants into rivers or directly into the marine environment is summarized in Table 4.2. The key laws are described below.

Table 4.2. Laws on the Discharge of Pollutants into Rivers or Directly into the Marine Environment

| Type | Title | Purpose, responsibility |
|---|---|---|
| Law | Environment Basic Law (1993) | Monitoring of public water |
| | Water Pollution Control Law | Regulating of effluent quality and quantity |
| | Sewage Law | Sewage construction and management |
| | Johkasou Law | Treatment of domestic wastewater |
| | Wastes Management and Public Cleansing Law | Water quality monitoring of dumping sites and regulation of night soil treatment |
| | Prevention of Marine Pollution and Maritime Disasters Law (according to London Convention (1996) and MARPOL73/78) | Effluent control of oil, hazardous substance, and waste from ships and marine facility, and dumping as well. |
| | Law Concerning Special Measures Against Dioxins | Establish measures relating to soil and water contamination by dioxins |
| | Chemical Substance Release, Reporting and Management Promotion Law | Management of 354 potentially harmful or hazardous chemicals released to the environment |
| | Basic Act on Ocean Policy(2007) | A comprehensive and systematic framework covering the ocean policies in Japan |
| Standards | Environmental Quality Standards | Environment Basic Law |
| | Uniform National Effluent Standards | Water Pollution Control Law |
| | Effluent Quality Standards for Sewage Treatment Facilities | Sewage Law |
| | Criteria for Ocean Dumping | Prevention of Marine Pollution and Maritime Disasters Law |
| | Environmental Standards for Dioxins Concerning Water Quality | Law Concerning Special Measures Against Dioxins |

The Environment Basic Law, which supplants The Basic Law for Environmental Pollution Control (1967), sets out the basic principles for environmental protection policy. This law went into effect on 19 November 1993. The law's intent is to comprehensively and systematically promote environmental protection policies that ensure healthy and cultured living for both current and future generations. It also contributes to the welfare of mankind by articulating basic principles, clarifying the responsibilities of State, local government, corporations and citizens, and by prescribing basic policy considerations for environmental protection.

Through the Environment Basic Law, the government creates a basic environmental protection plan (Basic Environment Plan) to comprehensively and systematically promote environmental protection policy. Under this law, Environmental Quality Standards (EQS) for water pollutants are established as target levels for water quality to be achieved and maintained in public waters.

The Water Pollution Control Law prevents the pollution of public water bodies by regulating effluent discharged by factories and other industrial establishments into surface or groundwater, thus protecting human health and preserving living organisms. The law establishes monitoring procedures to observe the quality of effluent discharged from factories and other industrial establishments into public water bodies, as well as monitoring water quality conditions within those public water bodies. The law establishes a set of national effluent standards. National effluent standards set maximum permissible levels of specific substances water discharged from the factories and businesses where specified facilities are set up.

In accordance with the enforcement of Chemical Substance Release, Reporting and Management Promotion Law in 1999, the Pollutant Release and Transfer Register (PRTR) system was introduced in Japan.

The PRTR system is a system that (i) requires businesses handling chemical substances potentially harmful to the environment to estimate the volume of chemical substances released and transferred in waste, and to report these estimated volumes to their local governments, and (ii) ensures that the national government then compiles data submitted and makes the results available to the general public.

Basic Act on Ocean Policy was enacted in 2007 in response to a necessity for the establishment of a comprehensive and systematic framework covering the ocean policies in Japan. The Act states several basic concepts, which include "harmonization of the development and use of the oceans with the conservation of marine environment", "securing the safety and security on the oceans", "improvement of scientific knowledge of the oceans", "sound development of ocean industries", "comprehensive governance of the oceans", and "international partnership with regard to the oceans".

The loads from different land based sources into the semi-enclosed seas (Tokyo Bay, Ise Bay, and Seto Inland Sea) have been managed under the Total Pollutant Load Control System (TPLCS). Although, these three seas are in the side of the Pacific Ocean rather than the NOWPAP marine area. The TPLCS aims to prevent water pollution in semi-enclosed seas in which the population and industrial activities are highly concentrated. The system was introduced in 1978 as a result of the revision of the Water Pollution Control Law and the Law Concerning Special Measures for Conservation of the Environment of Seto Inland Sea.

The Sewage Law promotes the construction and use of sewage systems to improve public health, to contribute to the healthy development of cities, and to maintain the quality of water in public water bodies.

The Law Concerning Special Measures Against Dioxins was enacted in 1999. The purpose of this law is to protect the health of citizens by establishing policy standards on dioxins, to establish necessary regulations, and to establish measures relating to soil pollution.

In addition to the eight key laws listed in Table 4.2, there are other laws that have water quality provisions, such as the River Law, Coast Law, Harbors Law, and Fishing Port Law. These laws authorize those in charge of managing rivers, coastal areas, and harbors to regulate or restrict human activities for the purpose of protecting water quality.

**Korea.** Korean environmental policies and laws related to regular environmental monitoring and conservation were first promulgated in the early 1960s (Table 4-3). Briefly, the history of environmental legislation can be divided into three periods, based on political decisions. In the 1960s, six basic environmental policies were established. Between the 1970s and 1980s, following the trend of the times, environmental conservation efforts were intensified. From the 1990s to the present, Korean environmental policies have developed based on various environmental issues and social demands.

Several laws are promulgated to control the land-based source of pollution. Point sources and non-point sources of pollution are controlled by the "Water Quality Conservation Act (1990)". The law sets the discharge quality standard for discharges from industrial treatment facilities. The discharges from sewage treatment facilities are regulated by "Sewage Act (1990). Also, the discharges from livestock industries are regulated by the "Act on the Disposal of Sewage, Excreta & Livestock Wastewater (1990)." The sea water quality standard is set by the "Marine Pollution Prevention Act (MPPA, 1991)." Under MPPA, the specially managed area can be designated for the restoration of polluted sea area.

Table 4.3. Key Korean Enviromental Laws

| 1960 (6 Acts) | 1970-1980 (9 Acts) | 1990 - 2008 (46 Acts) | |
|---|---|---|---|
| | | Current Status | Enacted Date |
| Environmental Pollution Prevention Act (1963. 11) | Environmental Conservation Act (1977. 12) | Framework Act on Environmental Policy | 1990. 8 |
| | | Clean Air Conservation Act | 1990. 8 |
| | | Framework Act on Sustainable Development | 2007. 8 |
| | | Environmental Education Promotion Act | 2008. 3 |
| | | Environmental Health Act | 2008. 3 |
| | | Indoor Air Quality Control in Public Use Facilities, etc. Act | 1996. 12 |
| | | Noise & Vibration Control Act | 1990. 8 |
| | | Foul Odor Prevention Act | 2004. 2 |
| | | Special Act on Metropolitan Air Quality Improvement | 2003. 12 |
| | | Water Quality and Ecosystem Conservation Act | 1990. 8 |
| | | Act Relating to the Han River Water Quality Improvement & Community Support | 1999. 2 |
| | | Act on the Nakdong River Watershed Management & Community Support | 2002. 1 |
| | | Act on the Geum River Watershed Management & Community Support | 2002. 1 |
| | | Act on the Yeongsan & Sumjin River Watershed Management & Community Support | 2002. 1 |
| | | Natural Environment Conservation Act | 1991. 12 |
| | | Act on Special Measures for the Control of Environmental Offenses | 1991. 5 |
| | | Environmental Dispute Adjustment Act | 1990. 8 |
| | | Act on Promotion of the Purchase of Environment-Friendly Products | 2004. 12 |
| | | Act on Environmental Test and Examination | 2006. 8 |
| | | Environment Improvement Expenses Liability Act | 1991. 12 |
| | | Natural Park Act | 1980. 1 |
| | | Special Act on the Ecosystem Conservation of Small Islands such as Dokdo Island | 1997. 12 |
| | | Wetland Conservation Act | 1999. 12 |
| | | Environmental Impact Assessment Act | 1999. 12 |
| | | Soil Environment Conservation Act | 1995. 1 |
| | | Act on the Protection of the Baekdu Daegan Mountain System | 2003. 12 |
| | | National Trust Act on Cultural Heritage & Natural Environment Assets | 2006. 3 |
| Act Protection of Birds, Mammals & Hunting (1967. 3) | | Wildlife Protection Act | 2004. 2 |
| | Environmental Pollution Prevention Corporation Act (1983. 5) | Environmental Management Corporation Act | 1983. 5 |
| | | Act Relating to Special Accounting for Environmental Improvement | 1994. 1 |
| | | Development of & Support for Environmental Technology Act | 1994. 12 |

| | | | |
|---|---|---|---|
| Act Relating to Toxic & Hazardous Substances (1963.12) | | Toxic Chemicals Control Act | 1990. 8 |
| | | Persistent Organic Pollutants (POPs) Control Act | 2007. 1 |
| Waste Cleaning Act (1961. 12) | Waste Control Act | Wastes Control Act | 1986. 12 |
| | | Act on the Disposal of Sewage, Excreta & Livestock Wastewater (annulled on Sep. 28, 2007) | 1991. 3 |
| | | Act on the Management and Use of Livestock Manure (jointly enacted) | 2006. 9 |
| | | Act on the Promotion of Saving and Recycling of Resources | Dec. 8, 1992 |
| | | Act on Resource Recycling of Electrical and Electronic Equipment and Vehicles (jointly enacted) | Apr. 27, 2007 |
| | | Act on the Control of Transboundary Movement of Hazardous Wastes and Their Disposal | Dec. 8, 1992 |
| | | Act on the Promotion of Construction Waste Recycling | Dec. 31, 2003 |
| | | Promotion of Installation of Waste Disposal Facilities and Assistance, etc. to Adjacent Areas Act | Jan. 5, 1995 |
| | | Sudokwon Landfill Site Management Corporation Act | Jan. 21, 2000 |
| | Compound Waste Treatment Corporation Act (1979. 12) | Korea Environment & Resources Corporation Act | Dec. 27, 1993 |
| Water Supply & Waterworks Installation Act Dec. 31, 1961 | | | |
| | | Management of Drinking Water Act | Jan. 5, 1995 |

The special waste discharge standards can be set and total daily maximum loads (TMDL) system can be introduced in the special management areas according to the law. MOMAF is preparing for the application of TMDL system to one of SMAs in 2007.

In Korea, the Total Daily Maximum Loads (TMDL) systems are applied to 4 major rivers and special management areas (SMAs). Special laws for the 4 rivers management were enacted by 2004 and are under enactment for SMAs. Under TMDL system, the target water quality and the total allowable discharges are determined prior to the implementation of the TMDL system. The target and total discharges are determined by scientific research and consensus-building of residents of area. Then, the total allowable discharges of pollutants are allocated to the region.

In Korea and in Japan as well, the discharge standard is based on the degree of contamination. Discharge permit is required explicitly in Korea and Japan but not in China.

In Korea, the dumping into the sea is regulated by Marine Pollution Prevention Act (1991). According to the law, dumping sites are designated, the limited dumping items are permitted, and permission certification for dumping is issued by the Commissioner General of Korea Coast Guard. Recently, Korean government announced the comprehensive plan for ocean dumping reduction. According to the plan, Korean government reduced the permissible items from 14 to 9 in 2006 and will reduce the dumping amount by half by 2011 compared to the dumping amount of 2004.

**Russia.** Federal laws, Federal Government decisions, and water quality standards established and amended at the Federal level (Table 4.4) are the legal basis for water use and water protection in Russia. The goal of the Federal Law "On Environmental Protection" is to establish and strengthen environmental law enforcement and to maintain environmental safety in the Russian Federation

Table 4.4. Key Russian Laws on water quality and water use.

| Type | Name and Published Year of Document | Purpose, responsibility |
|---|---|---|
| Laws approved by State Duma and Federal Council | Federal Law «On Environmental Protection» (Article 1), (No. 7-FZ of January 10, 2002). | definition and management of state environment monitoring |
| | "Water Code" of the Russian Federation (Article 78) (October 18, 1995). | description of water objects monitoring |
| | «The Federal law on wildlife» (No.52 - FZ of April 24,1995) | monitoring of water quality in protected areas |
| | Federal Law « On a continental shelf of the Russian Federation » (Article 33) | water quality issues during resources use at the continental shelf |
| Legislation approved by Government of the Russian Federation Decisions | "The agreement on cooperation in the field of ecological monitoring of the states - participants of the CIS » (The decision of the Government No.299 of April 04,2000) | coordination of structure and monitoring schemes within CIS |
| | « On Organization and Realization of the State Monitoring of Environment (the State Ecological Monitoring) – The Decision of the Government No. 177 of March 30,2003 | improvement of existing territorial structure for the state ecological monitoring |
| | "On State Service of Environmental Monitoring" - The Decision of the Government No. 622 of August 23, 2000 | definition and creation of state service of environmental monitoring |
| Standard approved by Ministries | Sanitary Standard for Drinking Water (1996) SanPIN 2.1.4.559-96 | Sanitary Epidemiological Service of the Ministry of Health (up to 2001) |
| | Sanitary Standard for the water of domestic, drinking and cultural uses – "public waters" (1996) according to SanPIN 2.1.4.559-96 | |
| | Sanitary Standard for Drinking Water (2003) according to GN 2.1.2.1315-03 | State Office for Supervision on the Protection of Consumer's Rights and Human Welfare – subdivision of Ministry of Health and Social Development (after 2001) |
| | Sanitary Standard for the water of domestic, drinking and cultural uses – "public waters" (2003) according to GN 2.1.2.1315-03 | |
| | Standard for the waters used for the fishery purposes – VNIRO, 1999 | State Fishery Service – subdivision of Ministry of Agriculture |

The "Russian Federation Act on Protection of the Natural Environment" (1991), and the "Regulation on a State Control of the Use and Protection of Water Objects" (1997) are the other main laws for these issues.

Government monitoring of water objects is an integral part of a system of environmental monitoring in Russia, and is described in detail in the Federal Water Code. Monitoring of water objects is managed by specially authorized government agencies established to regulate the use and protection of water resources. They work alongside of specially authorized government agencies that address environmental protection, government agencies that deal with hydrometeorology and environmental monitoring (surface water objects) and government agencies that deal with the use and protection of ground water sources.

Federal authorities of the Russian Federation establish monitoring procedures for water objects.

Environmental impact assessment is carried out in Russia in accordance with the federal laws on Ecological Expertise and on the Protection of the Environment. Article 105 of Federal Water Code also provides provisions for environmental impact assessment. Several normative legal acts have been adopted for further elaboration of these laws.

## 4.2. National and International Monitoring Programs

Each NOWPAP country has its own regulatory system based on its special economic, political, legal and social structure. However, a common point in all the government structure is that the regulatory system should be effective and efficient. Therefore, in order to reduce the problems created by fragmentation of competing regulatory authorities in environmental protection, an integrated approach has been more and more widely adopted in many countries.

The monitoring of surface water quality (rivers and lakes) as well as of coastal water is the distinct responsibility of each NOWPAP country. International cooperation is needed to exchange information, to conduct joint research projects, and to hold training activities. Water quality monitoring is carried out as part of each country's national program and according to country rules.

**China.**

The State Environmental Protection Administration is responsible for all surface water (lakes, reservoirs and rivers), underground water, coasts and near shore seawater, and wastewater discharge. It monitors water quality, biology, sediments and discharge volumes. This authority is provided in national laws and regulations, such as the Environmental Protection Law and the Water Pollution Prevention Law. Monitoring stations at every administrative level carry out routine monitory tasks and additional tasks mandated by supervisory requirements.

There are four levels of environmental monitoring in China: (1) China National Environmental Monitoring Center; (2) environmental monitoring centers in different provinces or municipalities governed by the central government; (3) environmental monitoring centers in municipalities governed by the provincial government; (4) environmental monitoring center in the counties and the district of municipalities.

Table 4.5. Chinese Surface Water Standards (GB3838-2002)

| No. | Item | Unit | Grade I | Grade II | Grade III | Grade IV | Grade V |
|---|---|---|---|---|---|---|---|
| 1 | pH | - | 6~9 | | | | |
| 3 | DO ≥ | mg/L | 7.5 | 6 | 5 | 3 | 2 |
| 4 | $COD_{Mn}$≤ | mg/L | 2 | 4 | 6 | 10 | 15 |
| 5 | COD≤ | mg/L | 15 | 15 | 20 | 30 | 40 |
| 6 | $BOD_5$ ≤ | mg/L | 3 | 3 | 4 | 6 | 10 |
| 7 | $NH_4^-$ ≤ | mg/L | 0.15 | 0.5 | 1.0 | 1.5 | 2.0 |
| 8 | T P ≤ | mg/L | 0.02 | 0.1 | 0.2 | 0.3 | 0.4 |
| 9 | T N ≤ | mg/L | 0.2 | 0.5 | 1.0 | 1.5 | 2.0 |
| 10 | Cu ≤ | mg/L | 0.01 | 1.0 | 1.0 | 1.0 | 1.0 |
| 11 | Zn ≤ | mg/L | 0.05 | 1.0 | 1.0 | 2.0 | 2.0 |
| 12 | F- ≤ | mg/L | 1.0 | 1.0 | 1.0 | 1.5 | 1.5 |
| 13 | Se ≤ | mg/L | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 |
| 14 | As ≤ | mg/L | 0.05 | 0.05 | 0.05 | 0.1 | 0.1 |
| 15 | Hg ≤ | mg/L | 0.00005 | 0.00005 | 0.0001 | 0.001 | 0.001 |
| 16 | Cd ≤ | mg/L | 0.001 | 0.005 | 0.005 | 0.005 | 0.01 |
| 17 | Pb ≤ | mg/L | 0.01 | 0.01 | 0.05 | 0.05 | 0.1 |
| 18 | $Cr^{6+}$ ≤ | mg/L | 0.01 | 0.05 | 0.05 | 0.05 | 0.1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 19 | CN-≤ | mg/L | 0.005 | 0.005 | 0.2 | 0.2 | 0.2 |
| 20 | V-phen≤ | mg/L | 0.002 | 0.002 | 0.005 | 0.01 | 0.1 |
| 21 | oils≤ | mg/L | 0.05 | 0.05 | 0.05 | 0.5 | 1.0 |
| 22 | LAS≤ | mg/L | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 |
| 23 | S-≤ | mg/L | 0.05 | 0.1 | 0.2 | 0.5 | 1.0 |
| 24 | Fcg≤ | cell/L | 200 | 2,000 | 10,000 | 20,000 | 40,000 |

Monitoring stations at each administrative level carry out routine monitoring tasks and additional tasks called for in regulatory requirements. There are two sets of river monitoring stations.

The first set includes 479 stations in six key drainage areas in NOWPAP regions: Haihe, Huaihe, Liaohe, Yangtze, Yellow, and Songhua Rivers. Water temperature, pH, electrical conductivity, dissolved oxygen, $COD_{Mn}$, $BOD_5$, $N\text{-}NH_4$, oil, volatile hydroxybenzene, Hg, Pb, water discharge are monitored monthly.

A second set includes 43 automatic stations within the drainage areas mentioned above. Automatic stations have operated since 1999 and register hourly and report weekly on water temperature (T), pH, dissolved oxygen (DO), electric conductivity (EC), turbidity (TB), chemical oxygen demand ($COD_{Mn}$), total organic carbon (TOC) and ammonium nitrogen ($NH_3$-N).

The assessment of surface water quality complies with the Environmental Quality Standard for surface water (GB3838-2002) (Table 4.5).

A single factor assessment method is used for the surface water quality classification system, namely once any assessment indicator at a certain monitoring site exceeds standards, water quality is changed to the next grade.

Surface water is divided into 5 grades according to the standard:

Grade I: River, lake, etc; nature reserve water source.

Grade II: First level reserve area drinking water source, habitat of rare aquatic animals and plants, spawn
ing area for fish and shrimp, food source area of cub hood fish.

Grade III: Second level reserve area drinking water source, winter habitat for fish and shrimp, migration routes,
fishery area and swimming area.

Grade IV: Water source for industry and water for amusement.

Grade V: Agricultural water source and water for sightseeing.

**Japan.**

Monitoring of surface, ground and coastal water quality is the responsibility of the prefectural governments and local offices of national administrative agencies. Moreover, a company that discharges effluents from specified factories are mandated to measure pollutant levels in their effluents and keep records of the measured findings for government inspection. Table 4.6 presents an outline of water quality monitoring. The total number of both the environmental standard points and the supplementary points on the 35 first class rivers in the NOWPAP region is 271, whereas the total number of the corresponding points in the prefectures in the NOWPAP region is 3,480.

Table 4.6. Water Quality Monitoring under the Water Pollution Control Law

| Water Type | Person Responsible for Observation | Number of Survey Points | Content of Observations | Frequency |
|---|---|---|---|---|
| Public water area (river, lakes and coastal area) | Prefectural governor and government ordinance mayor | Environmental standards monitoring point (5,978 points in all area of Japan, 2006 FY) | Environmental quality standard item concerning protection of human health | More than once a month |
| | | | Environmental quality concerning conservation of living environment | More than once a month |
| Industrial wastewater | Operating company | Facilities under the pollution control law | Effluent standard item | Measuring according to the situation |

The assessment of water and effluent quality is based on compliance with Environmental Quality Standards (EQS). Japanese EQS include EQS to protect human health (Table 4.7), EQS to protect living organisms (Table 4.8, 4.9), and effluent standard parameters (Table 4.10).

Table 4.7. Environmental Quality Standards to Protect Human Health

| Item | Standard Value |
|---|---|
| Cd, Pb, As, Se | 0.01 mg/L or less |
| Chromium (VI) | 0.05 mg/L or less |
| Total mercury | 0.0005 mg/L or less |
| Alkyl mercury, total cyanide | not detectable |
| Dichloromethane, 1,1-Dichloroethylene, Thiobencarb | 0.02 mg/L or less |
| Carbon tetrachloride, 1, 3-dichloropropene | 0.002 mg/L or less |
| 1, 2-dichloroethane | 0.004 mg/L or less |
| cis-1, 2-dichloroethylene | 0.04 mg/L or less |
| 1, 1, 1-trichloroethane | 1.0 mg/L or less |
| 1, 1, 2-trichloroethane, Thiuram | 0.006 mg/L or less |
| Trichloroethylene | 0.03 mg/L or less |
| Benzene, Tetrachloroethylene | 0.01 mg/L or less |
| Simazine | 0.003 mg/L or less |
| Nitrate nitrogen and Nitrite nitrogen | 10 mg/L or less |
| Fluorine, Boron | 0.8 -1.0 mg/L or less |
| Chloroform, 1, 2-dichlorpropane | 0.06 mg/L or less* |
| trans-1, 2-dichloroethylene, Isoprothiolane, oxine copper | 0.04 mg/L or less* |
| EPN | 0.006 mg/L or less |
| p-dichlorobenzene | 0.2 mg/L or less* |
| Diazinon | 0.005 mg/L or less* |
| Fenitrothion (MEP) | 0.003 mg/L or less* |
| Chlorothalonil (TPN) | 0.05 mg/L or less* |
| Propyzamide, Dichlorvos (DDVP), Iprobenphos (IBP), Isoxathion | 0.008 mg/L or less* |
| Fenobucarb (BPMC) | 0.03 mg/L or less* |
| Xylene & Toluene | 0.4-0.6mg/L or less* |
| di (2-etylhexyl) phatalate | 0.06mg/L or less* |
| Molybdenum | 0.07mg/L or less* |
| Antimony | 0.02mg/L or less* |
| Vinyl chloride monomer | 0.002mg/L or less* |
| Epichlorohydrin | 0.0004mg/L or less* |
| 1,4-dioxane | 0.05mg/L or less* |
| Total manganese | 0.2mg/L or less* |
| Uranium | 0.002mg/L or less* |

*- Additional data on their health effects must be collected before EQS can be established and their concentrations in the environment monitored.

Table 4.8. Environmental Quality Standards to Protect Rivers/Lakes

| Class | Item | Standard value (annual mean) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Water Use** | **pH** | **BOD*** | **SS** | **DO** | **Total Coli** | **Total N**** | **Total P**** | **Total Zn** |
| AA | Water supply class 1, conservation of natural environment, | 6.5-8.5 | < 1 mg/L | < 25/1 mg/L | >7.5 mg/L | 50 MPN/100ml | <0.1 mg/l | <0.005mg/l | <0.03 mg/l |
| A | Water supply class 2, fishery class 1, bathing | 6.5-8.5 | < 2 mg/L | < 25/5 mg/L | >7.5 mg/L | 1000 MPN/100ml | <0.2 mg/L | <0.01 mg/L | <0.03 |
| B | Water supply class 3, fishery class 2, | 6.5-8.5 | < 3 mg/L | < 25/15 mg/L | >5 mg/L | 5000 MPN/100ml | <0.4 mg/L | <0.03 mg/L | <0.03 |
| C | Fishery class 3, industrial water class 1, | 6.5-8.5 | < 5 mg/L | < 50 mg/L | >5 mg/L | - | <0.6 mg/L | <0.05 mg/L | <0.03 |
| D | Industrial water class 2, agricultural water | 6.0-8.5 | < 8 mg/L | < 100 mg/L | >2 mg/L | - | <1 mg/L | <0.1 mg/L | |
| E | Industry water class 3 and conservation of environment | 6.0-8.5 | < 10 mg/L | | >2 mg/L | - | <1 mg/L | <0.1 mg/L | |

Notes: * - BOD for rivers, $COD_{Mn}$ for lakes, SS: Suspended Solids, DO: Dissolved Oxygen, MPN: Most Probable Number; ** - for lakes only- At intake for agriculture, pH should be between 6.0 and 7.5 and DO shall be higher than 5mg/L. - Standard values are applied to unfiltered sample.

Environmental quality standards (EQS) to protect living organisms are established in accordance with a Japanese classification system that sets six grades for all public water bodies (Table 4.8). Some additional guidelines are established for substances dangerous for most sensitive aquatic organisms (salmon, crustaceans, their spawning stages) (Table 4.9).

Table 4.9. Guideline Values for Some Toxic Substances to Protect Most Sensitive Aquatic Organisms

| Items | Water Area | Class | Guideline Value |
|---|---|---|---|
| Chloroform | River and Lakes | Aquatic Organisms A | 0.7 mg/L or less |
| | | Aquatic Organisms special A | 0.006 mg/L or less |
| | Coastal Areas | Aquatic Organisms special A | 0.8 mg/L or less |
| Phenols | River and Lakes | Aquatic Organisms A | 0.05 mg/L or less |
| | | Aquatic Organisms special A | 0.01 mg/L or less |
| | Coastal Areas | Aquatic Organisms A | 2 mg/L or less |
| | | Aquatic Organisms special A | 0.2 mg/L or less |
| Formaldehyde | River and Lakes | Aquatic Organisms A | 1 mg/L or less |
| | Coastal Areas | Aquatic Organisms A | 0.3 mg/L or less |
| | | Aquatic Organisms special A | 0.03 mg/L or less |

Notes : Standard values are applied to unfiltered sample

Table 4.10. Uniform National Effluent Standards (Examples)

| **Items related to the protection of the human health** | **Permissible Limits** |
|---|---|
| Cd, Pb, As and its compounds | 0.1mg/L |
| Organic phosphorus compounds and cyanide compounds | 1mg/L |
| Chromium compounds | 0.5mg/L |
| Total mercury | 0.005mg/L |
| PCBs | 0.003mg/L |
| Trichloroethylene | 0.3mg/L |
| Benzene, Tetrachloroethylene | 0.1mg/L |
| Dichloromethane, 1,1-dichloro ethylene, Thiobencarb | 0.2mg/L |
| Total nitrogen | 100mg/L |
| **Items related to the conservation of living environment** | **Permissible Limits** |
| pH | 5.8-8.6 fresh water, |
| Biochemical Oxygen Demand (BOD) | 160mg/L (DAv 120mg/L) |
| Chemical Oxygen Demand (COD) | 160mg/L (DAv 120mg/L) |
| Suspended solids (SS) | 200mg/L (DAv 150mg/L) |
| N-hexane extracts (mineral oil) | 5mg/L |
| Phenols | 5mg/L |
| Dissolved Fe, Mn | 10, 10 mg/L |
| Total Cr, Cu, Zn, | 2, 2, 3 mg/L |
| Number of coliform groups | 3,000/$cm^3$ (DAv) |
| Nitrogen | 120mg/L (DAv 60mg/L) |
| Phosphorus | 16mg/L (DAv 8mg/L) |

Note: These limits are applied to unfiltered sample in principle; DAv – daily averaged

National effluent standards are uniformly applied in Japan and consist of two categories: those that protect human health (24 substances including heavy metals) and those that protect living organisms (16 substances). National effluent standards represent the maximum permissible levels of specific substances allowed in water discharged from the factories. Some of the regulated substances and permissible limit values established under the effluent standards are presented in Table 4.10. Where the national effluent standard is judged inadequate to attain the EQS in a certain water body, the governor of the prefecture is authorized to establish more stringent standards through a prefecture ordinance.

**Korea.** Ministry of Environment (MOE) monitors regularly the quality of water in rivers, streams, lakes, ground water and drinking water to ensure public health. Health injuring substances (biotic and abiotic) enter these waters from domestic activities and from transboundary pollution. Hence it is important to derive a risk assessment based on regular monitoring. Local Environmental Offices affiliated with MOE, local governments, the Korean Water Resources Cooperation (KOWACO) and the Korean Agricultural and Rural Infrastructure Corporation (KARICO) are responsible for managing and operating the monitoring system. Local environmental agencies are responsible for monitoring lakes and rivers. Local governments and KOWACO monitor drinking water supply source. KARICO handles agricultural waters. The National Institute of Environmental Research (NIER) of MOE provides necessary support to MOE and to other monitoring agencies. Regional environmental agencies are responsible for 461 stations, local governments for 820 stations, KOWACO for 139 stations, and KARICO for 417 stations.

Ministry of Land, Transport and Maritime Affairs (MLTMA) and Ministry for Food, Agriculture. Forestry and Fisheries (MFAFF) are responsible for monitoring coastal and open ocean waters for overall health of the marine ecosystem and that of human health. In a similar way, coastal waters are polluted by sewage, shipping, industrial and other domestic activities. Transboundary pollution may be a minor cause as well. These toxic substances may affect local fishery and ecosystem and hence regular monitoring is mandatory.

Korea's freshwater quality monitoring system is presented in Table 4.11 and includes water type, frequency of observations, number of stations and parameters. River water is monitored 12 times per year for 16 essential parameters, 4 times per year for 11 parameters, including trace metals. Water quality parameters at major points (21 stations) of five main rivers (Han, Nakdong, Keum, Yeongsan, and Seomjin) and in the Keumho River are measured 48 times per year for 16 essential parameters, 12 times per year for 11 parameters and once per year for 4 organic compounds.

Lake water is monitored 12 times/year for 21 parameters including nutrients, 4 times/year for 7 parameters including trace metals, and 1 time/year for 4 organic compounds.

Drinking water supply sources, such as rivers and lakes, are monitored more than once per month for 5 parameters, and 4 times per year for 18 parameters, including trace metals and organic compounds. Groundwater quality is measured more than 2 times per year for 19 parameters, including trace metals and pesticides.

Table 4.11. Fresh Water Quality Monitoring in Korea

| Classification | | Frequency | Stations | Parameters |
|---|---|---|---|---|
| River water | | 12 times/yr (five rivers: 48 times/yr) | 648 | Water level (flow rate), pH, DO, BOD, COD, SS, TN, NH3-N, NO3-N, TP, Water Temperature, phenol, Conductivity, MPN, Phytoplankton |
| | | 4 times/yr (12 times/yer) | | DTN, DTP, PO4-P, Chl.a, Cd, CN, Pb, Cr6+, As, Hg, ABS |
| | | One time/yr | | PCB, Organochloride, TCE, PCE |
| Lake water | | 12 times/yr | 185 | Water level (flow rate), pH, DO, BOD, COD, SS, TN, DTN, NH3-N, NO3-N, TP, DTP, PO4-P W.T., phenol, Cond., Chl.a, Transp., MPN, Phytoplankton |
| | | 4 times/yr | | Cd, CN, Pb, Cr6+, As, Hg, ABS |
| | | One time/yr | | PCB, Organochloride , TCE, PCE |
| Water Supply Source | Rivers | more than 1 time/month | 509 | BOD, pH SS, DO, MPN |
| | | 4 times/yr | | Cd, CN, Pb, Cr6+, As, Hg, F, Se, ABS, phenol, NH3-N, NO3-N , TCE, PCE, PCB, Cabaryl, 1,1,1-trichloroethane, Organochloride |
| | Lakes | more than 1 time/month | | COD, pH, DO, SS, MPN |
| | | 4 times/yr | | Cd, CN, Pb, Cr6+, As, Hg, F, Se, ABS, phenol, NH3-N, NO3-N , TCE, PCE, PCB, Cabaryl, 1,1,1-trichloroethane, Organochloride . |
| | Under-ground | more than 2 times/yr | | Cd, As, CN, Pb, Cr6+, Hg, F, Se, ABS, phenol, NH3-N, NO3-N , TCE, PCE, Cabaryl, 1,1,1-trichloroethane, Organochloride, Insecticides. |
| Agricultural Water | | 2 times/yr | 474 | DO, pH, BOD, COD, SS, TN, TP, Cu, Pb, Cd, Cl-, Conductivity, Phytoplankton |
| Industrial wastewater | | 24 times/yr | 122 | DO, pH, BOD, COD, SS, W.T., Cond. |
| | | 12 times/yr | | Cd, CN, Pb, Cr6+, As, Hg, Cu, Zn, Cr, F, ABS, TN, TP, phenol, N-hexan, dis.-Mn, dis.-Fe, MPN, Color |
| | | One time/yr | | Organochloride , PCB, TCE, PCE |

Agricultural waste waters are monitored two times/year for 13 parameters including nutrients and trace metals, while industrial wastewaters monitored 24 times/year for 7 essential parameters, 12 times/year for 19 parameters including trace metals and nutrients, and one time/year for 4 organic compounds.

MOE has installed and been operating 24-hour water quality telemetering systems to constantly monitor the water quality near water supply facilities in four major rivers and streams in Korea. They act as an early warning system for pollutants input into lakes and rivers by sending out a warning signal to managers and operators when it detects a sudden increase in pollutants input. This enables them to quickly respond to any contamination accident. Currently, there are 52 systems installed in 4 major rivers.

MOE provides access to the monitoring data for freshwater bodies through annual reports and its web site (http://www.me.go.kr and http://water.nier.go.kr).

Marine environmental monitoring in Korea started in 1972. Begun as a simple system with very limited parameters measured, the monitoring system has expanded over time to cover newly emerging pollution issues. Currently, monitoring of marine environment in Korea is largely composed of three monitoring systems: national marine environment monitoring system, oceanographic observation system, and red tide monitoring system with other occasional monitoring programs including TMS systems. The coastal monitoring system is the most comprehensive system that monitors coastal environmental qualities at a total of 296 stations in coastal area of Korean peninsula (Table 4.12).

National Fisheries Research and Development Institute (NFRDI) and its three affiliated institutes (East Sea Fisheries Research Institute, South Sea Fisheries Research Institute, and West Sea Fisheries Research Institute) manage the system that monitors general water quality parameters such as temperature, pH, chemical oxygen demand (COD), nutrients, and others, four times per year. Separately, the automatic water quality monitoring systems (9 stations) are installed in polluted semi-closed bay (Masan Bay, Shihwa Lake, Busan, and etc).

Table 4.12. Monitoring parameters of the coastal monitoring system of Korea

| Classification | | Frequency | No. of Stations | Parameters |
|---|---|---|---|---|
| Seawater | General items | 4 times/yr | 296 | W.T., Sal., pH, DO, COD, TN, TP, DIN, DIP, DSi, Oil, SS, Transparency |
| | Trace metals | 2 times/yr | 66 | Cu, Pb, Zn, Cd, Cr6+, Total-Hg, As, CN |
| | Organic compounds | 1 time/yr | 25 | PCBs, TBT |
| Sediment | General items | 1 time/yr | 60 | Particle size, IL, AVS, COD |
| | Trace metals | 1 time/yr | 60 | Cu, Pb, Zn, Cd, Cr6+, Total-Hg, As, CN |
| | Organic compounds | 1 time/yr | 25 | PCBs, TBT, Organochloride, PAHs, PCDDs/DFs |
| Organism | General items | 4 times/yr | 298 | Chl.a |
| | Trace metals | 1 time/yr | 30 | Cu, Pb, Zn, Cd, Cr6+, Total-Hg, As, CN |
| | Organic compounds | 1 time/yr | 25 | PCBs, TBT, Organochloride, PAHs, PCDDs/DFs |
| Automatic W.Q monitoring | Seawater | 2 hour | 9 | W.T, Sal., pH, DO, COD, TN, TP, DIN, DIP, |

Water Quality Standards (WQS) in Korea are the basis for a water quality-based pollution control program mandated by the Clean Water Act of Korea are presented in Table 4.13.

An additional oceanographic observation system that covers coastal sea of the Korean peninsula with a total of 175 stations is also managed by NFRDI and its affiliated institutes. This system monitors temperature, salinity, dissolved oxygen, chlorophyll-a, suspended solids, and nutrients. NFRDI is also responsible for a red tide (commonly harmful algal blooms, HABs) monitoring system with a total of 77 monitoring stations. Korea Coast Guard (KCG) and Korea Hydrographic and Oceanographic Administration (KHOA, www.nori.go.kr) manage the remaining two monitoring systems that mainly monitor physical parameters in offshore waters. Monitoring data from the coastal and offshore monitoring systems are published in annual reports and also posted on the web site of NFDRI (http://www.nfrdi.re.kr).

WQS define the goals for a water body by designating its uses (recreation, water supply, aquatic life, agriculture), by setting criteria to protect those uses (numeric pollutant concentrations and narrative requirements), and by establishing provisions to protect water bodies from pollutants. There are set of definitions for the different water types. For example, 1st grade fishery water means suitability for the aquatic creatures of clean water area, 2nd grade fishery water means suitability for the aquatic creatures of a slightly polluted water area. Conservation of natural environment means environmental protection for natural monuments. 1st grade source water for municipal use means usability after low level of treatment like filtration. 2nd grade source water for municipal use means usable after general water treatment such as sedimentation and filtration. 3rd grade source water for municipal use means usable after advanced water treatment including pre-treatment. 1st grade water for industrial use means usable after usual treatment like sedimentation. 2nd grade water for industrial use means usable after advanced water treatment like chemical application. 3rd grade water for industrial use means usable after special treatment. Conservation of living environment means the degree not to give displeasure to daily lives of people.

Table 4.13. The Water Quality Standards for Korean River Water

| **Purpose** | **Grade** | **The Applicable Objects for the use** | **Water Quality Standard** | | | | |
|---|---|---|---|---|---|---|---|
| | | | **pH** | **BOD (mg/l)** | **SS (mg/l)** | **DO (mg/l)** | **Coli (MPN/ 100ml)** |
| Living Environment | I | - 1st grade source water for municipal use<br>- Conservation of natural environment | 6.5-8.5 | ≤1 | ≤25 | ≥7.5 | ≤50 |
| | II | -2nd grade source water for municipal use<br>-1st grade fishery water<br>-Swimming water | 6.5-8.5 | ≤3 | ≤25 | ≥5 | ≤1,000 |
| | III | -3rd grade source water for municipal use<br>-2nd grade fishery water<br>-1st grade water for industrial use | 6.5-8.5 | ≤6 | ≤25 | ≥5 | ≤5,000 |
| | IV | -2nd grade water for industrial use<br>-Irrigation water | 6.0-8.5 | ≤8 | ≤100 | ≥2 | - |
| | V | -3rd grade water for industrial use<br>-Conservation of municipal living environment | 6.0-8.5 | ≤10 | No trashes | ≥2 | - |
| Protection of human health | whole water area | No detection for cyanide, Hg, Organic Phosphorous, PCBs;<br>≤ 0.01mg/l for Cd; ≤ 0.05 mg/l for As, $Cr^{6+}$; ≤ 0.1mg/l for Pb;<br>≤ 0.5 mg/l for ABS | | | | | |

There are other WQS in Korea established for lake water, ground water and sea water. The differences in WQS for river and lake water is minimal (for example, the suspended solids – SS in lake water should be less than 1, 5, 15 mg/l, for water Grade I, II, III, respectively). WQS for ground water include $NO_3$ (20 mg/l), $Cl^-$ (250 mg/l), phenols (0.005 mg/l), tri- and tetrachlorethylene (0.03 and 0.01 mg/l) (the numbers are the most strict values).

**Russia**. The Federal Service on Hydrometeorology and Environmental Monitoring (ROSHYDROMET) is responsible for routine monitoring in Russia. In Primorskii Krai, monitoring of contamination of river and coastal waters is implemented by the Primorskii Krai Office on Hydrometeorology and Environmental Monitoring according to State Monitoring Programs.

Table 4.14. Maximum Permissible Concentrations (MPC) of Chemical Substances (mg/l) in Waters Used for Different Purposes

| **Parameter** | **Drinking** | **"Public" waters** | **Fishery purpose** | **TL** |
|---|---|---|---|---|
| pH | 6-9 | 6-9 | 6.5-8.5 | 4 |
| Mineralization | 1000 | 1000 | 1000 | 4 |
| BOD5 | nd | nd | 2.0 | 4 |
| COD | 5 ($KMnO_4$) | 5 ($K_2Cr_2O_7$) | 15 ($K_2Cr_2O_7$) | 4 |
| PHC(petroleum hydrocarbons) | 0.1 | 0.1 | 0.05 | 3 |
| Detergents (Surfactants) | 0.5 | 0.5 | 0.1 | 4 |
| Phenols (summary) | 0.25 | 0.25 | 0.001 | 3 |
| Al 3+ | 0.5 | 0.5 | 0.04 | 2/4 |
| Be 2+ | 0.0002 | 0.001 | 0.0003 | 1/2 |
| B (summary) | 0.5 | 0.5 | 10*, 0.1 | 2/4 |
| Fe (summary) | 0.3 | 0.3 | 0.05*, 0.1 | 3/4 |
| Cd (summary) | 0.001 | 0.001 | 0.005 | 2 |
| Mn(summary) , Ni(summary) | 0.1 | 0.1 | 0.05*, 0.01 | 3/4 |
| Cu(summary) | 1.0 | 1.0 | 0.005*, 0.001 | 3 |
| As(summary) | 0.05 | 0.05 | 0.01*, 0.05 | 2/3 |
| Se(summary) | 0.01 | 0.01 | 0.0016 | 2 |
| Hg(summary) | 0.0005 | 0.0005 | 0.0001* | 1 |
| Cr | 0.05 $Cr^{6+}$, 0.5 $Cr^{3+}$ | 0.02$Cr^{6+}$, 0.07 $Cr^{3+}$ | | 3 |
| Zn (summary) | 5 | 1.0 | 0.05*, 0.01 | 3 |
| Pb(summary) | 0.03 | 0.03 | 0.01*, 0.1 | 3 |
| N-NO3- | 10 | 10 | 9.1 | 2 |
| N-NO2- | 0.75 | 0.8 | 0.02 | 3 |
| N-NH4- | nd | 1.0 | 0.4 | 2 |
| SO42- | 500 | 500 | 100 | 3/4 |
| F- | 1.2-1.5 | 1.5 | 0.75 | 2 |
| CN- | 0.035 | 0.1 | 0.05 | 2/3 |
| HCH | 0.002 | 0.02 | <0.00001 | 2/3 |
| DDT (summary) | 0.002 | 0.1 | <0.00001 | 1 |
| PCBs | 0.001 | 0.001 | 0.0001 | 2/1 |

* - for sea water only; nd – not determined; TL for drinking water/TL for fisheries

Water quality assessments in Russia are based in compliance with maximum permissible concentrations (MPC is analogue of EQS). There are three sets of MPC in ambient water: (1) for the drinking water; (2) for the water of domestic, drinking and cultural uses – "public waters" (both according to former SanPIN 2.1.4.559-96, from the July 2003 – GN 2.1.2.1315-03); (3) for the water used for the fishery purposes. All substances are divided into four classes of danger (toxicity level - TL) according to their toxicity for people and/or fish, cumulative and prolonged effects, etc: 1st class – extremely dangerous, 2nd class – high dangerous, 3rd class – dangerous, 4th – moderately dangerous.

MPC for the most common, potentially hazardous chemical substances in water for different types of water use are presented in Table 4.14. MPC are also set for more than 600 organic chemical substances in drinking water, more than 1,000 chemical substances in public water, and more than 800 chemical substances in water used for fisheries.

MPC for drinking water are a mandatory hygienic norm with no exceptions. For some public water and water used for fisheries, MPC are an environmental norm, that is, there is an option to exceed MPC with adequate deterioration of water quality. Such cases are the subjects for special investigation procedures.

The amount and quality of all types of municipal and industrial wastewater are controlled by regional agencies of the Federal Service for Environmental, Technological and Nuclear Supervision. Key is setting Maximum Permissible Discharges of wastes – MPD. MPD are developed by scientific and engineering organizations for different water users and are approved by the Federal Service for Environmental, Technological and Nuclear Supervision, and Ministry of Natural Resources. The regional offices of the Ministry of Natural Resources are responsible for ground water quality.

The quantitative criteria for observed concentrations are established to classify contamination events in ambient water (Table 4.15). According to these criteria, all events are divided into pollution (exceeding MPC), high pollution (exceeding 5-30 MPC), and extremely high pollution (exceeding 20-50 MPC). The Office for Supervising the Protection of Consumer's Rights and Human Welfare, an agency of the Ministry of Health and Social Development, is the executive authority responsible for establishing sanitary hygienic MPC. The State Fishery Service, a subdivision of the Ministry of Agriculture, is responsible for establishing and confirming MPC for fisheries water.

The water quality assessment in all NOWPAP countries is based on the compliance with basic standards. Despite the differences in the substances listed in each country, there is an obvious, general similarity in water quality standards - EQS, WQS, MPC - in NOWPAP member states (Table 4.16).

Table 4.15. Water Quality Criteria based on Chemical Substance Concentrations (mg/l)

| Parameter | Type of water use | MPC | High pollution | Extremely high pollution |
|---|---|---|---|---|
| Mineralization | fisheries | 1,000 | > 10,000 | > 50,000 |
| DO | fisheries | | < 3.0 | < 2.0 |
| $BOD_5$ | fisheries | 2.0 | > 10 | > 40 |
| $COD_{(K2Cr2O7)}$ | fisheries | 15 | > 150 | > 750 |
| $N\text{-}NH_4^+$ | fisheries | 0.4 | > 4.0 | > 20 |
| $N\text{-}NO_2$- | fisheries | 0.02 | > 0.2 | > 1.0 |
| $N\text{-}NO_3$- | fisheries | 9.1 | > 91 | > 910 |
| $P\text{-}PO_4$ | fisheries | 0.05 | > 0.5 | > 2.5 |
| $SO_4^{2-}$ | fisheries | 100 | > 1,000 | > 5,000 |
| Fe | hygienic | 0.1 | > 3.0 | > 5.0 |
| Al | fisheries | 0.04 | > 0.4 | > 2.0 |
| Zn | fisheries | 0.01 | > 0.1 | > 0.5 |
| Mn | fisheries | 0.01 | > 0.3 | > 0.5 |
| Ni | fisheries | 0.01 | > 0.1 | > 0.5 |
| Cu | fisheries | 0.001 | > 0.03 | > 0.05 |
| Cd | hygienic | 0.005 | > 0.015 | > 0.025 |
| $Pb^{2+}$ | hygienic | 0.006 | > 0.018 | > 0.03 |
| $Cr^{6+}$ | fisheries | 0.02 | > 0.2 | > 1.0 |
| $Cr^{3+}$ | fisheries | 0.07 | > 0.7 | > 3.5 |
| PHC | fisheries | 0.05 | > 1.5 | > 2.5 |
| Detergents | fisheries | 0.1 | > 1.0 | > 5.0 |
| Phenols | fisheries | 0.001 | > 0.030 | > 0.050 |
| HCH, DDTs | fisheries | 0.00001 | > 0.00003 | > 0.00005 |
| F- | fisheries | 0.75 | > 7.5 | > 37.5 |
| B | hygienic | 2.67 | > 26.7 | > 133.5 |
| $H_2S$ | fisheries | 0.00001 | > 0.00010 | > 0.00050 |

The main differences in the water quality standards are the follows: (1) WQS and EQS for $BOD_5$ and $COD_{Mn}$ in Japan and Korea are significantly tougher than in Russia and China; (2) WQS and EQS for TN (total nitrogen) in China, Korea and Japan are more strict than MPC for dissolved nitrate ($NO_3^-$) in Russia; (3) MPC for dissolved forms of metals in Russia are more tough as a rule, than in other countries, but close in some case to the MDL.

It should be noted that in China and Japan the EQS are applied to unfiltered water, though in Russia some MPC (for nutrients and some metals) and in Korea (for nutrients) are applied to filtered samples (for dissolved forms, only).

Table 4.16. Comparison of Some EQS (mg/l) for Surface Water in NOWPAP Countries

| Characteristic | China* | Japan** | Korea*** | Russia**** | MDL, mg/L |
|---|---|---|---|---|---|
| DO ≥ | 7.5 | 7.5 | 7.5 | 5 | 0.2; 0.5 |
| $COD_{Mn}$≤ | 2 | 1(lakes) | 1(for lakes) | 5 | 0.5 |
| $COD_{Cr}$≤ | 15 | - | - | 15 | 1.5 |
| $BOD_5$≤ | 3 | 1 (rivers) | 1 | 2 | 0.4; 2.0 |
| $NH_4$- ≤ | 0.15 | - | - | 0.4 | 0.002; 0.05 |
| $NO_3^-$ < | - | 10 | - | 9.1 | 0.2; 0.01; 0.5 |
| T P ≤ | 0.02 | 0.05 | 0.01(for lakes) | 0.05[1] | 0.001; 0.01 |
| T N ≤ | 0.2 | 0.1 | 0.2 (forlakes) | 9.5[1] | 0.002; 0.05 |
| Cu ≤ | 0.01 | 0.04 | - | 0.001 | 0.001; 0.005 |
| Zn ≤ | 0.05 | 0.03 | - | 0.01 | 0.0005-0.05 |
| F- ≤ | 1.0 | 0.8 | - | 0.75 | 0.05; 0.2 |
| Se ≤ | 0.01 | 0.01 | - | 0.01 | 0.002 |
| As ≤ | 0.05 | 0.01 | 0.05 | 0.005 | 0.0005; 0.005 |
| Hg ≤ | 0.00005 | 0.0005 | N/d | 0.0005 | 0.00005; 0.0005 |
| Cd ≤ | 0.001 | 0.01 | 0.01 | 0.001 | 0.0005; 0.002 |
| Pb ≤ | 0.01 | 0.01 | 0.1 | 0.006 | 0.005; 0.040 |
| $Cr^6$+ ≤ | 0.01 | 0.05 | 0.05 | 0.02 | 0.004; 0.010 |
| CN-≤ | 0.005 | N/d | N/d | 0.035 | 0.01; 0.1 |
| V-phen≤ | 0.002 | - | 0.005 | 0.002 | 0.002; 0.005 |
| oils≤ | 0.05 | - | - | 0.05 | 0.01; 0.02 |
| surfactants≤ | 0.2 | - | 0.5 | 0.1 | 0.01; 0.05 |
| ColiForm≤ | 200 | 50 | 50 | 100 | |

All standards in mg/L, except ColiForm in MPN/100ml; MDL – minimum detection limit according to working documents of NOWPAP countries.

*- most strict EQS for Grade I waters; ** - most strict EQS for Grade AA waters and human health protection; *** - most strict WQS for Grade I Water; **** - most strict MPC for fishery purpose waters; - means not determined; N/d means should be below detection limit; [1] – for dissolved forms ($PO_4$ and $NO_3$+$NH_4$+$NO_2$).

## 4.3. Methodologies and Procedures

### *4.3.1. Brief Characteristic of National Monitoring Water Quality Networks*

**China.** 479 monitoring stations report monthly on t°C, pH, conductivity, DO, $COD_{Mn}$, $BOD_5$, $NH_4$-N, oil, volatile phenols, Hg, Pb as monitoring items, and 43 weekly reported automatic monitoring stations with t°C, pH, DO, $COD_{Mn}$, conductivity, turbidity, total organic carbon (TOC) and $NH_4$-N as monitoring items.

**Japan.** 271 stations report monthly on environmental standard and supplementary points for the first class rivers (35 rivers NOWPAP). Monitoring items include SS, DO, $COD_{Mn}$, $BOD_5$, T-N, T-P, $NO_2$, $NO_3$, Pb, Cd, As, Hg, Se, F, B plus 15 organic pollutants like benzene, thiuram, PCBs etc.

**Korea.** 648 monitoring stations report monthly on 12 rivers, including 21 major stations on 5 main rivers that report weekly. Monitoring items include pH, SS, Conductivity, DO, $COD_{Mn}$, $BOD_5$, T-N, $NO_3$ , $NH_4$-N, T-P, phenols, Coli. Some additional parameters ($PO_4$, Chl-a, CN, Cd, Pb, As, $Cr^{6+}$, Hg, detergents) are measured quarterly (4 times/yr) and others (PCBs, organic pollutants) are measured once a year on the same network.

**Russia**. 43 stations, including 20 that report monthly and 13 quarterly (4 times/yr) reported. Monitoring items at monthly reported stations include t°C, pH, conductivity, DO, SS, $BOD_5$, $COD_{Cr}$, and 2-3 characteristic pollutants. On the quarterly operated stations the additional parameters are determined including macro-ions, N-$NH_4$, $NO_3$, $NO_2$, $PO_4$, Fe, Si, oil products (PHC), PAHs, trace metals, POPs.

### *4.3.2. Methodological Features of Sample Preservation and Analysis*

The main features of water sample analysis used for the water quality monitoring in the NOWPAP countries are presented at the Table 4.17 and 4.18.

Table 4.17. Water Sample Preservation Methods Used in NOWPAP Countries

| **Parameter** | **China*** | **Japan**** | **Korea***** | **Russia****** |
|---|---|---|---|---|
| DO | u | u | u | u |
| $COD_{Mn}$ | 0-5° C | 0-5° C | u, $H_2SO_4$ (pH<2) | u 0-5° C |
| $COD_{Cr}$ | $H_2SO_4$ (pH<2) | - | - | u 0-5° C |
| $BOD_5$ | 0-5° C | 0-5° C | u,0-5° C | u 0-5° C |
| $NH_4^-$, $NO_3^-$ | $H_2SO_4$ (pH<2) | 0-5° C | f, $H_2SO_4$ (pH<2) | f, $CHCl_3$ |
| T P | $H_2SO_4$ (pH<2) | 0-5° C | u,$H_2SO_4$ (pH<2) | - |
| T N | $H_2SO_4$ (pH<2) | 0-5° C | u,$H_2SO_4$ (pH<2) | - |
| Cu, Zn, Cd | $HNO_3$(pH<1) | HCl (pH<1) | u,$HNO_3$ (pH<1) | f, $HNO_3$(pH<1) |
| Se | $HNO_3$(pH<1) | HCl (pH<1) | u,$HNO_3$ (pH<1) | f, $HNO_3$(pH<1) |
| As | $HNO_3$(pH<1) | HCl (pH<1) | u,$HNO_3$ (pH<1) | f, $HNO_3$(pH<1) |
| Hg | $HNO_3$(pH<1) | HCl (pH<1) | u,$HNO_3$(pH<1) | f, $HNO_3$(pH<1) |
| Pb | $HNO_3$(pH<1) | HCl (pH<1) | u,$HNO_3$ (pH<1) | f, $HNO_3$(pH<1) |
| $Cr^{6+}$ | NaOH (pH8-9) | HCl (pH<1) | u, 0-5° C | f, 0-5° C |
| $CN^-$ | NaOH (pH8-9) | NaOH, pH>11 | u,NaOH (pH>12) | u, NaOH (pH>11) |
| V-phen | $H_3PO_4$(pH<2) | - | u,$H_2SO_4$ (pH<4) | u 0-5° C |
| Oils | HCl (pH<2) | - | u,$H_2SO_4$ (pH<2) | u, $CCl_4$ (2ml/l) |
| Surfactants | $H_2SO_4$(pH<2) | - | u, 0-5° C | u, $CHCl_3$(2ml/l) |

*China – 30 min deposition and subsequent analysis of unfiltered liquid; HNO3 for metals (pH<
**Japan – unfiltered samples;
***Korea – unfiltered (u) and filtered (f) samples;
****Russia – unfiltered (u) and filtered (f) samples;
- means not determined or not used in regular monitoring of water quality.

Preservation methods are fairly similar in all NOWPAP countries. The main discrepancy is data on nutrients and metals because Russia and Korea partly (for the determination of dissolved inorganic nutrients) use filtered samples and other NOWPAP countries use unfiltered samples. Another issue is a COD using $KMnO_4$ as an oxidant in China, Japan and Korea, and COD using a stronger reagent $K_2Cr_2O_7$ in Russia. A third issue is the widespread use of total nitrogen (TN) and total phosphorus (TP) for the assessment of water quality in all NOWPAP countries except Russia.

The methods used in the NOWPAP countries to determine many substances are similar, for example, dissolved oxygen (DO), $BOD_5$, COD, $NH_4$-N, metals, CN-ions, TP, TN, detergents. The main methods are **UV-Vis Spectrophotometry** (Colorimetry, Absorptiometry) for nutrients, surfactants (detergents, ABS), CN-ions, boron determination; **Ion selective potentiometry** for DO, $BOD_5$, pH determination; **Atomic absorption spectrophotometry** in different modification (or **ACP-OES/ACP-MS**) to determine metals with corresponding sensitivity; **Ion Chromotography** (**IC**) for nutrients (alternatively or complementary), sulfate, chloride; **Gas Chromatograhy** (**GC**) for the organic contaminants (PCBs, chlorine- and phosphorus-organic pesticides, chloroethylenes, etheres, volatile compounds like benzene and toluene). The detection limits are depended upon equipment used, but as a rule significantly less than water quality standards. The only exception is absorptiometric (spectrophometric) determination of volatile phenols with detection limit 0.002-0.005 mg/l in China, Korea, and Russia that is practically equal to the water quality standards.

Most significant differences in methods are listed in Table 4.17. There is a difference in detecting $NH_4$-ions limits due to various modifications of the methods used. Nitrate analysis is carried out using different methods: absorptiometric in Japan, ion chromatography in Korea, and colorimetric in Russia with corresponding sensitivity. In China nitrate content is not a monitored parameter in river water. The same is true for fluorine determination. The analysis of phenols is carried out by less sensitive absorptiometric methods in China, Korea and Russia.

Oil (petroleum hydrocarbons – PHC, extracted by hexan or carbon tetrachloride) content in water is analyzed by IR-spectrophotometry in China and Russia, but in Japan and Korea this parameter is not used in the routine monitoring of surface water quality.

Table 4.18. Major Differences in Water Analysis Methods Used in NOWPAP Countries

| Parameter | China | Japan | Korea | Russia |
|---|---|---|---|---|
| $NH^{4-}$ | Colorimetric, 0.01-0.05 mgN/l | Absorptiometric, 0.7 mgN/l | Absorptiometric, 0.002 mgN/l | Colorimetric, 0.05 mgN/l |
| $NO_3$ | -* | Absorptiometric, 0.2 mgN/l | IC, 0.01 mgN/l | Colorimetric, 0.05 mgN/l |
| F- | - | Absorptiometric, 0.2 mg/l | - | Ion selective electrode, 0.01mg/l |
| Phenols | 4-AAP spectrophotometric, 0.002 mg/l | - | Absorptiometric 0.005 mg/l | Absorptiometric, 0.002 mg/l |
| Oils (PHC) | IR-spectrophoto-metry, 0.01 mg/l | - | - | IR-spectrophoto-metry, 0.02 mg/l |

-* - means not determined/used for water quality monitoring.

### *4.3.3. QA/QC Procedures*

In China QA/QC procedures for water quality monitoring are described in detail in the GB3838-2002 - Environmental Quality Criterion of the Surface Water - that includes guidelines for sampling, storage, preservation and analysis.

In Japan each institution conduction analyses must obtain a license guaranteeing accuracy; this is mandated in the Measurement Law. It must also comply with ISO/IEC17025 (JIS Q 17025), an international standard for accurate management and skills testing based on ISO/IEC Guide 43-1 (the Japan Chemical Analysis Academy).

In Korea the QA/QC procedures for surface water quality monitoring are implemented according to rules set and approved by the MOE. Since 1983, the Ministry of the Environment (MOE) has been engaged in developing various environmental analytical protocols, with the exception of those involving seawater. Analytical institutions evaluating freshwater must follow the QA/QC standards of the environmental technology law. Before 2005, MOE evaluated the QC of freshwater biological oxygen demand (BOD), chemical oxygen demand (COD), total nitrogen (T-N), total phosphorus (T-P), phenol, CN, Cd, Pb, Hg, As, and Cr. In 2007, the Ministry of Land, Transport, and Maritime Affairs established the Marine Environment Management Law. One major provision implements QA/QC standards for marine environmental measurement data. The law stimulated a new, ongoing research program to construct a QA/QC system for marine environmental data.

The components of QA/QC include well calibrated equipment, use of only standard operating procedures, personnel training, rigorous quality control procedures (precision and accuracy), measurements that ensure data tracking and data verification.

The QA/QC procedures in Russia (Primorskii Krai Environmental Monitoring Center (EMC) are executed according to official recommendations of the State Committee of Russia on Standards, Metrology and Certification No. 52.24.509-96, "Implementation of Measures Regarding the Quality of Hydrochemical Information", and No. 52.18.599-98 "Implementation of Inspections of the Accredited Laboratories (Centers)." External quality control by the State Hydrochemical Institute (Rostov-on-Don), Scientific-Production Association "Typhoon" (Obninsk) and the ADORC Center (Niigata) is regularly carried out to verify analytical techniques, thus using blind samples (at least once a year).

### *4.4. Research Activities (National and International)*

**China**. A joint Chinese and Republic of Korea international cooperation project called "Yellow Sea Environmental Cooperative Research" was carried out during 1996-2004. Another cooperative project on technologies for environmental protection and management of the Olympic sailing boat venue and adjacent marine environment was executed in 2002 with the cooperation of the Qingdao Environmental Monitoring Center and the First Institute Oceanography of State Oceanic administration and Ocean University of China. This is a successful, ongoing project.

The special item on environmental research report, Clean Blue Sea Plan of Shandong Province, has been compiled in 2004. The special item on environmental research report, Clean Blue Sea Plan of Changjiang estuary, has been compiled in 2006. The State Report of Global programme of Action for the Marine Environment from land-based Activities was published by SEPA in 2006.

**Japan.** There are a number of past and current research projects underway on river environments to the fill data gaps left in National Monitoring Programs. For instance, chemical substance loads in rivers cannot be evaluated without additional data. Furthermore, the load assessment needs certain models to estimate unknown variables. In this regard, research activities to design models are equally important to the monitoring effort.

A group of civil engineering researchers have systematically assessed environmental changes in rivers based on the data of the River Water Quality Monitoring and they proposed adding inorganic nutrients such as nitrate, nitrite, ammonia, phosphate and silicate to the monitoring parameters, although the main indicators of the river environment have primarily been BOD, total-N and total-P.

A group of researchers recently proposed the "Global NEWS" (Global Nutrient Export from Watersheds) as a program for LOICZ under the IGBP (International Geosphere-Biosphere Program). The objective is to construct a spatially explicit, multi-element (N, P, Si and C) model to understand human and natural processes. They also intend to link up with the UNEP-Mediterranean Action Plan and with UNESCO. Research includes verification of the "silica deficiency hypothesis" as the project studies deterioration of marine environments due excessive N and P and a decline in Si, including an analysis of historic data on river water quality before and after the 1960s (period of rapid economic growth) and an assessment of the effect of the economic growth. Dissolved inorganic nutrients are measured monthly in the Sai River (with dams) and the Chikuma River (with fewer dams) that merge to form the large Shinano River flowing into the NOWPAP Region.

A symposium titled "Dynamics of semi-enclosed marine systems: the integrated effects of changes in sediment and nutrient input from land" was co-organized by IUGG[1)], SCOPE [2)] and SCOR[3)] in Germany in March 2007 considering the contribution to environmental policy makings. There, East China & Yellow Seas were chosen as one of the 13 SEMS (Semi-Enclosed Marine Systems). Four "cross-cut discussion" groups composed of leading scientists, the results of which were published as No. 70 of the SCOPE Series Books (Urban et al., 2008). The chapters “Threshold effects in semi-enclosed marine systems”and “Fluxes of nutrients and selected organic pollutants carried by rivers” are important components of this book and closely related to the aims of this Regional Overview.

**Korea.** A network of research institutes that include NIER, NFRDI, and KORDI are carrying out various research projects with specialization in different research fields.

The National Institute of Environmental Research (NIER) focuses on terrestrial surface waters, in support of national environmental policy decisions. The National Fisheries Research and Development Institute (NFRDI), a Korean government institute, researches the coastal environment. These two institutes independently monitor natural water quality and periodically update a legally mandated monitoring database. The two institutes campaigned for the recent establishment of the national water-quality standard and QA/QC program.

NIER is responsible for supporting the Ministry of Environment in the formulation of environmental policies through surveys and studies, research, tests and assessments related to environmental pollution prevention. The institute was separated from the National Health Research Institute in July 1978 as a specialized research institute on the environment. With the inauguration of the Environment Administration in 1980, the institute was transferred to the Environment Administration. The institute consists of four departments, two sections, one research center and four water quality inspection laboratories. NIER is responsible for the monitoring of air and water quality of the environment. Since the incidence of phenol pollution of the river water which was used for drinking water, Ministry of Environment invested enough budget to purchase modern equipments like high resolution GC-MS and ICP-MS.

NFRDI was established in 1921 as the Fisheries Experiment Station. It was reorganized in 1949 as the Central Fisheries Experiment Station under the Ministry of Commerce and Industry. It was renamed in 1963 as the National Fisheries Research and Development Institute and was reorganized in 1966 under the National Fisheries Administration. Recently it was reorganized in 2008 under the Ministry for Food, Agriculture, Forestry. NFRDI has been responsible for the national marine environment monitoring program. It also has been surveyed the outbreak of red tides in the coastal areas. NFRDI plans to revise the monitoring program to include trace metals and persistent organic pollutants in the sediment and biota (fish and bivalves). It needs to be equipped with high resolution GC-MS, HPLC-MS to study the persistent organic pollutants and endocrine disruptors in the marine environment.

KORDI is a government funded research institute. It was established at the Korea Institute of Science & Technology (KIST) in 1973. KORDI separated itself from KIST in 1990 and reorganized under the MOMAF in 1996. KORDI has been carrying out short-term (generally 3 years) research projects funded by MOMAF, MOENV, MOST, other related government agencies and private sectors. It has been carrying out monitoring projects not only surveying the pollutants level but also the effects of pollutants on marine organisms like biomarkers (eg. histopathology of bivalves) and imposex of marine snails. It needs to be equipped with high resolution GC-MS, HPLC-MS to study the persistent organic pollutants and endocrine disruptors in the marine environment.

**Russia.** Scientific research on surface water chemical composition and quality is carried out at Russian Academy of Sciences Institutes (Pacific Geographical Institute - PGI, Pacific Oceanographic Institute - POI, Far Eastern Geological Institute - FEGI), Regional Research Institute of Federal Service on Hydrometeorology and Environmental Monitoring (FERHRI) and universities.

PGI and FERHRI specialists have for several decades been studying river inputs into marine environments. Chudaeva (2002) recently published a book on river transport of different chemical substances in the Russian Far East from Chukotka to Primorskii Krai. Shulkin (2007) at PGI obtained and published new data on Zn, Cd, Pb, Cu, Mn and Fe concentration in river water in Primorskii Krai. These data improve the opportunities to use metal concentrations in river water to trace the level of anthropogenic press on ecosystems. Some novel methods were suggested for the assessment of the river fluxes influence on the coastal sea areas (Shulkin, 2005). Gavrilevski et al. (1998) at FERHRI has collected and analyzed information on possible sources that are directly polluting the sea adjacent to Vladivostok.

Specialists at the Pacific Oceanographic Institute (POI) carried out comprehensive investigations of river-sea interactions. Field surveys in the NOWPAP region were implemented in the Razdolnaya River and its estuary that flows into Amursky Zaliv. Different kinds of laboratory experiments and computer modeling of river-sea systems (carbonate system components in estuaries) were also performed (Tischenko et al., 2005, Zvolinski et al., 2005).

Sorption process modeling shows that mercury, vanadium, and arsenic in sea water and river water are largely an adsorbed form while the share of suspended cobalt and chromium in river water is only 14.4 and 4.6%, respectively. In sea water they are in totally dissolved form.

POI researchers also estimated the discharge of trace metals to the marine environment via different routes: river inputs, industrial wastewater and atmospheric deposition (e.g., Mishukov et al., 2001).

## 4.5. Training Activities

**China.** Technical training and forums on automated monitoring of surface water were conducted three times in 2002. Participants represented 42 automated stations and the relevant provincial monitoring centers. Technical training to assess surface water was held in XinJiang Province on September 23-25, 2004. The participants came from 31 Provincial monitoring centers and the monitoring centers of 47 key cities.

Technical training for monitoring red tide was held in Zhoushan in June, 2004. The participants learned theory and techniques for monitoring red tide.

In October - December 2004 CNEMC and the Off-Shore Environmental Monitoring Center held meetings for marine water monitoring laboratories. The components are $NO_3$-N, $NO_2$-N, $NH_3$-N and active phosphate.

**Japan.** The National Environmental Research and Training Institute (Ministry of the Environment) conducts trainings for MoE, national and local government staff on environmental administration. The training issues include 1) administration training, 2) international training, 3) analysis training, 4) training for environmental officials, and 5) an environmental administrative business. The analysis training includes water quality, endocrine disrupters, dioxins, plankton and benthos, advanced analysis technology.

The Japan Sewage Works Agency conducts practical training for government sanitary and sewer engineers that includes 1) planning and design of sewage systems and treatment works, 2) management, 3) execution design, 4) construction supervisor management, and 5) control of maintenance with water quality issues.

The Research Laboratory for Public Health set up in prefectures and designated cities for an integrated organization to protect human health from infectious diseases, toxic chemicals (dioxin etc.) in food and drinking water. The laboratory also conducts training and provides guidance on health, safety and environmental protection.

**Korea**. Environmental Training Department of NIER started in 1980, as an organization that trains the government officer of the Environmental Agency. It expanded training concerning various fields of environmental administration for the national and local government staff with responsibility for protecting the environment. As for the content of training, it is classified into 1) environmental administration, 2) environmental policy, 3) natural environment, 4) water management, 5) waste management, 6) environment management, and 7) environmental analysis. The content of the last is the analysis of water quality, endocrine disrupters, toxic chemicals including dioxins, and familiarization with advanced equipment.

National Fisheries Research & Development Institute (NFRDI) carries out training of Government officers, Fishermen and Marine industry. Training fields are Basic and Professional Training Course, Fishermen Training Course, and Video Communicating Training Course.

Korea Institute of Maritime and Fisheries Technology (KIMFT) carries out education and training of personnel engaged in maritime and fisheries sectors, services promoting an international exchange of technology related to maritime affairs and fisheries, and services for the execution of the maritime license examination. KIMFT has devoted a lot of efforts to the improvement of seafarer's competency and proficiency together with developing various effective training course, publishing up-to-date training materials, dispatching the trainers on board for the practical study, and installing high-tech taining facilities.

4) KORDI carries out international training for APEC and PEMSEA countries for twice a year (3 weeks). The training include analytical techniques of POPs, EDCs, Oil pollution, Nutrients and on board training. Financial supports are provided by APEC (main funding), MOMAF, and KOICA (Korea International Cooperation Agency)

**Russia**. The specialists from the Primorskii Branch of Federal Service on Hydrometeorology and Environmental Monitoring (ROSHYDROMET) are trained in Moscow and Rostov-on-Don at central institutions. Training at research institutions is done using a "hands-on" approach, i.e. young researchers are being trained during field surveys, expeditions, laboratory experiments.

The specialists from the subdivisions of Federal Service for Environmental, Technological and Nuclear Supervision, involved in the control of the chemical composition of wastes, are trained in the key laboratories of central institutions, and at the different training courses arranged by Federal Service. The central office of the Ministry of Natural Resources is responsible for the training courses on the management of water use, including the issues of water quality assessment.

# 5. Present Situation

## 5.1. Chemical Composition of River Run-Off

**China.** The 2007 annual averaged water quality data available for down streams areas in the Chinese rivers relevant to the NOWPAP region are presented in Tables 5.1. These data are obtained by China National Environmental Monitoring Center (CNEMC) at the closest to the river mouth sections.

Some additional information on the chemical composition of the northeastern Chinese rivers in 2002 has been presented in Regional Overview, 2006.

For the not very polluted rivers like Yalu, Luan and Yangtze with ammonia ($NH_4^-$) and nitrite ($NO_2$) concentrations less than 1.0 and 0.05 mgN/l respectively, the nitrate ($NO_3^-$) specie of dissolved nitrogen prevails with concentration about 2-3 mgN/l, and TN concentration no more than 3-4 mgN/l. The ammonia specie strongly dominates in the polluted rivers like Daling, Daliao, and, especially Yongdingxin, Chaobaixin and Hai (Table 5.1). The nitrate ($NO_3^-$) concentrations decrease down to the 0.3-0.4 mgN/l in such cases.

Suspended solids (SS) content in the rivers of northeastern China extremely variable from 6.3 mg/l in Luan River to the 520 mg/l in Yangtze and 27000 mg/l in Yellow River (Treatise in Geochemistry, 2003). The significant (5-9 times) seasonal variations of SS due to monsoon floods (Zhang, 1999) further complicates the regional assessment of the suspended solids run off.

Table 5.1. Chemical composition of main Chinese rivers flowing into the NOWPAP sea areas in 2007.

| river | Discharge | $COD_{Mn}$ | $BOD_5$ | $NH_4$ | oils | v-phen | Pb | Hg |
|---|---|---|---|---|---|---|---|---|
| Songhua | 2416 | **6,1** | **2,6** | **0,70** | 0,03 | 0.001 | 0.004 | 0.02 |
| Wusulijiang | 588 | **6,1** | 1,2 | **0,60** | 0,03 | 0.001 | 0.011 | 0.02 |
| Tumen | 287 | **15,9** | **7,8** | **0,50** | **0,11** | 0.004 | 0.01 | 0.01 |
| Yalu | 1200** | 2,4 | 1 | 0,10 | 0,03 | 0.001 | 0.005 | 0.02 |
| Daliao | 469 | **8,1** | **6,7** | **3,12** | 0,05 | 0.001 | 0.005 | 0.02 |
| Daling | 118*** | **113.9** | **60,4** | **1,30** | **0,22** | 0.042 | 0.010 | 0.03 |
| Luan | 144*** | **4,1** | **4,7** | **0,82** | 0,03 | 0.001 | 0.001 | 0.08 |
| Yongdingxin | nd | **13,5** | **9** | **19,0** | 0,02 | 0.015 | 0.008 | 0.08 |
| Chaobaixin | nd | **10,3** | **9,6** | **2,79** | **0,06** | 0.001 | 0.008 | 0.01 |
| Hai | 723 | **11,9** | **7,7** | **12,9** | **0,07** | 0.004 | 0.005 | 0.07 |
| Duliujian | nd | **5,6** | **7,4** | **0,53** | **0,43** | 0.006 | 0.002 | 0.01 |
| Yellow | 2087 | 3.0 | 2,3 | **0,50** | 0,03 | 0.005 | 0.0085 | *nd |
| Yi | nd | **4,3** | 3,1 | **0,32** | 0,04 | 0.001 | 0.005 | 0.01 |
| Huai | 1972 | **4,3** | 2,6 | **1,11** | 0,01 | 0.001 | 0.01 | 0.01 |
| Yangze | 30166 | 2,5 | 1 | **0,53** | 0,03 | 0.003 | 0.002 | 0.01 |
| **EQS, I** | | **3** | **2** | **0.15** | **0.05** | **0.002** | **0.01** | **0.05** |
| **EQS, IV** | | **10** | **6** | **1.5** | **0.50** | **0.010** | **0.05** | **1.00** |

Notes: ** - by Zhang et al., 1998; *** - discharge assessed by watershed square; EQS – Environment Quality Standard for the Grade I and IV waters; nd - no data; Discharge, m3/s; Hg, ug/l; others, mg/l; All nutrients and metal in unfiltered samples; No data on Si, $PO_4$, $Fe_{tot}$ , Mn, Cu, Zn, HCH and DDT concentrations in river waters.

Dissolved oxygen (DO) concentration is high enough in the almost all rivers of northeastern China. The Daliao river is only exception where decrease of DO was observed in 2002 (Regional Overview, 2006).

The water quality of many Chinese rivers is not so good. This is especially true in terms of $BOD_5$ , COD and ammonia ions concentrations. Last two parameters do not exceed EQS for the I Grade water only in the 1-2 big rivers from the 15 presented (Table 5.1). And in the third part of rivers $BOD_5$ and $NH_4^-$ values exceed EQS for IV Grade waters. Oil pollution is observed at the same rivers, though some exceptions take place. Contamination by volatile phenols (v-phen) takes place in the four rivers, and three of them (Daling, Yongdingxin and Duliujian) show the heavy pollution by such other parameters like $BOD_5$ and $NH_4^-$. The contamination of Chinese rivers by microelements (Pb, Cd, As) is below most strict EQS for I Grade waters. Hg is only exception with elevated concentration in Yongdingxin river.

**Japan**. 2006 data on water quality of first class Japanese rivers that flow into the NOWPAP region are presented in Table 5.2. These data were obtained at the environmental standard points closest to the river mouths.

Table 5.2 Water Quality of the Rivers that Flow into the NOWPAP Region in 2006 (mg/L)

| **Rivers** | **SS** | **$BOD_5$** | **$COD_{Mn}$** | **DO** | **T-N** | **T-P** | **$NO_3$+$NO_2$** | **Pb**** | **As**** |
|---|---|---|---|---|---|---|---|---|---|
| Teshio | 15 | 0.5 | -- | 11 | 0.52 | 0.03 | 0.005 | <0.005 | 0.007 |
| Rumoi | 14 | **1.3** | -- | 11 | **1.2** | **0.11** | 0.017 | 0.008 | **-** |
| Ishikari | 38 | 1 | -- | 11 | **1.2** | **0.08** | 0.023 | -- | <0.005 |
| Shiribetsu | 5 | 0.5 | -- | 12 | 0.58 | 0.026 | -- | -- | <0.005 |
| Shiribetsu-toshibetsu | 3 | 0.6 | -- | 11 | 0.36 | 0.027 | 0.005 | -- | -- |
| Iwaki | 19 | 0.8 | 3.9 | 11 | **0.78** | 0.072 | -- | 0.002 | 0.001 |
| Yoneshiro | 4 | 0.9 | -- | 11 | 0.55 | 0.026 | 0.4 | <0.005 | <0.001 |
| Omono | 6 | 1 | -- | 10 | 0.58 | 0.031 | -- | <0.005 | <0.001 |
| Koyoshi | 7 | 1 | -- | 10 | 0.51 | 0.03 | -- | <0.005 | <0.001 |
| Mogami | 16 | 0.8 | 2.8 | 11 | **0.68** | 0.026 | -- | <0.005 | <0.001 |
| Aka | 11 | 0.8 | 2.2 | 11 | **0.61** | 0.013 | 0.29 | <0.005 | <0.005 |
| Ara | 6 | 0.5 | 2 | 11 | 0.42 | 0.018 | 0.22 | <0.005 | <0.005 |
| Agano | 13 | 0.6 | 4.6 | 11 | -- | -- | -- | -- | <0.005 |
| Shinano | 21 | 0.6 | 2.8 | 9.4 | -- | -- | -- | -- | |
| Seki | 26 | 0.8 | 3.1 | 10 | **0.76** | 0.06 | 0.34 | <0.005 | <0.005 |
| Hime | 37 | 0.6 | 2.1 | 11 | -- | -- | -- | -- | 0.006 |
| Kurobe | 5 | 0.6 | 1.2 | 11 | 0.23 | 0.011 | 0.17 | <0.005 | <0.005 |
| Joganji | 6 | 0.8 | 1.5 | 11 | 0.35 | 0.018 | 0.22 | <0.005 | <0.005 |
| Jintsu | 4 | **1.3** | 1.6 | 10 | **1.5** | 0.02 | 0.79 | <0.005 | <0.005 |
| Sho | 4 | 0.8 | 1.5 | 10 | 0.39 | 0.016 | -- | -- | <0.005 |
| Oyabe | 6 | **2.2** | 4.2 | 8.7 | **1.1** | **0.068** | 0.53 | <0.005 | <0.005 |
| Tedori | 11 | 1 | -- | 11 | -- | -- | 0.37 | <0.005 | <0.005 |
| Kakehashi | 6 | 0.8 | -- | 9.9 | -- | -- | 0.43 | 0.005 | <0.005 |
| Kuzuryuu | 8 | **1.3** | 3.5 | 9.8 | -- | -- | -- | <0.002 | <0.005 |
| Kita | 3 | 0.6 | 1.7 | 10 | -- | -- | -- | <0.002 | <0.005 |
| Yura | 4 | 0.6 | 2.1 | 9.3 | -- | -- | 0.61 | <0.005 | <0.005 |
| Maruyama | 5 | **1.2** | -- | 9.1 | 0.26 | 0.027 | 0.088 | 0.002 | 0.001 |
| Chiyo | 3 | 0.8 | 1.8 | 8.5 | 0.51 | **0.087** | 0.4 | <0.005 | <0.005 |
| Tenjin | 2 | 0.8 | 1.8 | 11 | -- | -- | 0.5 | <0.005 | <0.005 |
| Hino | 3 | 0.8 | 2.3 | 10 | -- | -- | 0.5 | <0.005 | <0.005 |
| Hii | 6 | 0.7 | -- | 10 | 0.57 | 0.028 | -- | <0.005 | <0.005 |
| Gono | 2 | 0.6 | -- | 9.8 | -- | -- | 0.42 | <0.005 | <0.005 |
| Takatsu | 2 | 0.5 | -- | 11 | -- | -- | 0.38 | <0.005 | 0.005 |
| Onga | 9 | **1.2** | 3 | 8.2 | **1.3** | **0.093** | 0.49 | <0.005 | <0.005 |
| Matsuura | 9 | **1.2** | 4.1 | 7.8 | **0.69** | **0.053** | -- | -- | -- |
| **EQS, AA** | **25** | **1.0** | **1.0*** | **7.5** | **0.10*** | **0.005*** | **--** | **0.010** | **0.010** |
| **EQS, A** | **100** | **3.0** | **5.0*** | **>2** | **0.60*** | **0.05*** | **--** | **--** | **--** |

Notes: Unfiltered samples are measured for all monitoring items except for $NO_2$-N and $NO_3$-N; the symbol "--" means no data; symbol "<" means that the values are under the detection limits which are registered in the government manual published in 1974; * - EQS for lakes; ** - data for 2002 (Regional Overview, 2006)

All Japanese first class rivers from the west coast are in good condition with annual mean suspended solids less than most strict EQS for the AA Grade. This is in accordance with mountainous origin of main part of Japanese rivers. Of course, it is not exclude temporally significant increase of the suspended solids content during the flood events.

The mean value of $BOD_5$ is in the range of 0.5-2.2 mg/L, and $COD_{Mn}$ is 1.2-4.6 mg/L. COD and $BOD_5$ are indexes of organic pollution in rivers that flow in the NOWPAP region. In terms of $BOD_5$ the quality of the river waters is excellent. The slightly elevated $BOD_5$ up to 2.2 mg/l was observed only in Oyabe river. In other 6 rivers $BOD_5$ was in range 1.0-2.0 mg/l, that is slightly above very tough EQS for AA Grade waters, but below the EQS for the next A Grade. The EQS for $COD_{Mn}$ is established for the lakes only. If we apply it to the rivers, the compliance of $COD_{Mn}$ observed with EQS for AA Grade water does not take place in the rivers of western coast of Japan. It is explained by the existence of natural organic dissolved and suspended substances oxydizable by $KMnO_4$. The $COD_{Mn}$ in rivers does not exceed EQS for A Grade waters, and this confirms the pollution degree of Japanese first class rivers is insignificant. The pretty high level of dissolved oxygen (DO) is in accordance with it.

The concentrations of total nitrogen (TN) in all first class rivers exceed the very strict EQS for AA waters (0.1 mgN/l). The concentration of TN exceeds also strict EQS for the A Grade waters (0.6 mg N/l) in the 10 rivers from the 23 studied. Japanese EQS by TN is established for the lakes only, and this exceedance does not lead to the administrative measures, but could be an indicator of the initial stage of eutrophication of river waters.

The similar situation is observed for the total phosphorus (TP). In all Japanese first class rivers concentration of TP exceeds the very strict EQS for AA Grade lake waters (0.005 mgP/l). In 6 rivers from 23 studied the annual mean concentration of TP exceeds EQS for A Grade lake waters (0.05 mg P/l). Again it does not mean severe pollution of Japanese rivers by phosphorus, and just reflect the natural concentration of P in water of rivers, draining the landscapes with large portion of agricultural land use.

Cd, Cr, Hg, and Se concentrations are always less than MDL registered in the government manual published in 1974, that is Cd < 0.001-0.005 mg/l; $Cr^{6+}$ <0.02-0.005 mg/l; Hg < 0.0005 mg/l, Se<0.002 mg/l. The values for Cd, Se, and $Cr^{6+}$ (partly) are one order less than corresponding EQS. For Hg MDL established in 1974 (0.0005 mg/l or 0.5 μg/l, or 500 ng/l) is equal to EQS.

Fluorine and boron concentrations vary between <0.02-0.30 mg $F^-$/l and <0.08-0.15 mg B/l, that is far less than EQS 0.8 and 1.0 mg/l respectively.

Concentration of Pb in the Japanese first class rivers is close or below the MDL which are registered in the government manual published in 1974, and in any case is well below the EQS.

All volatile organic compounds (dichloromethane, trichlorethylen etc. as well as benzene, thiuram, thiobencarb) are not found in the first class Japanese rivers, that is less than MDLs, which in turn one order less than EQSs.

High level scientific research to determine persistent organic pollutants (POPs) has been carried out on the Ishikari River (Hokkaido Island) in 2002 (Table 5.3).

Table 5.3. Concentration of POPs in the Ishkari River on 2002 (ng/L)

| POPs | Sample No. 1 | Sample No. 2 | Sample No. 3 | Average | MDL |
|---|---|---|---|---|---|
| PCBs | 0.180 | 0.420 | 0.370 | 0.32 | 0.0009 |
| Aldrin | 0.0013 | 0.0011 | 0.0013 | 0.0012 | 0.0006 |
| Dieldrin | 0.071 | 0.076 | 0.082 | 0.076 | 0.0018 |
| Eldrin | 0.008 | 0.008 | 0.008 | 0.008 | 0.006 |
| DDT(p,p'+ o,p') | 0.272 | 0.246 | 0.497 | 0.338 | 0.0006 |
| DDE(p,p'+ o,p') | 0.114 | 0.089 | 0.154 | 0.119 | 0.0006 |
| DDD(p,p'+ o,p') | 0.068 | 0.065 | 0.109 | 0.081 | 0.00024 |
| Chlordane | 0.041 | 0.042 | 0.068 | 0.050 | 0.0015 |
| alpha-HCH | 0.150 | 0.180 | 0.250 | 0.19 | 0.0009 |
| beta-HCH | 1.1 | 1.1 | 1.1 | 1.1 | 0.0009 |

**Korea**. The results of monitoring the water quality of the major rivers that flow into the NOWPAP region in fiscal year 2007 are summarized in Table 5.4. These values are the annual average for downstream of the rivers and were collected from the Ministry of Environment database (http://water.nier.go.kr). The dissolved oxygen is high enough to provide the suitable condition for the water creatures. Slightly below WQS concentration of dissolved oxygen (DO) is observed in Han River only, though DO observed (7.1 mg/l) much higher than fatal 2 mg/l, and even more than 5-6 mg/l level is sufficient for most aquatic species. The pH values in Korean Rivers fall within range 7.0-7.8 that is complies with WQS.

The mean value of $BOD_5$ is in the range of 0.8 – 6.6 mg/L and exceeds the most strict WQS for I Grade waters in 9 rivers from 11 studied, and exceeds WQS for II Grade waters in 4 rivers. Waters having $BOD_5$ values less than 1.0 mg/l considered clean, and river water with $BOD_5$ less than 3.0 mg/l is considered as normal.

Table 5.4. Water Quality of Major Korean Rivers (2007)

| River | DO (mg/l) | COD (mg/l) | $BOD_5$ (mg/l) | SS (mg/l) | TN (mg/l) | TP (mg/l) | $NO_3^-$ (mg/l) | $NH_4^-$ (mg/l) | $PO_4^-$ (mg/l) |
|---|---|---|---|---|---|---|---|---|---|
| Han | 11.7 | 3.6 | 1.2 | 9.4 | 2.4 | 0.1 | 2.1 | 0.1 | 0.0 |
| Nakdong | 10.9 | 6.0 | 2.6 | 17.6 | 3.0 | 0.1 | 1.9 | 0.1 | 0.1 |
| Geum | 11.6 | 6.6 | 2.9 | 11.6 | 4.1 | 0.2 | 2.4 | 0.4 | 0.1 |
| Yeongsan | 10.1 | 6.3 | 5.1 | 15.4 | 5.1 | 0.3 | 3.4 | 0.5 | 0.2 |
| Seomjin | 9.0 | 7.6 | 1.1 | 8.2 | 1.7 | 0.0 | 1.2 | 0.1 | 0.0 |
| Anseongcheon | 9.6 | 9.2 | 6.0 | 27.7 | 6.2 | 0.2 | 2.9 | 2.2 | 0.1 |
| Sapgyocheon | 10.7 | 8.0 | 3.8 | 27.7 | 6.3 | 0.3 | 3.7 | 0.6 | 0.1 |
| Dongjin | 9.9 | 3.5 | 1.1 | 5.1 | 1.9 | 0.1 | 1.2 | 0.0 | 0.0 |
| Tamjin | 10.4 | 2.5 | 0.9 | 2.6 | 0.9 | 0.0 | 0.6 | 0.0 | 0.0 |
| Taehwa | 10.3 | 2.6 | 0.6 | 1.5 | 3.4 | 0.0 | 1.6 | 0.3 | 0.0 |
| Hyeongsan | 10.5 | 5.8 | 3.3 | 9.2 | 3.2 | 0.1 | 2.4 | 0.2 | 0.0 |
| ***WQS, I Grade*** | ***>7.5*** | ***6*** | ***1.0*** | ***25*** | ***0.2**** | ***0.01**** | ***9.1***** | ***0.2*** | ***0.05***** |
| ***WQS, II Grade*** | ***5.0*** | ***8*** | ***3.0*** | ***25*** | | | | | |

*- US EPA standards;
** - Russian MPC; "-" – means no data

Parameter $COD_{Mn}$ varies in range 2.5-9.2 mg/L. The COD standard is established in Korea for lake water with low SS only. COD is higher in the much more turbid rivers. BOD standards at 2 and 3 mg/l are considered normal. COD and BOD values in Korean rivers indicate ‘satisfactory’ condition. However, some small rivers like Anseongcheon, Sapghocheon and Hyeongsan showed BOD values 3.8-6.0 mg/l and COD 5.8-9.2 mg/l indicating attention is necessary.

High counts of fecal coliform bacteria (do not shown in the Table 5.4) in rivers, streams and lakes are caused by feces contamination. While most Korean rivers fall within the safe Grade I and II range, Han and Nakdong Rivers and some small streams exceed the upper limit.

Total Nitrogen (TN) and total Phosphorus (TP) are used as a eutropication index in closed water areas such as lake and bays. Therefore assessment of river water quality with TN and TP should be done with care. The US EPA recommended values for TN in rivers is 6 mg/L and Han River exceeded this limit. The US EPA recommended values for TP is 1 mg/L and fortunately, the value is far lower in all the sampled rivers. The US EPA limit for $NO_3$ is 10 mg/L and the values in Table 5.4 are much lower.

T-N was between 1.7 mg/l and 6.2 mg/l with the Yongsang River posting the highest values. Overall, rivers with artificial dikes had higher T-N concentrations. Regional differences stemming from construction effects were more noticeable in T-P concentrations.

A value of 0.2 mg/L was identified as a pollution threshold for ammonia. If we apply this to our data, 80% of the sampled rivers exceed this limit. According to US EPA, phosphates in rivers should not exceed 0.025-0.05 mg/L.

Concentrations of Cd, Pb, $Cr^{6+}$, As, Hg, phenols and cyanide (CN) are also monitored in the Korean rivers, but all were under the method detection limit (MDL) used in the routine monitoring surveys. Moreover MDL for all metals except Hg are one order below WQS. For Hg, CN-ions and phenols MDLs are close to WQS. Noteable ABS (alkyl benzene sulfonate) concentrations 0.010 mg/l have been found in Han River only.

**Russia**. 2002 data on chemical composition and concentration of contaminants in the river water of Primorskii Krai obtained by the state Environmental Monitoring Center (EMC) of Primorskii Territorial Office on Hydrometeorology and Environmental Monitoring are presented in Table 5.5.

The data were used on the stations of State Observation Network closest to the sea coast. One must note that hydro-chemical observations of the region are uneven. A number of rather large rivers in the rather unpopulated north, including the Koppi, Botchi and Tumnin Rivers are not described with respect to contaminant concentrations. More recent data by 2007 for some rivers of Primorskyi Krai are presented in Tables 5.6.

Dissolved oxygen (DO) and pH of river water do not indicate any deterioration in water quality. At the same time, $BOD_5$ values exceed MPC 2 mg/l in all rivers draining moderately populated and economically developed watersheds, namely in Razdolnaya and Knevichanka (tributary of Arteomovka). The only exception is down stream of the Tumen River with rather low BOD but with elevated COD that exceeds MPC 15 mg/l. The enlarged COD was observed also in the rivers Razdolnaya and Knevichanka where clear pollution by $BOD_5$ took place.

COD parameter in many Russian rivers is significantly higher than in Japanese rivers and even in Korean ones. The use of stronger oxidant $K_2Cr_2O_7$ for the determination of COD in Russia is a first reason. Besides pristine rivers, draining the forest landscapes of the north Primorye, are rich in natural dissolved organic substances which can be oxidized and give the elevated COD.

$NH_4$ and $NO_2$ as well as $PO_4$ ions in river water equal or exceed MPC in the most anthropogenically loaded Razdolnaya, Knevichanka and Rudnaya Rivers only. Down stream of the Tumen River in China, $NH_4$ content is also elevated, but near the Tumen River mouth in Russia $NH_4$ decreases while $NO_3$ increase.

Phenol and oil (petroleum hydrocarbons – PHC) concentrations exceed MPC in the most anthropogenically influenced rivers, though MPC for phenol is nearly equal to MDL and improvement of the method used for the determination of phenol is needed.

Table 5.5. Chemical composition of Primorskii Krai rivers flowing into the NOWPAP sea area (average for 2002)

| Rivers | SS* (mg/l) | $BOD_5$ (mg/l) | COD (mg/l) | DO (mg/l) | Si (mgSi/) | $NH_4$ (mgN/l) |
|---|---|---|---|---|---|---|
| Tumen** | 124 (126) | 1.93 (2.18) | 18.8 (20.1) | 10.5 (5.59) | 12.2 (-) | 0.17 (0.54) |
| Tsukanovka | 9.6 | 3.79 | 4.3 | 12.1 | 7.96 | 0.03 |
| Razdolnaya | 73 | 11.9 | 15.1 | 12.1 | 6.4 | 0.44 |
| Artyomovka | 38.7 | 1.94 | 7.8 | 11.4 | 5.7 | 0.03 |
| Partizanskaya | 38.7 | 2.2 | 6.7 | 11.7 | 3.9 | 0.02 |
| Margaritovka | 22.5 | 1.75 | 5.4 | 10.7 | 4.6 | 0.05 |
| Avvakumovka | 22.5 | 1.81 | 5.9 | 12.4 | 5.0 | 0.04 |
| Zerkalnaya | 22.5 | 1.28 | 5.4 | 11.5 | 4.0 | 0.08 |
| Rudnaya | 19.6 | 1.03 | 6.5 | 12.5 | 4.5 | 0.10 |
| Serebryanka | 21.7 | 1.4 | 4.3 | 11.8 | 5.3 | 0.07 |
| Maksimovka | 21.7 | 2.4 | 7.5 | 13.2 | 5.4 | 0.04 |
| Samarga | 21.7 | 0.7 | 9.0 | 13.4 | 5.3 | 0.05 |
| ***MPC*** | ***-*** | ***2.0*** | ***15*** | ***<3.0*** | ***-*** | ***0.4*** |
| **Rivers** | **$NO_2$ (mgN/l)** | **$NO_3$ (mgN/l)** | **$PO_4$ (mgP/l)** | **PHC (mg/l)** | **v-phenols (mg/l)** | **Sufract (mg/l)** |
| Tumen | 0.014 (0.015) | 0.29 (0.19) | 0.013(-) | 0.02 (-) | 0.003 (0.0028) | 0.020 (-) |
| Tsukanovka | 0.004 | 0.01 | 0.007 | 0.01 | 0.001 | 0.015 |
| Razdolnaya | 0.03 | 0.22 | 0.047 | 0.04 | 0.004 | 0.024 |
| Artyomovka | 0.003 | 0.01 | 0.006 | 0.06 | 0.001 | 0.008 |
| Partizanskaya | 0.004 | 0.01 | 0.003 | 0.07 | 0.001 | 0.012 |
| Margaritovka | 0.001 | 0.02 | 0.001 | 0.03 | 0.001 | 0.005 |
| Avvakumovka | 0 | 0.02 | 0.002 | 0.13 | 0.001 | 0.005 |
| Zerkalnaya | 0.003 | 0.05 | 0.034 | 0.08 | 0.003 | 0.014 |
| Rudnaya | 0.022 | 0.02 | 0.117 | 0.04 | 0.002 | 0.018 |
| Serebryanka | 0 | 0.12 | 0.002 | 0.04 | 0.002 | 0.005 |
| Maksimovka | 0 | 0.01 | 0.003 | 0.01 | 0.001 | 0.005 |
| Samarga | 0 | 0.08 | 0.002 | 0.08 | 0.002 | 0.016 |
| ***MPC*** | ***0.020*** | ***9.1*** | ***0.050*** | ***0.050*** | ***0.001*** | ***0.100*** |

*– averaged for all period of observation; **SS** = suspended solids; All **nutrients** in filtered samples, other parameters in unfiltered; **Sufract** – concentration of anionic detergents; **MPC** = maximum permissible concentration for the Russian fresh waters analogous to Water Class I-II (Korea) or A-AA (Japan);
** - data from Chinese NR are presented in brackets

The concentrations of chloro-organic pesticides group DDT (sum of DDT and its metabolites DDD and DDE) were less than 35 ng/l, and group HCH (sum of hexachlorcyclohexan isomers: Eldrin etc.) were less than 4 ng/l in the rivers studied.

The observation on the down reach of Tumen River are carried out by China specialists (40 km up stream of river mouth), and Russia specialists (15 km up stream of river mouth) as well. Taking in mind some differences in sampling places and methods, data for down stream reaches of the Tumen River gathered by Russia and China show good concordance.

Table 5.6 Chemical characteristic (mg/l) of some rivers of Primorskii Krai Rivers by 2007

| River | $COD_{Cr}$ | $BOD_5$ | $N_{NH4}+$ | $N_{NO3}-$ | $P_{PO4}^{3-}$ | oil | v-phenols | SS |
|---|---|---|---|---|---|---|---|---|
| Ussury (Wisuli) | 18.5 | 0,99 | 0,14 | 0,02 | 0,045 | 0,03 | 0,002 | 5,8 |
| Ussurka | 9 | 0,59 | 0,08 | 0,05 | 0,035 | 0,12 | 0,003 | 5,2 |
| Rudnaya | 6,9 | 1,5 | 0,13 | 0,11 | 0,246 | 0,16 | 0,002 | 5,9 |
| Partizanskaya | 7,6 | 1,86 | 0,05 | 0,04 | 0,019 | 0,03 | 0 | 7,9 |
| Knevichanka | 27,4 | 8,05 | 2,22 | 0,04 | 0,493 | 0,07 | 0,004 | 34,4 |
| Artemovka | 14,7 | 1,94 | 0,13 | 0,04 | 0,034 | 0,01 | 0 | 4,8 |
| Razdolnaya (Suifun) | 23,8 | 2,55 | 0,68 | 0,1 | 0,868 | 0,09 | 0,002 | 35 |
| **MPC** | **15.0** | **2.0** | **0.40** | **9.1** | **0.05** | **0.05** | **0.001** | **-** |

Nutrients are determined in the filtered (0.45 mkm) samples, others – in the unfiltered ones

The use of trace metal (heavy metal) concentrations for water quality assessment as part of routine monitoring procedures in Russia meets with some of the same problems as encountered in other countries (for example, MAP MTS #141, 2003). The main reasons are analytical problems in obtaining reliable “contamination-free” results and the need to use filtered samples for analysis given an affinity of most metals to suspended particles. Analytical monitoring procedures in China, Japan and Korea are, as a rule, carried out with unfiltered samples. At the same time, the usefulness of metal concentrations in rivers for assessing anthropogenic influence on the surface waters is obvious.

Existing reliable data on dissolved forms of some metals in Russian rivers within the NOWPAP region are presented in Table 5.7. These data have been borrowed from the published scientific research of Pacific Geographical Institute RAS (Shulkin et al., 2007, Shulkin et al., 2009).

The concentrations of most potentially hazardous dissolved forms for heavy metals Cd and Pb are far below MPC as well as for Zn and Ni. The only exception is the polluted Rudnaya River that drains a mining district. Dissolved Cu concentration exceeds MPC 1 µg/l (0.001 mg/l) in many rivers, but is explained by unsupportable low MPC established for exclusively ionic dissolved forms of Cu, though in natural water the major part of dissolved Cu is presented by less toxic organic complexes.

Table 5.7. Concentration of dissolved forms of metals in some rivers flowing into the NOWPAP sea area from Primorskyi Krai

| Rivers | Pb d (µg/l) | Cu d (µg/l) | Mn d (µg/l) | Fe d (µg/l) | Cd d (µg/l) | Zn d (µg/l) | Ni d (µg/l) |
|---|---|---|---|---|---|---|---|
| Tumen | 0.16 | **1.57** | **95.3** | 86.5 | 0.024 | 0.94 | 0.72 |
| Tsukanovka* | 0.022 | 0.49 | 4.1 | 20.4 | 0.006 | 0.31 | 0.31 |
| Razdolnaya | 0.023 | **1.27** | 14.9 | 23.7 | 0.012 | 0.36 | 0.80 |
| Artyomovka | 0.19 | 0.75 | 10 | 44 | 0.014 | 0.7 | 0.61 |
| Rudnaya | 0.64 | **1.35** | **110** | 21 | 0.25 | **120** | 0.8 |
| Zerkalnaya** | 0.039 | 0.32 | 2.5 | 14.7 | 0.008 | 1.54 | 0.10 |
| ***MPC*** | ***6*** | ***1*** | ***10*** | ***100*** | ***5*** | ***10*** | ***10*** |

*** -** and other rivers of southwestern part of Primorye; ** - and other rivers of the eastern part of Sikhote-Alin range; **Me d** – concentration of dissolved metal forms in filtered (0.45 mkm) samples.

Dissolved Mn and Fe are not very toxic, but in some rivers concentrations of these metals exceed MPC. This is explained by prevalence of colloidal forms for Fe and mobilization from swampy and/or polluted landscapes for Mn.

## 5.2. Temporal Trends in River Water Quality Assessment

The water quality from 2001 to 2007 in the main rivers of the northwestern part of **China** inflowing to the NOWPAP sea area shows somewhat consistency (Fig. 6). That is less polluted and largest rivers Yalu, Yellow and Yangtze continue to be relatively clean during the last seven years. Moreover the COD and especially $BOD_5$ values in these rivers show decrease trend. In Yangtze, Yalu and Yellow rivers the annually averaged $BOD_5$ value declines in 2.2, 1.5 and 1.5 times respectively during this period.

$NH_4^-$ decrease is observed in the Yalu river only. In other moderately polluted big rivers the increase trend of annual mean $NH_4^-$ took place (Fig. 6d).

In the more polluted rivers Hai, Daliao, Tumen, and Huai the annual means of chemical parameters were more variable last years (Fig. 6). COD in Hai and Tumen rivers show increase trend, though in Daliao and Huai – opposite one (Fig. 6a). $BOD_5$ annually averaged values in Chinese polluted rivers are very variable, but some increase trend are observed for all these rivers. Especially significant enhance of BOD contamination has been observed in Daliao river (Fig. 6c). The somewhat similar increase trend took place for the $NH_4^-$ in the polluted Tumen, Daliao and especially Hai rivers (Fig. 6b, d). The moderately polluted Huai river is only example of the decrease trend of $NH_4^-$ concentration during last seven years (Fig. 6d).

Data on the annual mean of oil concentration in the rivers of northeastern Chinese provinces allow noting constantly low level in the biggest and less polluted Yalu, Yellow and Yangtze rivers. At the same time the annual mean in the more polluted Hai, Daliao and Tumen rivers is higher and more variable.

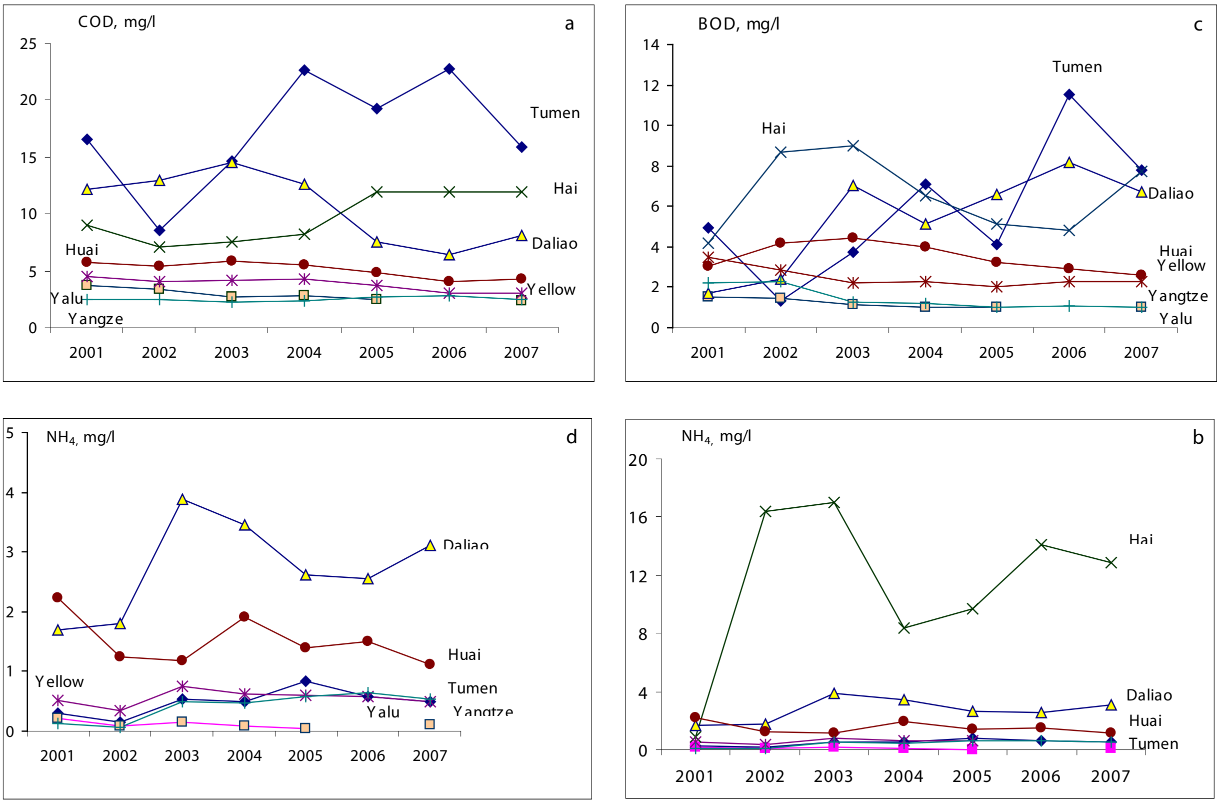



Figure 6. Trends of some chemical parameters in the Chinese northeast rivers in 2001-2007

The water quality in the major **Japanese** rivers within NOWPAP area (e.g. , Teshio, Mogami, Ishikari) is characterized by 1.5-2 times lower concentration of $BOD_5$ and COD compare with large Chinese rivers (Yangtze and Yalu) (Fig. 6, 7, 8).

It is partly explained by the different nature of Chinese and Japanese rivers: plain for the former, and mountainous for the last. Obviously, the inter annual change of the BOD and COD averages in the major Japanese rivers cannot be significant (Fig. 7, 8).

The spatial difference between annually averaged BOD and COD is not significant as well in these rivers. At the same time in the some Japanese rivers BOD and COD values are elevated up to 2-3 mg/l and 5-6 mg/l respectively. There are Iwaki River and Rumoi River at the north and Oyabe River at the south. This level continues to be significantly lower than in the Chinese rivers with distinct anthropogenic load, like Tumen River or Daliao River, or Hai River. Moreover some trends of decrease were observed for the COD and especially BOD values in the Iwaki and Rumoi rivers last years (Fig. 7), noting the improvement of water quality.

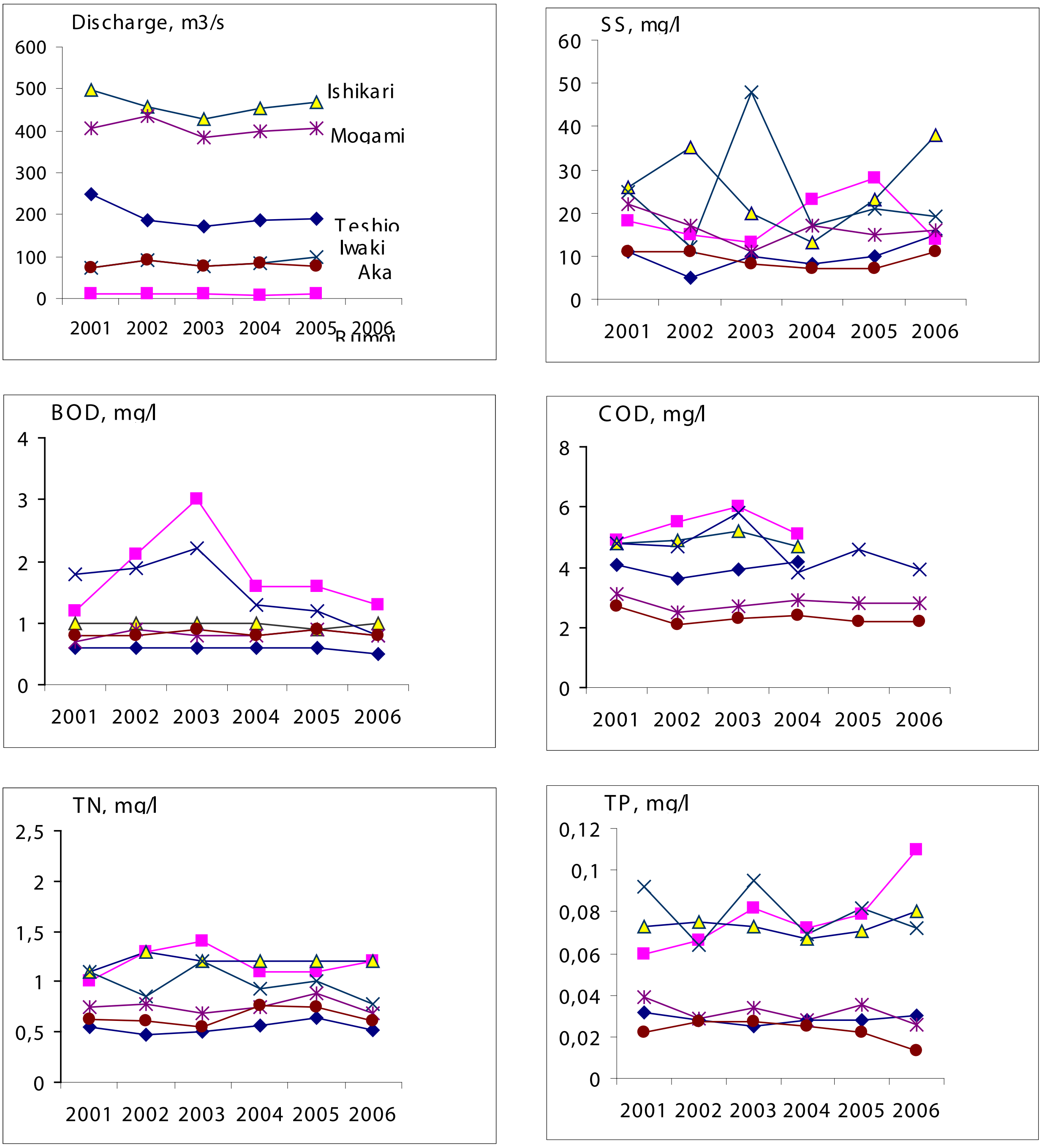



Figure 7. Trends of some chemical parameters in the Japanese rivers of the Hokkaido, Aomori, Akita, Yamagata Prefectures (north part of the NOWPAP area within Japan)

The situation is not so unambiguously in terms of inter annual change of nutrients concentration (total nitrogen – TN, and total phosphorus – TP). In the most major Japanese rivers Teshio, Mogami and Shinano concentration of TN is rather stable (0.5-1.0 mgN/l). In the rivers with slightly elevated TN concentration (1.0-2.0 mgN/l), there is stability or even decrease trend by 0.5 mgN/l during last years marking the improvement of water quality (Fig. 7, 8).

Total phosphorus (TP) annually averaged concentration is stable in the rivers of the Northern prefectures, but in the rivers with elevated TP (0.06-0.10 mgP/l) concentration of TP was increased last years (Fig. 7). The inter annual change of averaged TP concentration in the rivers of southern prefectures is contradictory (Fig. 8). There is some increase in the initially pristine Yura River, but the decrease trend is prevailed for the many rivers including biggest one Shinano River and most polluted one Oyabe River.

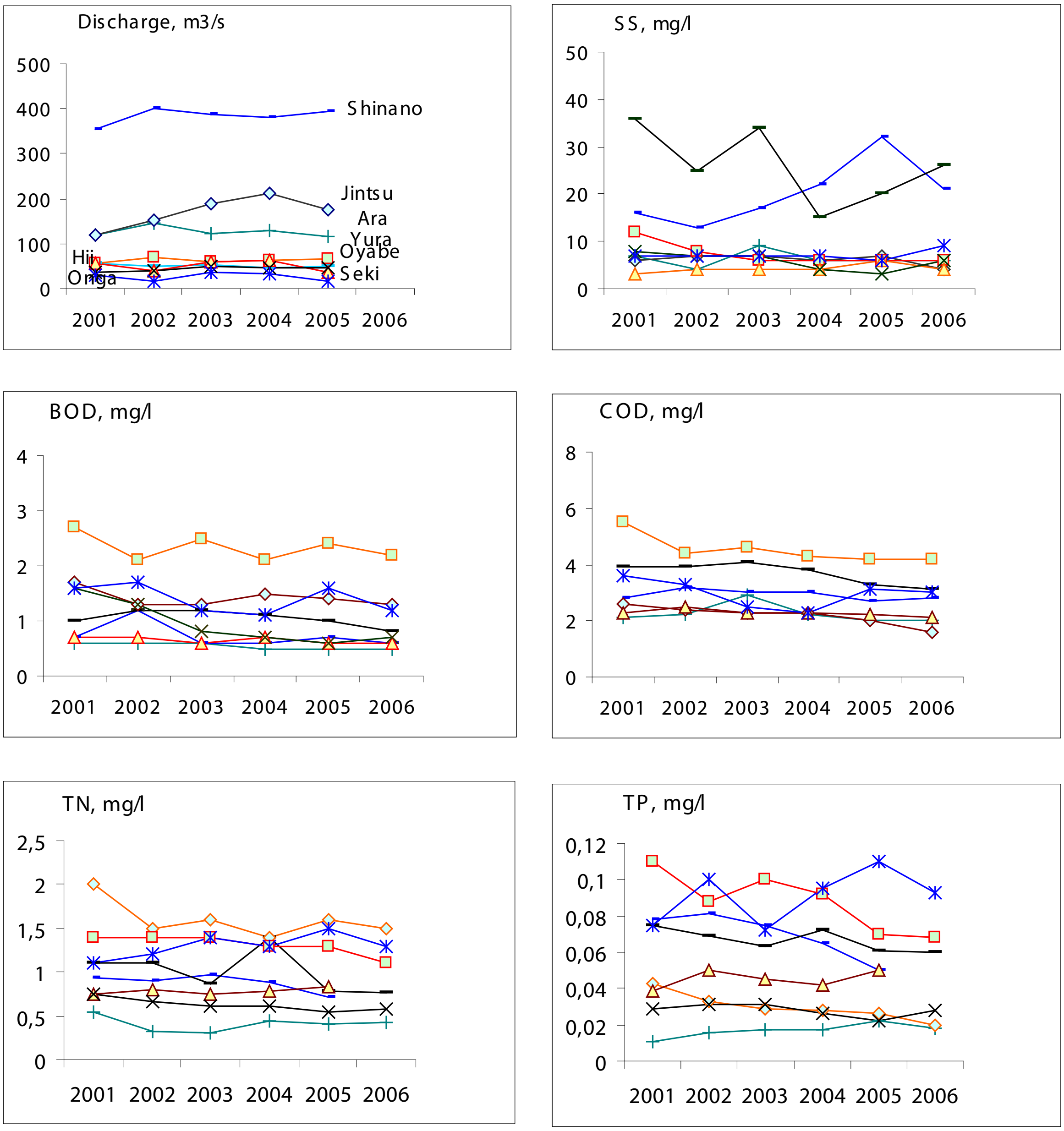



Figure 8. Trends of some chemical parameters in the Japanese rivers of the Niigata, Toyama, Kyoto, Shimane and Fukuoka Prefectures (south part of the NOWPAP area within Japan)

The spatial variability by TN, and especially by TP is more pronounced in the rivers of the southern prefectures (Niigata – Fukuoka) compare with northern ones (Hokkaido – Yamagata) (Fig.7 and Fig.8).

The data on the annual means of chemical parameters for the 6 largest rivers of **Korea** show somewhat contradictory trends during 2001-2007. The water quality of the largest Han River was rather stable except the 2002 when the significant deterioration of all parameters took place (Fig. 9). But for the same 2002 the annual means of TN, SS, BOD and COD were minimal in the rather clean Seomjin River and more polluted Anseongcheon River.

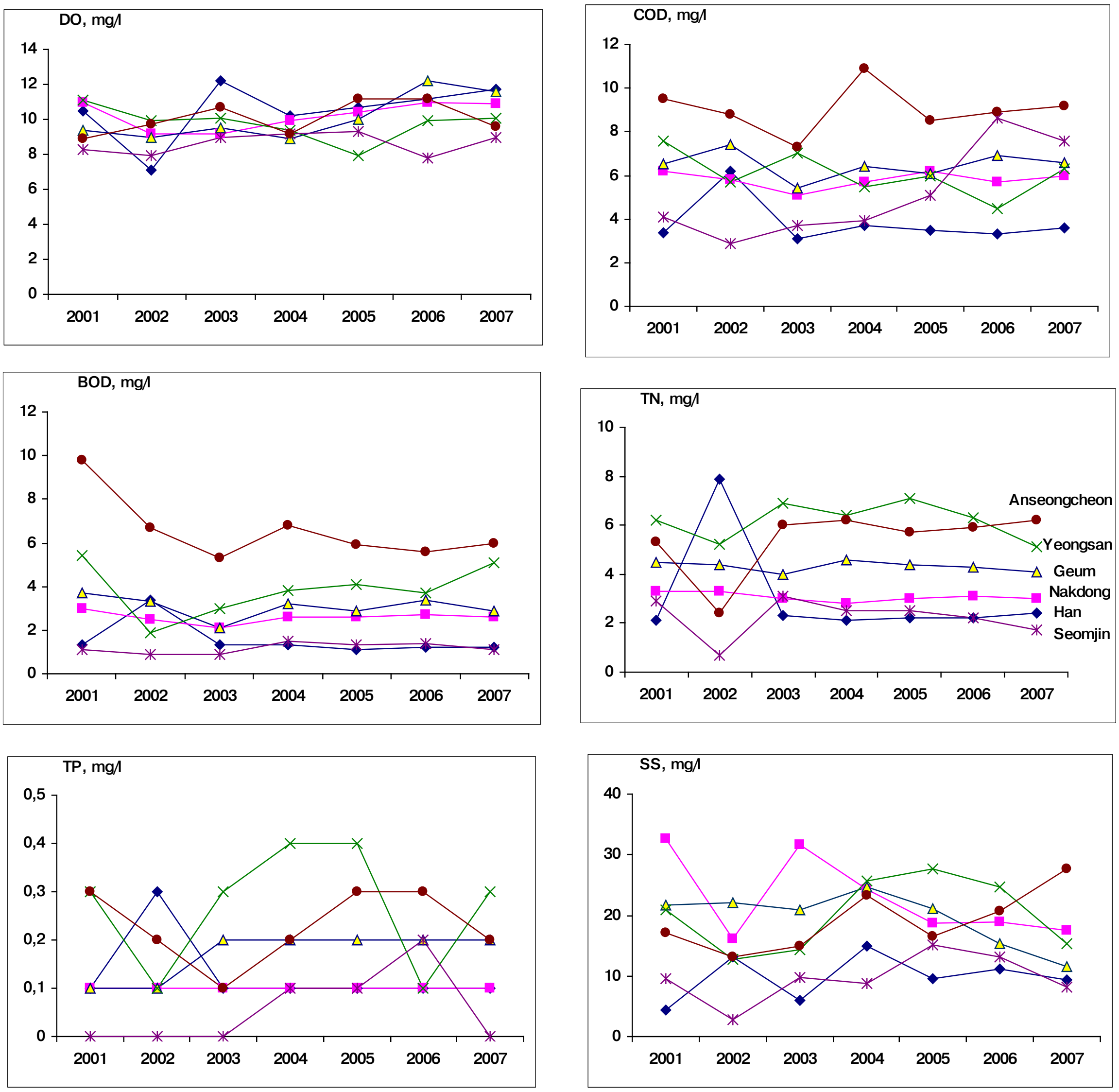



Figure 9. Trends of the water quality chemical parameters for the main Korean rivers

The most obvious improvement during last 7 years is observed in the polluted Anseongcheon River where BOD shows clear diminishing, though COD and TN continue to be higher than in other rivers. The weak increase trend for dissolved oxygen (DO) (Fig. 9) also points out the some improvement of Korean rivers water quality in the beginning of XXI century. BOD and T-N gradually decreased over time in the Nakdong and Guem Rivers. However, T-P has increased since 2002. Seomjin River COD increased rapidly from 2004 to 2006.

Inter annual change of chemical composition of **Russian** rivers within NOWPAP area is different for different parameters (Fig. 10).

The COD does not demonstrate any clear trend except the continuously elevated COD in the polluted rivers. The high COD values in the Russian rivers compare with lower COD in the rivers of other NOWPAP countries (Fig. 6, Fig. 10) are explained partly by the use in Russia more strong oxidative at the COD

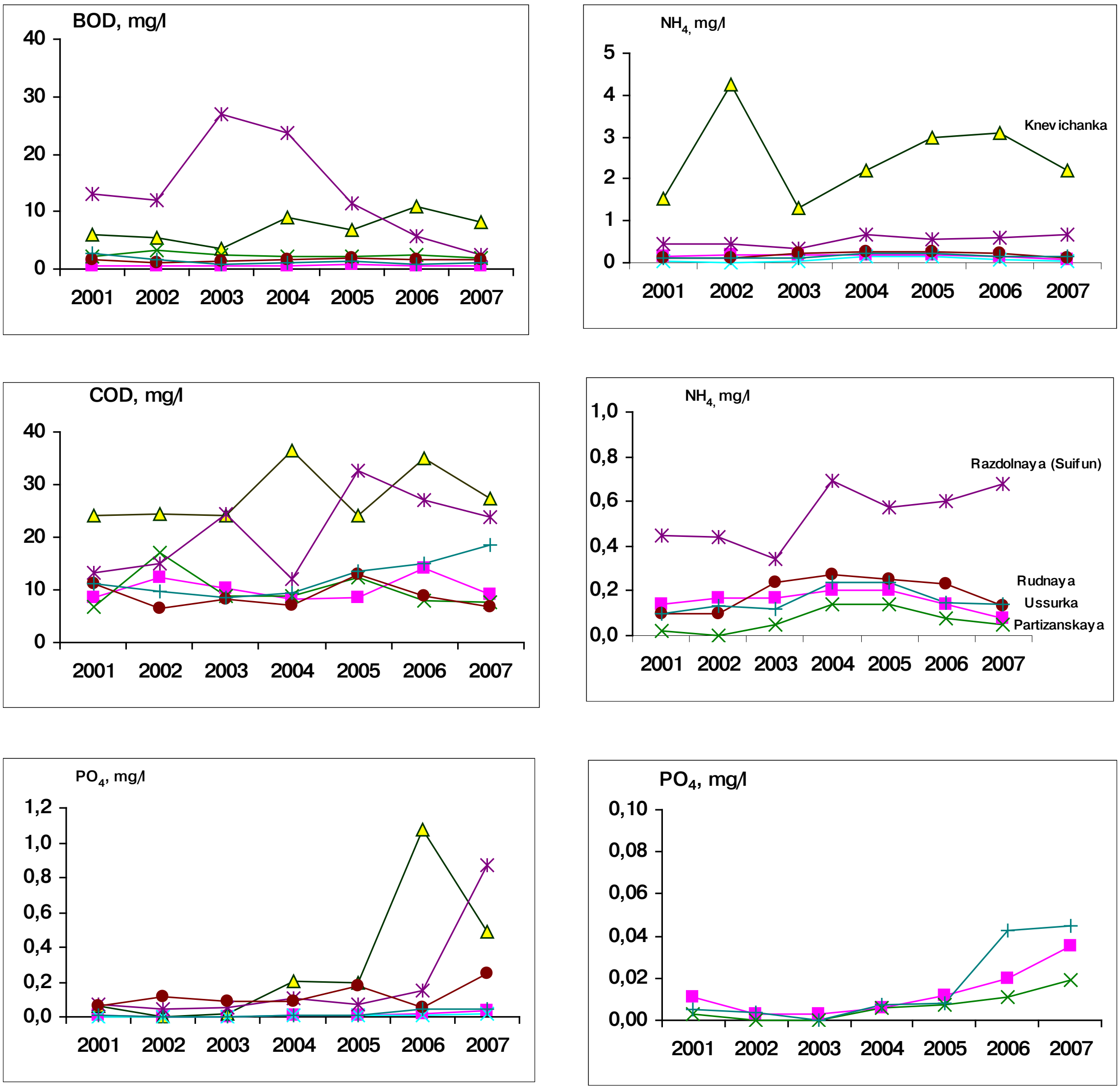



Figure 10. Trends of the water quality chemical parameters for some Russian rivers within NOWPAP area

determination. The BOD shows distinct decrease trend in the rather polluted Razdolnaya River (Fig. 10), but in other polluted stream – Knevichanka River BOD increase 1.5-2 times last years.

Rather pristine Russian rivers do not show any clear trend for BOD. Annual means of phosphate show trend of increase during last 7 years in the polluted rivers, and that is more important, in the pristine ones (Fig. 10). 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 in the Razdolnaya River at least, but in the pristine rivers there was stabilization or even decrease of ammonia nitrogen concentration last 1-2 years (Fig. 10).

### 5.3. Pollution Loads via Rivers

When referring to river water quality, the concentration of chemical substances is an issue, but when discussing river input into, and river influence on the marine environment, the load (flux) of substances carried by rivers becomes more important. Another interest to the assessment of river fluxes is appeared when we need to compare the natural background fluxes with anthropogenic wastewaters, sewages and exhausts generation and discharge. These negative consequences of human activities are expressed as fluxes usually (amount per time unit).

The first proxy of estimation of river fluxes to the sea can multiplies water discharge (Table 2.1) by the chemical substance concentrations (Table 5.1, 5.2, 5.4, 5.6). Such estimates for chemical parameters broadly used as water quality indices are presented in Table 5.8, 5.9, 5.10, 5.11 for China, Japan, Korea and Russia, respectively based on the data for 2005.

Table 5.8. Annual Discharge of Water ($km^3$) and Some Chemical Substances (tons/year) in Major Chinese Rivers Adjoining NOWPAP Region (2005 data)

| Rivers | Water*** | $COD_{Mn}$ | $BOD_5$ | $NH_4$-N | Oils |
|---|---|---|---|---|---|
| Songhua | 76.2 | 518,099 | 128,763 | 41,143 | 7,619 |
| Wusulijiang | 18.5 | 111,259 | 22,808 | 14,278 | 14,278 |
| Tumen | 9.05 | 174,665 | 37,286 | 7,512 | 453 |
| Yalu* | 37.8 | 94,500 | 37,800 | 1,512 | 756 |
| Daliao | 14.8 | 112,407 | 97,025 | 38,751 | 592 |
| Daling** | 3.7 | 555,000 | 204,980 | 2,923 | 1,813 |
| Luan** | 4.6 | 17,940 | 15,640 | 4,646 | 138 |
| Yongdingxin | - | - | - | - | - |
| Chaobaixin | - | - | - | - | - |
| Hai | 22.8 | 271,326 | 117,195 | 220,253 | 5,700 |
| Duliujian | - | - | - | - | - |
| Yellow | 65.8 | 243,518 | 131,631 | 39,489 | 658 |
| Yi | - | - | - | - | - |
| Huai | 62.2 | 298,507 | 201,492 | 86,443 | 1,244 |
| Yangze | 951.3 | 2,568,550 | 951,315 | 551,763 | 57,079 |
| Subtotal-1 | 221 | 1,767,863 | 843,049 | 401,528 | 11,353 |
| Subtotal-2 | 315 | 2,397,221 | 994,620 | 456,950 | 33,251 |
| Total | 1267 | 4,965,771 | 1,945,935 | 1,008,713 | 90,329 |

* - water discharge for evaluation from Zhang et al., 1998; ** - water discharge for evaluation is assessed by watershed square; *** water discharge is cited partly from Regional Overview, 2006; Subtotal-1 - data except Yangtze, Songhua and Wisuli Rivers; Subtotal-2 – data exept Yangtze River; nd – means no data

Table 5.9. Annual Discharge of Water ($km^3$) and Some Chemical Substances (tons/year) in Major Japan Rivers Flowing into the NOWPAP Region (2005 data)

| Rivers | Water | SS | $BOD_5$ | $COD_{Mn}$ | T-N | T-P | $NO_3$ |
|---|---|---|---|---|---|---|---|
| Teshio river | 6.00 | 59,972 | 3,598 | - | 3,838 | 168 | - |
| Rumoi river | 0.37 | 10,261 | 586 | - | 403 | 29 | 56 |
| Ishikari river | 14.72 | 338,467 | 13,244 | - | 17,659 | 1,045 | - |
| Shiribetsu river | 2.37 | 14,193 | 1,183 | - | - | - | - |
| Shiribeshitoshibetsu | 0.85 | 4,261 | 511 | - | 290 | 25 | - |
| Iwaki river | 3.15 | 66,113 | 3,778 | 14,482 | 3,148 | 258 | - |
| Yoneshiro river | 6.73 | 26,914 | 6,729 | - | 4,306 | 182 | - |
| Omono river | 8.70 | 86,989 | 8,699 | - | 7,046 | 365 | - |
| Koyoshi river | 1.97 | 11,800 | 1,967 | - | 1,062 | 65 | - |
| Mogami river | 12.81 | 192,215 | 11,533 | 35,880 | 11,405 | 449 | |
| Aka river | 2.47 | 17,311 | 2,226 | 5,441 | 1,830 | 54 | 816 |
| Ara river | 3.70 | 22,197 | 1,850 | 7,399 | 1,517 | 81 | - |
| Agano river | 14.34 | 143,391 | 8,603 | 37,282 | 7,313 | 602 | - |
| Shinano river | 12.40 | 396,657 | 8,677 | 33,468 | 8,925 | 620 | - |
| Seki river | 1.59 | 31,839 | 1,592 | 5,253 | 1,242 | 97 | 621 |
| Hime River | 1.91 | 87,808 | 1,145 | 3,436 | 783 | 229 | - |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Kurobe river | 3,09 | 27,786 | 2,161 | 4,322 | 864 | 52 | - |
| Joganji river | 0.59 | 4,126 | 589 | 1,061 | 283 | 14 | 150 |
| Jintsu river | 5.56 | 38,932 | 7,786 | 11,123 | 8,899 | 145 | 4,260 |
| Sho river | 1.15 | 4,603 | 1,151 | 1,841 | - | - | - |
| Oyabe river | 2.06 | 12,358 | 4,943 | 8,650 | 2,678 | 144 | 1184 |
| Tedori river | 2.37 | 21,355 | 2,135 | - | 1,115 | 69 | - |
| Kakehashi river | 0.57 | 4,582 | 573 | - | 389 | 33 | 263 |
| Kuzuryuu river | 3.32 | 29,861 | 2,986 | 10,617 | - | - | - |
| Kita river | 0.42 | 2,078 | 208 | 790 | - | - | - |
| Yura river | 1.17 | 7,033 | 703 | 2,579 | 985 | 59 | 821 |
| Maruyama river | 0.96 | 4,817 | 867 | - | 511 | 36 | 341 |
| Chiyo river | 1.76 | 5,287 | 1,410 | 2,996 | - | - | - |
| Tenjin river | 0.68 | 1,370 | 411 | 1,233 | - | - | - |
| Hino river | 1.05 | 4,207 | 1,262 | 2,419 | - | - | - |
| Hii river | 1.43 | 4,295 | 859 | - | 787 | 31 | 556 |
| Gono river | 3.81 | 7,618 | 2,286 | - | - | - | - |
| Takatsu river | 1.28 | 1,284 | 1,027 | - | - | - | - |
| Onga river | 0.52 | 3,116 | 831 | 1,610 | 779 | 57 | - |
| Matsuura river | 0.12 | 494 | 111 | 482 | 51 | 4 | - |
| Total (subtotal) | 16.0 | 1,695,590 | 108,221 | (192,365) | (88,107) | (4,912) | (9,067) |

"-" means no data; in brackets - subtotal by some rivers only

Table 5.10. Annual Discharge of Water ($km^3$) and Some Chemical Substances (tons/year) in Major Korea Rivers Flowing into the NOWPAP Region (2005 data)

| River | Water | $COD_{Mn}$ | $BOD_5$ | SS | TN | TP | $NO_3$-N | $NH_4$-N | $PO_4$- P |
|---|---|---|---|---|---|---|---|---|---|
| Han | 27.97 | 97,904 | 30,770 | 265,738 | 61,539 | 2,797 | 61,539 | 2,797 | 0 |
| Nakdong | 11.51 | 71,366 | 29,928 | 216,400 | 34,532 | 1,151 | 21,870 | 1,151 | 1,151 |
| Geum | 7.88 | 48,092 | 22,864 | 166,352 | 34,690 | 1,577 | 16,556 | 4,730 | 788 |
| Yeongsan | 1.42 | 8,515 | 5,818 | 39,168 | 10,076 | 568 | 5,393 | 1,135 | 284 |
| Seomjin | 3.22 | 16,405 | 4,182 | 48,893 | 8,042 | 322 | 3,860 | 643 | 643 |
| Anseongcheon | 0.60 | 5,093 | 3,535 | 9,946 | 3,415 | 180 | 1,917 | 839 | 120 |
| Sapgyocheon | 0.66 | 4,834 | 2,119 | 39,073 | 4,040 | 199 | 1,788 | 927 | 66 |
| Dongjin | 0.91 | 3,109 | 823 | 5,396 | 1,738 | 91 | 1,006 | 183 | 0 |
| Tamjin | 0.32 | 1,041 | 315 | 2,397 | 378 | 32 | 189 | 32 | 0 |
| Taehwa | 0.38 | 1,097 | 265 | 416 | 1,060 | 38 | 454 | 151 | 0 |
| Hyeongsan | 0.47 | 2,649 | 1,419 | 4,399 | 1,514 | 0 | 1,041 | 95 | 47 |
| Total | 55.3 | 260,106 | 102,038 | 798,179 | 161,023 | 6,954 | 115,614 | 12,684 | 3,100 |

The inter annual changes of the river fluxes of chemical substances are determined by the variation of water discharge and by the variability of the concentration as well. The relationship between these parameters is rather complicated, is dependent from many natural and anthropogenic factors. The relationship between hydrological and hydrochemical characteristics has been studied in terms of seasonal variability (e.g. Gaillardet et al., 2003), but for the annually averaged indexes this linkage is unclear. The discharge and concentration data presented from the NOWPAP states (Fig. 6, 7, 8, 9, 10) show the compatible scale of inter annual variation.

For the time being we have a set of data on the inter annual change of fluxes for the Japanese rivers. There is obvious decrease trend of the BOD and COD load for the major rivers Ishikari, Shinano, Hii, and for many others (Fig. 11 – 14). Taking into account the relative small water discharge variability and decrease trend for the concentration (Fig. 7, 8) this fact reflects and confirms the improvement of the water quality for

Table 5.11. Annual Discharge of Water (km$^3$) and Some Chemical Substances (tons/year) in Major Russian Rivers Flowing into the NOWPAP Region (2005* data)

| Rivers, Sub-Regions | Water | SS | BOD | $COD_{Cr}$ | $NH_4$ | $NO_3$ | $PO_4$ | Oils |
|---|---|---|---|---|---|---|---|---|
| Tumen | 9.05 | 1,122,200 | 17,467 | 170,140 | 1,539 | 2,625 | 118 | 181 |
| West PTG Bay, (1) | 0.8 | 7,700 | 3,032 | 3,440 | 20 | 8 | 6 | 10 |
| Razdolnaya, (2) | 3.02 | 111,136 | 34,126 | 98,452 | 1,721 | 1,419 | 227 | 242 |
| East PTG Bay, (3) | 1.97 | 76,200 | 4,137 | 13,593 | 45 | 20 | 8 | 128 |
| Primorsky coast “south”(4) | 3.67 | 82,600 | 6,239 | 20,552 | 206 | 73 | 11 | 128 |
| Rudnaya (5) | 0.10 | 396 | 180 | 1,267 | 25 | 34 | 17 | 12 |
| Primorsky coast “north”(6) | 21.7 | 470,900 | 26,040 | 190,960 | 977 | 260 | 43 | 282 |
| Southwest Sakhalin coast (7) | 3.33 | 353,000 | nd | nd | nd | 50 | 123 | - |
| **Total** | **43.6** | **2,224,132** | **91,221** | **498,404** | **4,533** | **4,489** | **553** | **983** |

* - for some rivers 2002 data were used; PTG Bay – Peter The Great Bay, number in brackets means sub-regions

the many Japanese rivers within NOWPAP area. At the same time there are rivers Tedori and Kuzuryuu where some increase trends was observed for BOD and COD last years. Somewhat similar trends take place for the inter annual changes of TN and TP loads (Fig. 13 and Fig. 14), though there is less regularity compare with BOD and COD pictures. Increase trend was observed as well for the inter annual change of TP load for the Hii River and Onga River (Fig. 14).

Thus at the west coast of Japan the inter annual variability of river fluxes of chemical substances is determined first of all by the level and variation of concentrations.

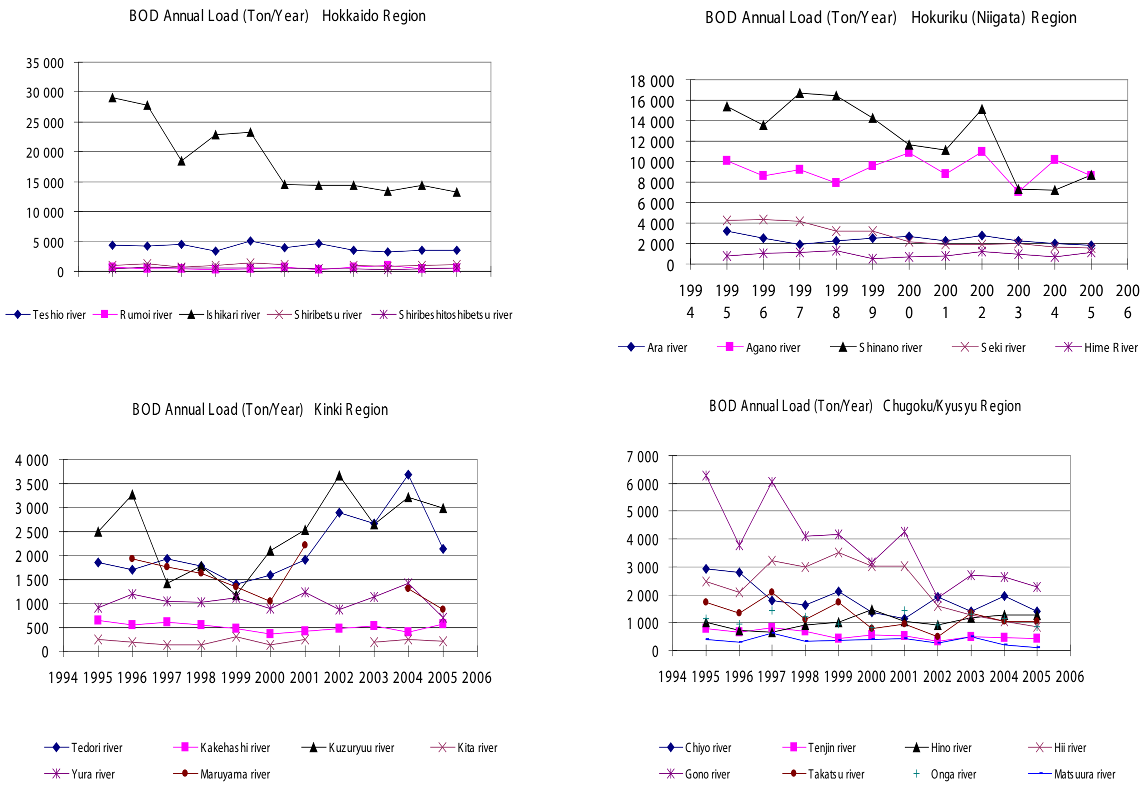



Figure 11. Inter annual variability of BOD load for Japanese rivers within NOWPAP area

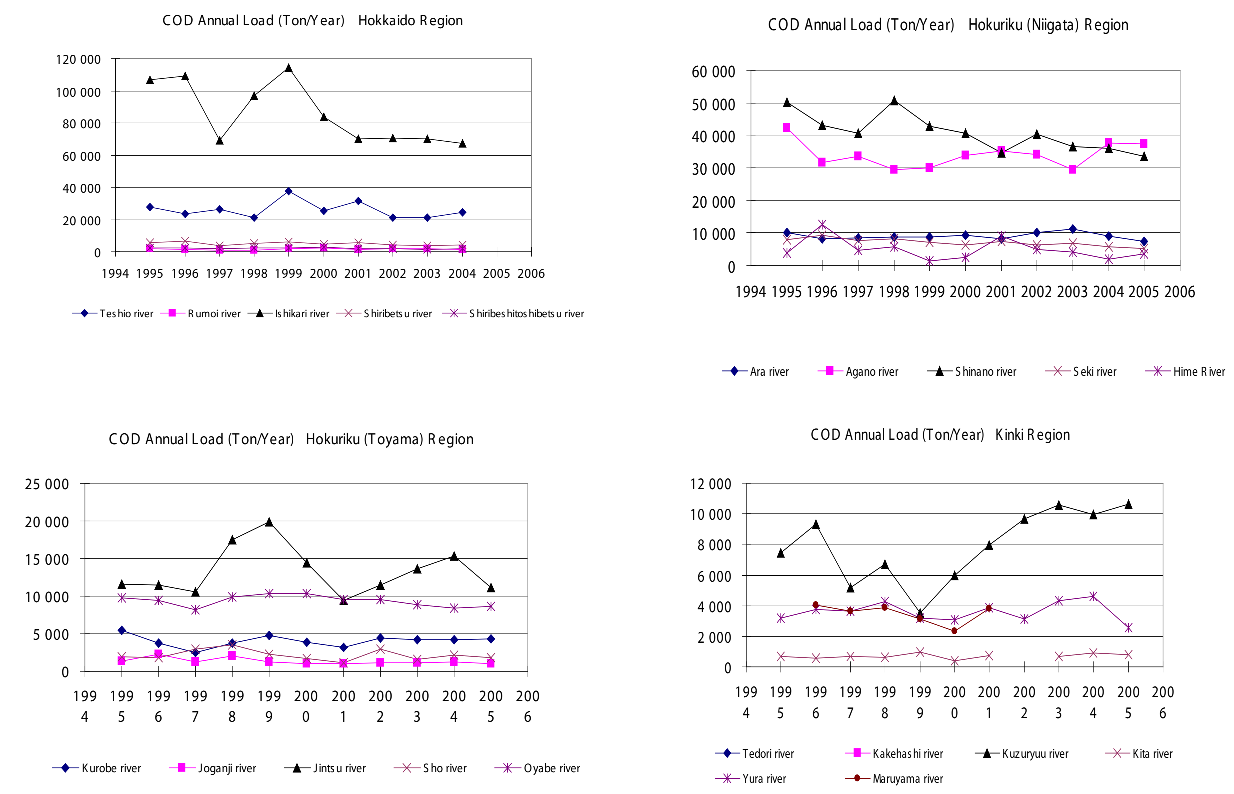



Figure 12. Inter annual variability of COD load for Japanese rivers within NOWPAP area

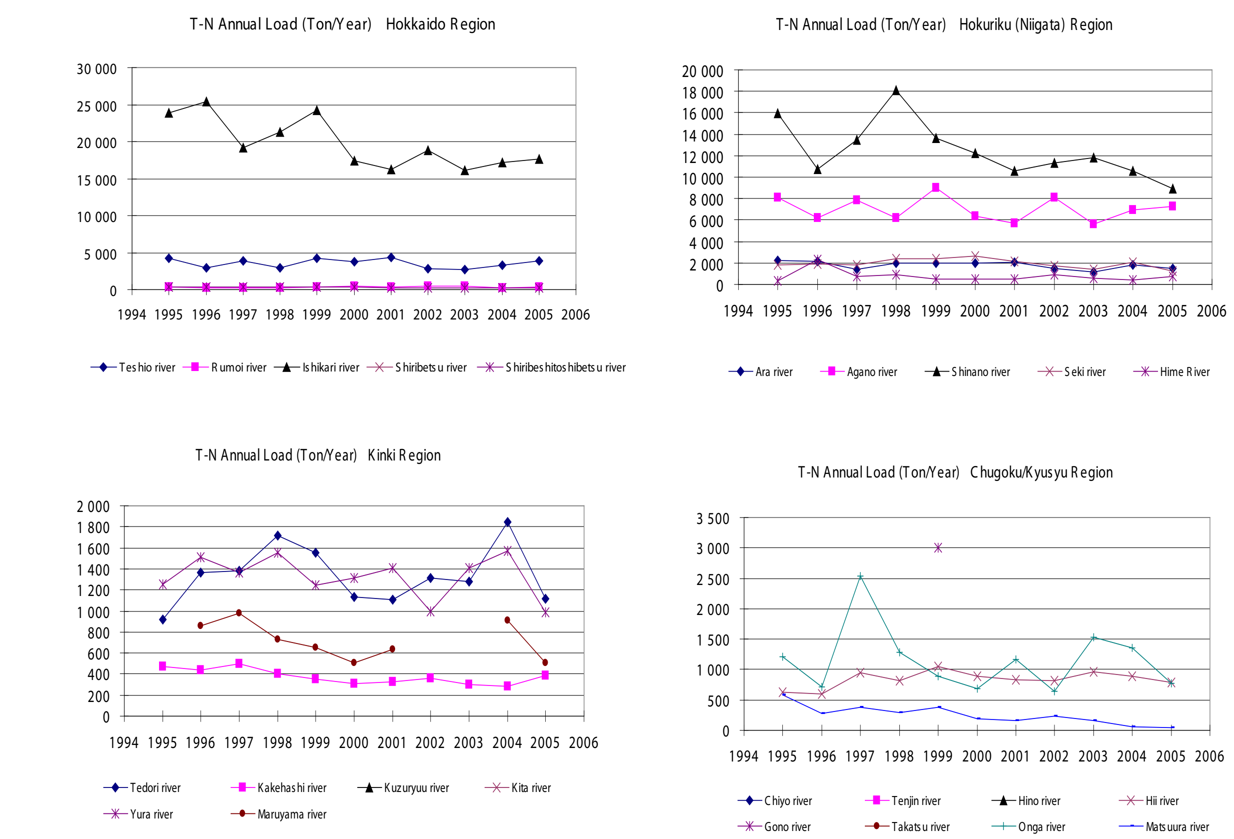



Figure 13. Inter annual variability of T-N load for Japanese rivers within NOWPAP area

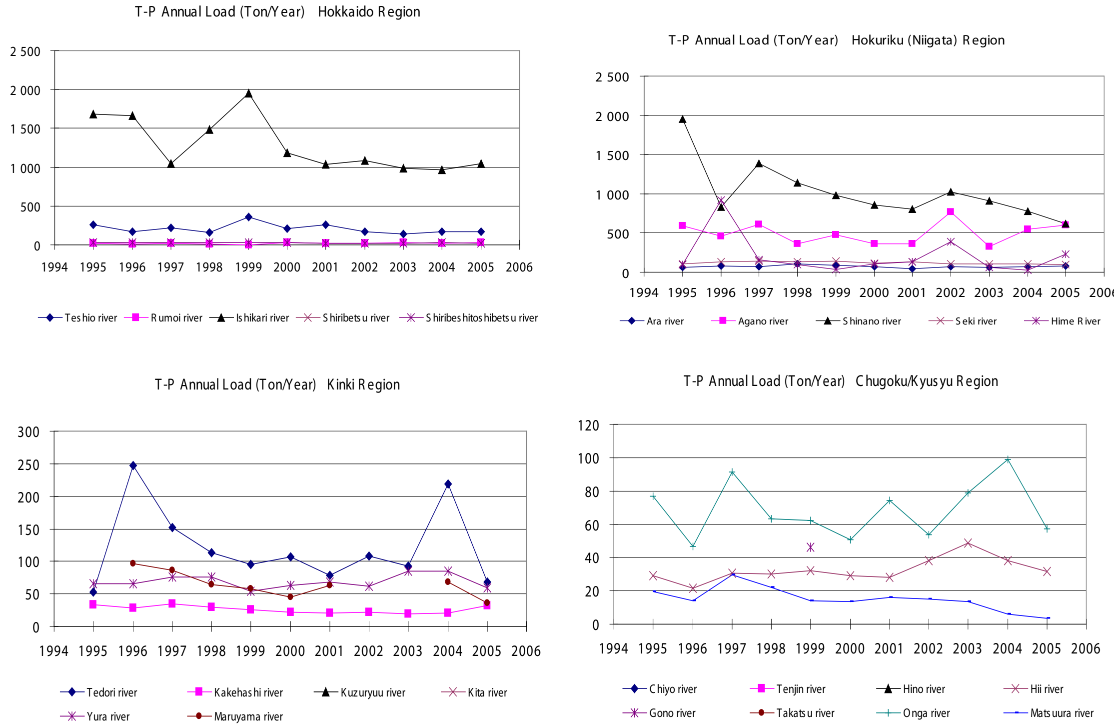



Figure 14. Inter annual variability of T-P load for Japanese rivers within NOWPAP area

In **Korea** the very significant variability of annually averaged water discharge was observed last years, and the variation of water discharge becomes the main factor controlling the inter annual changes of chemical substance loads (Fig. 15).

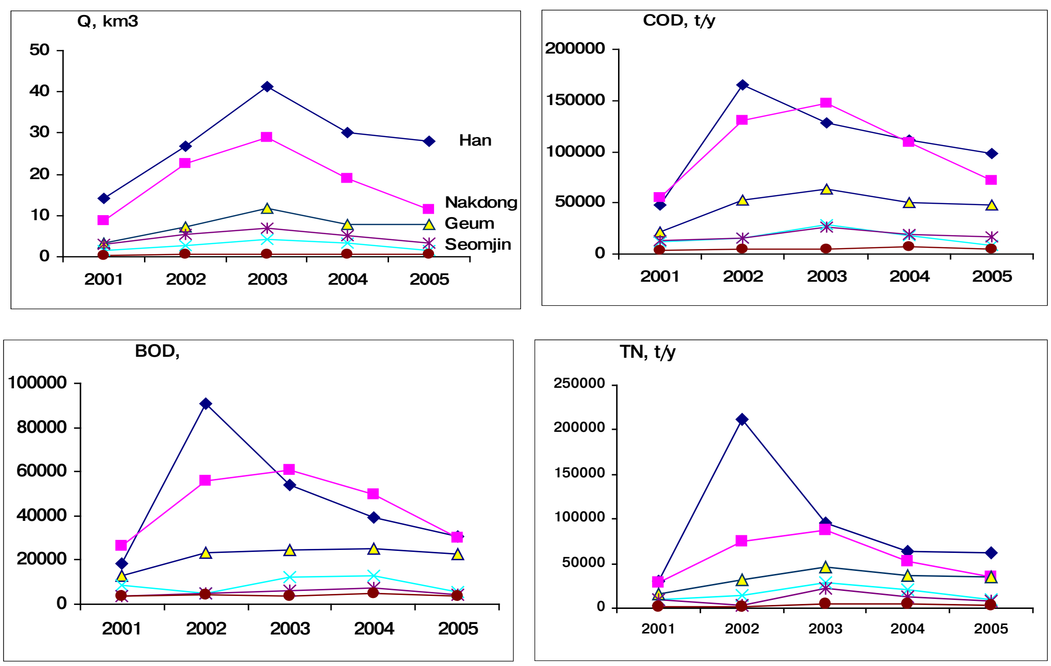



Figure 15. Inter annual variability of water discharge (km$^3$/y) and BOD, COD and TN loads (tons/y) for the major Korean rivers for the last five years

Thus the extremely high water runoff of Han and Nakdong rivers in 2002-2003 led to the distinct maximum of all pollutant loads. The different level of concentration leads to the different level of fluxes, but character of inter annual variability is determined by the water discharge.

The direct comparison of the loads presented in tables 5.8 – 5.11 for the study and characteristic of the spatial variability within NOWPAP area is complicated by the quite different scale of the rivers considered, by the partially incompatible parameters that are measured, and by the absence of data for some rivers or parameters. Moreover, there is a significant difference in the shape and length of coast lines. Normalization procedures can be recommended to facilitate comparisons. One is a traditional watershed square normalization (specific discharge in $l.s^{-1}. km^{-2}$ or $tons.year^{-1} km^{-2}$) that mainly characterizes the intensity of processes taking place at the watersheds. For an assessment of the intensity of input from a land to a marine environment, another measure was recently suggested (Shulkin, 2005): coastal specific discharge which is the input of any substances divided by the length of the coast line. This assessment method could prove useful at the regional and sub-regional level as a first stage evaluation. Some examples of comparative assessment of river water and suspended matter input from the NOWPAP countries on a coast line basis are presented in Table 5.12. On the example of water run-off, it is obvious that traditional specific discharge (normalized on watershed square, Q/S) is not suitable for the assessment of a river’s impact on a marine environment because it is minimal for China given the country’s river delivered impact on the sea.

Table 5.12. Normalization of some river fluxes for NOWPAP countries

| | **S, $10^3 km^2$** | **L, km** | **Q, $km^3$** | **Q/S, $l.s^{-1} km^{-2}$** | **Q/L, $l.s^{-1} km^{-1}$** | **SS/L, $t.y^{-1}.km^{-1}$** | **BOD/L $t.y^{-1}.km^{-1}$** | **COD/L $t.y^{-1}.km^{-1}$** | **$NH_4$/L $t.y^{-1}.km^{-1}$** | **$NO_3$/L $t.y^{-1}.km^{-1}$** |
|---|---|---|---|---|---|---|---|---|---|---|
| China* | 1634 | 10,054 | 221 | 4.3 | 696 | *** | 84 | 176 | 39.9 | 31.9 |
| Japan | 89.5 | 11,610 | 126 | 44.6 | 344 | 146 | 9 | 28 | *** | 5.9 |
| Korea | 68.1 | 6,050 | 55.3 | 25.8 | 290 | 132 | 17 | 43 | 2.1 | 19.1 |
| Russia** | 133.4 | 3,095 | 43.6 | 10.4 | 447 | 719 | 29 | 161 | 1.5 | 1.5 |

Watershed Size (S), Coast line length (L), Annual water discharge (Q), Specific discharges for water (Q/S and Q/L), Suspended solids (SS/L)

* - without Yangtze and Songhua Rivers; ** - including Tumen River; *** - not evaluated due to data lack

Of course, such an assessment on the whole state basis is a first and a rough estimate, especially given the shortage of available data. There are reasonable differences between NOWPAP countries as to possible impact on adjoining coastal waters due to river input.

The natural conditions in terms of spatial variability of river inputs are rather diverse within each of NOWPAP countries. Therefore the next step was the implementation of such assessment for the different sub-regions (prefectures, provinces) within NOWPAP area based on the data from Tables 1.1, 5.8, 5.9, 5.10, 5.11. The evaluation of the river runoff normalized by the coastal line length was made for BOD, COD and TN ($NH_4^-$ for Chinese rivers). The results are presented for TN, COD and BOD on Fig. 16, 17, 18 respectively. Obviously that normalized riverine loads of BOD and COD are similar and allow distinguishing the areas where intensity of outer (river) inputs of organic matter to the coastal water varies by 1-2 orders. The spatial variability of the TN river runoff has some regional features, namely the diminished input from the Russian parts of NOWPAP area and southwestern coast of Japanese Islands.

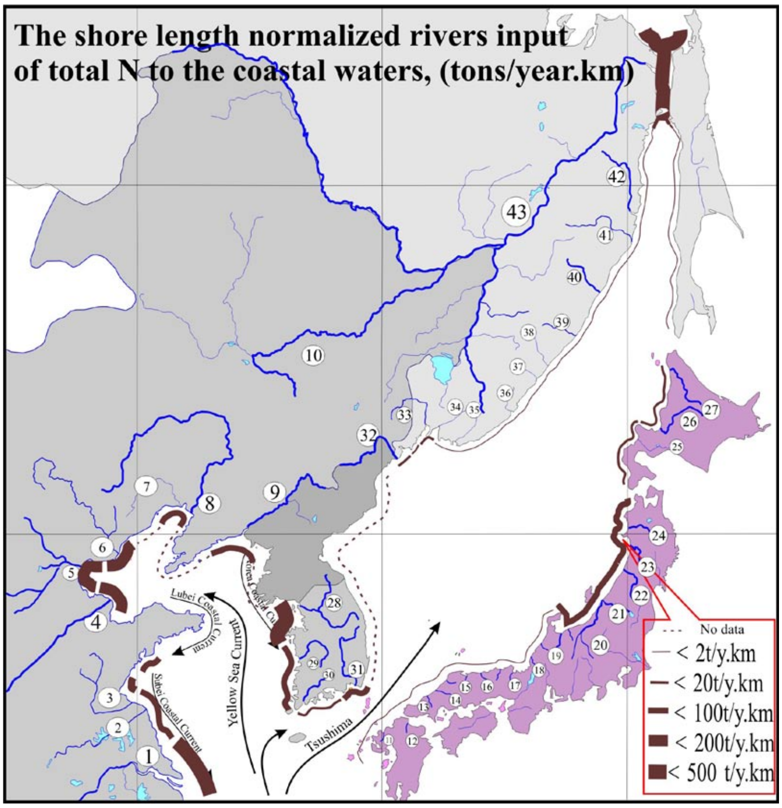



Figure 16. The coastal line length normalized river input of total nitrogen (t/year/km)

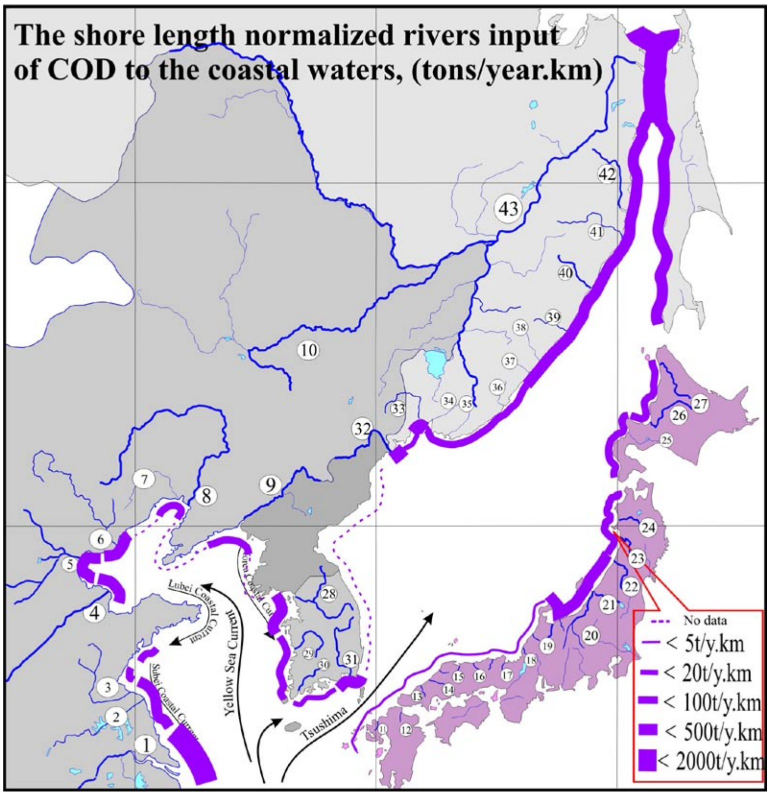



Figure 17. The coastal line length normalized river input of COD (t/year/km)

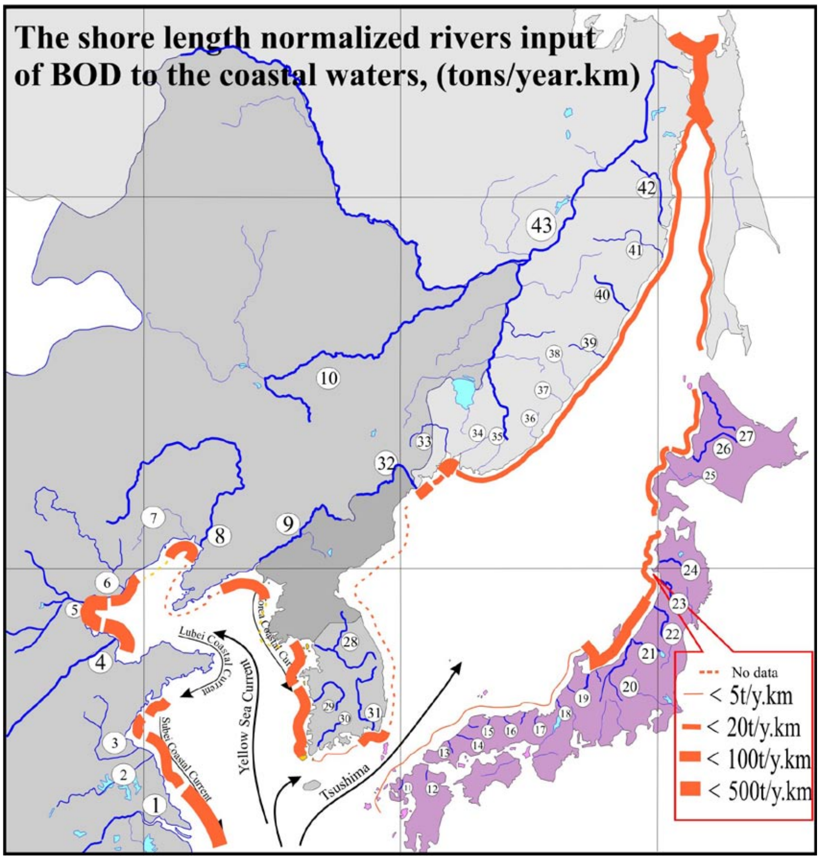



Figure 18. The coastal line length normalized river input of BOD (t/year/km)

## 5.4. Direct Input

Three **Chinese** provinces are responsible for the direct input of pollutants into the marine environment adjoining the NOWPAP region. Municipal sewages and industrial wastewaters are two major sources of direct input. The evaluation of direct discharge of pollutants from Chinese provinces adjoining the NOWPAP region is presented at Table 5.13.

Table 5.13. Direct Discharge of Municipal Sewage and Industrial Wastewater (million tons/year) and Pollutants (tons/year) to the Chinese coast within NOWPAP area (for 2002)

| Province | Municip. sewages | Industr. wastes | COD municip | COD industrial | $NH_4$ municip | $NH_4$ industr. | Phenol | oils | As | Pb | CN- |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Industrial Wastewater | | | | |
| Liaoning | 13.6 | 3.1 | 10,225 | 1,477 | 1,684 | 627 | nd | 0.0 | 0.006 | 0.038 | 0.1 |
| Jiangsu | 226.4 | 10.4 | 82,588 | 25,185 | 9,616 | 2,200 | 3.4 | 16.5 | 0.645 | 0.012 | 0.6 |
| Shandong | 81.6 | 52.3 | 26,146 | 16,262 | 3,480 | 338 | 1.0 | 14.8 | 0.039 | 0.001 | 0.2 |
| Total | 321.6 | 65.9 | 118,959 | 42,924 | 14,780 | 3,165 | 4.4 | 31.3 | 0.690 | 0.051 | 0.9 |

Table 5.14 include the data assessing the trend of direct discharge of industrial and municipal wastewaters and associated main pollutants (COD and $NH_4$) to the Yellow Sea during 2001-2005. There is obvious increase of the amount of wastewaters and associated pollutants accepted by the coastal areas of Yellow Sea.

Table 5.14 Main pollutants acceptance in the coastal area of the Yellow Sea in 2001-2005 year

| year | Waste waters (million tons) | | | Quantity of COD discharge(tons) | | | Quantity of ammonia discharge(tons) | | |
|---|---|---|---|---|---|---|---|---|---|
| | industry | municipal sewage | total | industry | municipal sewage | total | industry | municipal sewage | total |
| 2001 | 200 | nd | 200 | 38,000 | nd | 38,000 | 2,400 | nd | 2,400 |
| 2002 | 270 | 320 | 590 | 43,000 | 119,000 | 162,000 | 3,000 | 15,000 | 18,000 |
| 2003 | 260 | 330 | 590 | 41,000 | 111,000 | 152,000 | 3,000 | 13,000 | 16,000 |
| 2004 | 320 | 260 | 580 | 42,000 | 112,000 | 154,000 | 2,000 | 13,000 | 15,000 |
| 2005 | 690 | 660 | 1,350 | 81,000 | 217,000 | 298,000 | 9,000 | 29,000 | 38,000 |

In 2007 the direct input of industrial wastewaters only at the coastal area of Yellow Sea within Liaoning, Shandong and Jiangsu provinces was 818.4 million tons with COD load 89,057 tons and $NH_4$-N load 10,243 tons. The increase compare with 2005 (Table 5.14) is 18.6% by wastewaters volume, 10% by COD load, and 13.8% by $NH_4$-N load. This increase is significant, but less intensive than in 2003-2005 periods, and some improvement of the wastewater treatment takes place.

The discharge of treated wastewaters of sewage treatment plants is one of the documented source of direct inputs of contaminants in **Japan**, and the available data for 2002 and 2006 are listed in Table 5.15. The amount of BOD and COD discharge is calculated by multiplying the amount of the effluent from each sewage treatment plant ($m^3$/day) by the concentration of BOD and/or in the corresponding effluent (mg/L), and consequent recalculation on the annual basis. Values of the total amounts of discharges should be regarded nominal because of the scales of each sewage treatment plant varies over a wide range.

Both the amount of BOD discharge and COD discharge in Fukuoka in 2002 was the highest of all the prefectures, respectively. The amount of the effluent is the main factor to the highest values. The amount of the effluent in Fukuoka, 859,033 (m3/day), is far higher than the other prefectures (e.g. the amount of the effluent in Toyama, the second highest value, is 218,201 (m3/day)), while the average concentrations of BOD in 2002 in Fukuoka and Toyama were 5,8 mg/L and 4.9 mg/L, respectively, not so different from each other. At the same time a significant reduction, more than 4 times, of the amount of BOD discharge in Fukuoka from 2002 to 2006 originates from the fact that the average concentration of BOD was changed from 5.8 mg/L to 2.0 mg/L, due to improvement of processes.

Table 5.15. BOD and COD Loads Discharged Directly to the NOWPAP Region

| Prefecture | 2002 | | 2006 | |
|---|---|---|---|---|
| | Amount of BOD discharge (tons/year) | Amount of COD discharge (tons/year) | Amount of BOD discharge (tons/year) | Amount of COD discharge (tons/year) |
| Hokkaido | 198 | 962 | 158 | 801 |
| Aomori | nd | nd | nd | nd |
| Akita | 115 | 378 | 132 | 573 |
| Yamagata | 2 | 7 | 0 | 0 |
| Niigata | 31 | 49 | 25 | 36 |
| Toyama | 501 | 662 | 427 | 834 |
| Ishikawa | 29 | 80 | 134 | 232 |
| Fukui | 44 | 110 | 18 | 106 |
| Nagano | nd | nd | nd | nd |
| Kyoto | 74 | 261 | 107 | 414 |
| Hyogo | 1 | 0 | 3 | 13 |
| Tottori | 15 | 54 | 38 | 191 |
| Shimane | 3 | 5 | 0 | 0 |
| Yamaguchi | 250 | 536 | 154 | 481 |
| Fukuoka | 1764 | 3231 | 373 | 2980 |
| Saga | 52 | 153 | 34 | 47 |
| Nominal total | 3078 | 6487 | 1603 | 6708 |

nd – means no data; (Source) Sewage Statistics, Japan Sewage Works Association

Another source of direct input of pollutants into the sea is waste dumping. Japan dumped 6,285,000 tons of waste into the sea in 2007. 59% of this amount was dredged sediments, 40% - bauxite residues and construction sludge, and only 1.5% or 94,000 tons was municipal sewage rich in organic substances.

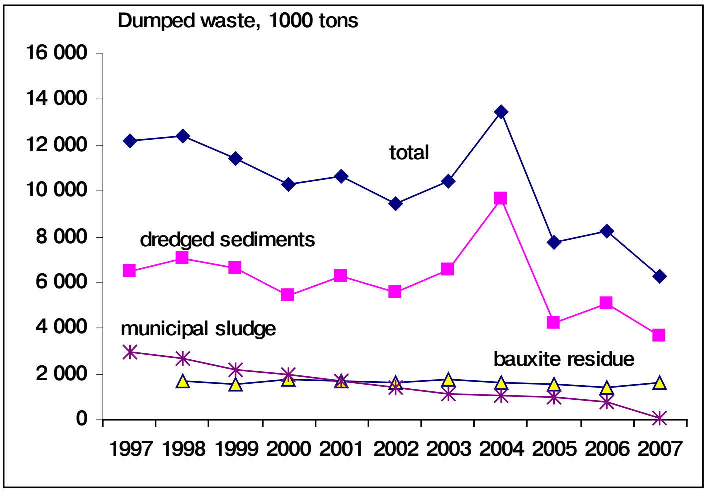



Figure 19. Amount of Waste Discharged to Sea Nationwide in Japan during last decade.

Compare with 2002, overall amount of waste dumping has been reduced significantly by 34%, though the composition of wastes continue to be the same. The decrease trend of sea dumping in Japan is observed during last decade at least (Fig. 19). This trend is caused by the change of dredged sediments first of all, but also by the significant decrease of municipal sludge amount.

In **Korea** the total amount of ocean waste dumping reaches a maximum of 9,929,000 tones in 2005. The amount of oceanic waste dumping increased gradually up until 2005, but then rapidly decreased by 23% after 2005 (Table 5.16) because of policies to reduce ocean dumping. The major dumped wastes were night soil, organic wastewater, and wastewater treatment sludge (Table 5.17.).

Table 5.16 Amount of Waste Discharged to Sea Nationwide in Korea (1000 tons/year)

| | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** |
|---|---|---|---|---|---|---|---|---|---|---|
| West | 2,429 | 2,380 | 2,423 | 2,390 | 2,424 | 2,406 | 2,397 | 2,383 | 2,160 | 1,878 |
| East-a | 2,140 | 2,325 | 2,862 | 3,394 | 4,088 | 4,372 | 5,262 | 5,883 | 5,475 | 4,483 |
| East-b | 1,407 | 1,739 | 1,819 | 1,887 | 1,963 | 2,096 | 2,090 | 1,663 | 1,177 | 1,090 |
| **Total** | **5,976** | **6,444** | **7,104** | **7,671** | **8,475** | **8,874** | **9,749** | **9,929** | **8,812** | **7,451** |

- West: 200km west of Gunsan; East-a: 125km east of Pohang; East-b: 90km east of Busan

Table 5.17. Kinds of waste discharge to sea (1000 tons/year)

| | **Items / Total** | **Night Soil** | **Organic waste water** | **Waste water treatment sludge** | **Sewage treatment Sludge** | **Sea product leftovers** | **Inorganic sludge** |
|---|---|---|---|---|---|---|---|
| 1998 | **5,976** | 1,891 | 1,821 | 1,361 | 489 | 9 | 199 |
| 1999 | **6,444** | 2,073 | 1,574 | 1,622 | 682 | 13 | 308 |
| 2000 | **7,104** | 2,432 | 1,256 | 1,837 | 1,050 | 13 | 409 |
| 2001 | **7,671** | 2,681 | 1,416 | 1,848 | 1,156 | 12 | 491 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2002 | **8,475** | 3,164 | 1,520 | 1,794 | 1,280 | 32 | 685 |
| 2003 | **8,874** | 3,599 | 1,660 | 1,674 | 1,382 | 50 | 509 |
| 2004 | **9,749** | 3,928 | 1,956 | 1,660 | 1,570 | 41 | 594 |
| 2005 | **9,929** | 3,552 | 2,275 | 1,460 | 1,655 | 28 | 959 |
| 2006 | **8,812** | 2,971 | 2,219 | 1,368 | 1,682 | 9 | 563 |
| 2007 | **7,451** | 2,396 | 2,066 | 1,168 | 1,609 | 11 | 201 |

In addition to ocean dumping, marine spills are a major marine pollution source. In 2007, the *Hebei Spirit* oil spill was responsible for the remarkably high crude oil figure. The greatest number of pollutant spill accidents were recorded in the South Sea of Korea, where large harbors are located.

The volume of wastewater generated and discharged in **Russia** in 2002 in the sub-regions of Primorskii Krai relevant to the NOWPAP area was 398 million $m^3$, and reached up 407.3 million $m^3$ in 2007 (Natural Resources and Protection of Environment…, 2007), that is rather stable. Sewage from the region's largest city, Vladivostok, accounts for 84% of this amount. Expert assessment adds an additional 138 million $m^3$/year of waste and storm water from the Vladivostok area and 21 million $m^3$/year from the rest part of region as storm water run-off. An assessment of annual direct input can be made (Tabl. 5.19) accounting for the concentrations of some chemical substances in waste and storm water run-off (Table 5.18).

Table 5.18. Concentrations (mg/l) of Substances in the Waste and Storm Water Wastes of Vladivostok (Gavrilevski et al., 1998)

| | $BOD_5$ | $NH_4$ | $PO_4$ | Sufr* | PHC** | Phenols |
|---|---|---|---|---|---|---|
| Wastewater | 32.6 | 4.2 | 1.9 | 0.11 | 0.92 | 0.015 |
| Storm Water wastes | 17.8 | 3.5 | 0.25 | 0.17 | 1.09 | 0.011 |

*Sufr means detergents or surface active compounds; ** PHC means petroleum hydrocarbons

Table 5.19. Summary of Annual Wastewater Input ($10^6$ $m^3$) and Chemical Substances (tons) in Sewage and Storm Water Wastes from other Districts of Primorskii Krai

| **Districts**** | **V*** | **$BOD_5$** | **$NH_4$** | **$PO_4$** | **Sufr** | **PHC** | **Phenols** |
|---|---|---|---|---|---|---|---|
| Khasanskii (1) | 6.16 | 189 | 25 | 10.4 | 0.73 | 5.8 | 0.10 |
| Vladivostok+Artem + Nadezhdinskii (2) | 484.4 | 14,859 | 1,990 | 816.5 | 57.06 | 456.4 | 7.01 |
| Shkotovskii+Fokino +Nakhodka+Partizansk (3) | 44.52 | 1,366 | 183 | 75 | 5.24 | 41.9 | 0.64 |
| Lazovskii+Olginskii +Kavalerovskii (4) | 3.22 | 99 | 13 | 5.4 | 0.38 | 3.0 | 0.05 |
| Dalnegorskii (5) | 18.62 | 571 | 77 | 31.4 | 2.19 | 17.5 | 0.27 |
| Terneiskii (6) | 0.42 | 13 | 2 | 0.7 | 0.05 | 0.4 | 0.01 |
| **Total** | 557.5 | **17,101** | **2,291** | **939.6** | **65.67** | **525.2** | **8.07** |

V* - summary volume of wastes equal to official data corrected by increasing coefficient 1.22 plus 15% addition of storm water wastes; ** Wastewater data are presented on administrative districts base, number in parentheses indicated the closest closed sub-regions from Table 2.1

Official data on the waste dumping at the Russia within NOWPAP area are absent. The main part of dumped waste consists of dredged sediments. Negative influence of this material on the coastal waters connected with elevated concentration of pollutants because dredging operations at Russian Far East are carried out in the harbor areas with usually contaminated bottom sediments.

## 6. The contribution of different Land Based Sources.

The most recent (2007) data on the main pollutants discharge of the **China** provinces relevant to the NOWPAP area is presented in the Table 6.1, and the trends for the 2001-2007 is presented on Fig. 20.

Table 6.1 Discharge of wastewaters and main associated pollutants in the Chinese provinces relevant to the NOWPAP area in 2007

| **Province** | **Waste water (0.1 billion tons)** | | | **Quantity of COD discharge (ten thousand tons)** | | | **Quantity of ammonia discharge (ten thousand tons)** | | |
|---|---|---|---|---|---|---|---|---|---|
| | **industry** | **municipal** | **total** | **industry** | **municipal** | **total** | **industry** | **municipal** | **total** |
| Jiangsu | 26.9 | 23.7 | 50.6 | 27.8 | 61.3 | 89.1 | 1.7 | 5.8 | 7.5 |
| Shandong | 23.7 | 16.8 | 33.4 | 30.4 | 41.6 | 72.0 | 2.0 | 5.7 | 7.7 |
| Liaoning | 9.5 | 12.6 | 22.1 | 25.8 | 37.0 | 62.8 | 1.0 | 5.8 | 6.9 |
| Jilin | 4.0 | 5.8 | 9.8 | 16.5 | 23.5 | 40.0 | 0.3 | 2.7 | 3.1 |
| Heilongjiang | 3.8 | 7.1 | 10.9 | 14.3 | 34.5 | 48.8 | 1.0 | 4.1 | 5.1 |
| total | 60.9 | 66.0 | 126.8 | 114.8 | 197.9 | 312.7 | 6.0 | 24.1 | 30.3 |
| Subtotal* | 37.2 | 35.2 | 65.3 | 72.7 | 102.1 | 174.8 | 3.3 | 14.2 | 17.7 |

*Subtotal – data for the Shandong, Liaoning and Jilin provinces most relevant to the NOWPAP area (Yellow Sea)

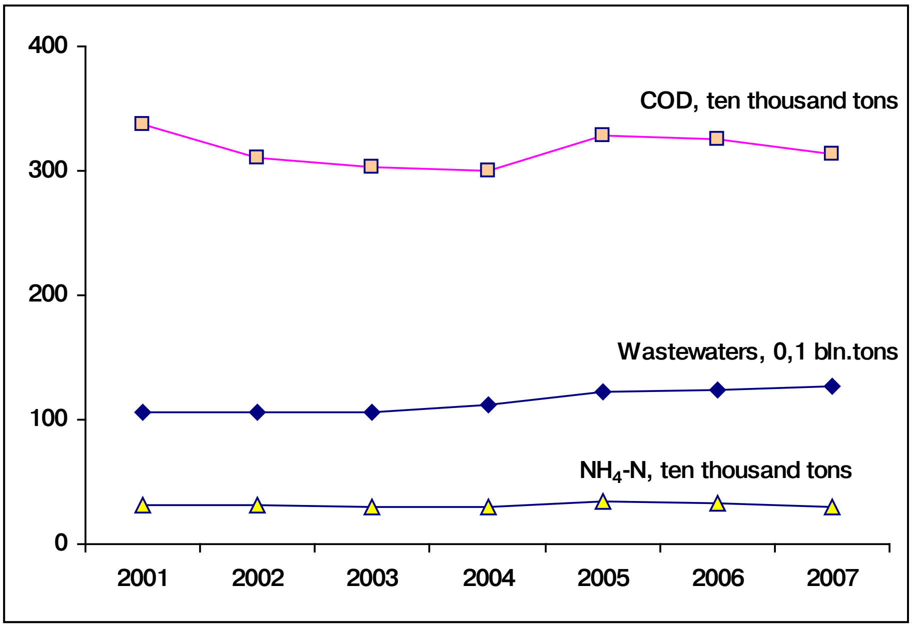



Figure 20. The trend of the wastewaters and associated COD and $NH_4^-$ discharged in the 5 Chinese provinces relevant to the NOWPAP area

Obviously, that amount of the wastewaters discharge continue to rise with annual growth 1% for the industrial wastewaters, and 5% - for the municipal sewages. The ammonia discharge was rather stable in municipal wastewaters and slightly decrease in industrial wastewaters. COD discharge shows most clear decrease, especially in the industrial wastewaters: by 16% during 2001-2007.

For the comparison of wastewater discharge (Table 6.1) with the river discharge, direct discharge and evaluation of the quota of wastewaters accepted by Yellow Sea from Tables 5.8, 5.13 and 5.14, it is necessary to adjust data from Table 6.1 and Table 5.8. Namely, to use the data from the Shandong, Jilin and Liaoning for the characteristic of wastewaters discharge most relevant to the NOWPAP area, and exclude data on river discharge of the Yantgze, Songhua and Wisuli. The comparison of these adjusted data of the annual fluxes of water (wastewater), COD and ammonia gives some points (Fig. 21). First point is a significant contribution of ammonia (31%) and COD (45%) of wastewaters comparable with river discharge of these pollutants, though wastewater volume contribution does not exceed 3%.

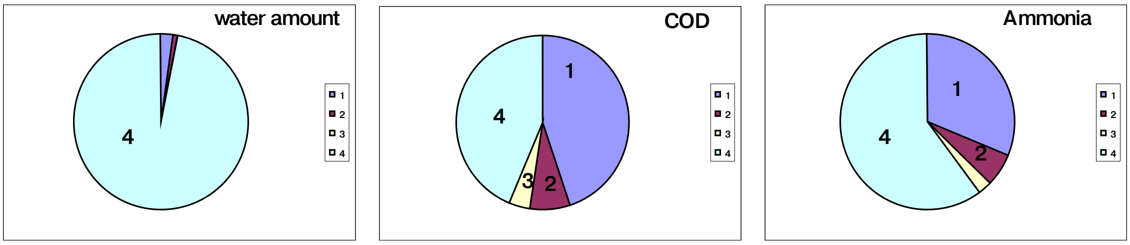



Figure 21. The contribution of water, ammonia and COD amounts (fluxes) in the northwestern part China relevant to the NOWPAP area. (1) total wastewaters; (2) wastewaters accepted by coastal waters of Yellow Sea; (3) direct input; (4) river discharge.

The looking at industrial and municipal wastewaters separately gives the same conclusions. Unfortunately for the time being we have not data for the further detailed analysis of the land based sources of wastewaters and associated pollutants within northeastern China.

In **Japan** the data on the loadings from different land based sources into three semi-enclosed seas (Tokyo Bay, Ise Bay, and Seto Inland Sea) have been managed under the Total Pollutant Load Control System (TPLCS, see 4.2). These three seas are surrounded by highly populated and industrialized areas and the discharges into them could be certainly recognized as "hotspots" compared to those from the other part of Japan. However, these areas are situated in the side of the Pacific Ocean rather than the NOWPAP marine area. The data on the other area has not been compiled in the same manner, and the hotspots are not clearly defined within the Japanese part facing the NOWPAP marine area.

An outline of the TPLCS is as follows:

i) Screening process: the Japanese government designates the TPLCS area. Tokyo Bay, Ise Bay, and Seto Inland Sea, all of which face the Pacific Ocean, have been designated as the TPLCS area.

ii) Planning: prefectural governments prepare a reduction plan, which include water quality goals, a target year, pollutant loads (both current and future) from households, industries, and other source, reduction goal for each source, and methods for pollutant reduction. The water quality goals are set for the achievement of EQS of $COD_{Mn}$, T-N, and T-P.

iii) Implementation: the prefectural governments implement the reduction plan. At this stage, industrial sectors are required to ensure compliances regarding the TPLCS. For example, if the industrial sectors violate TPLCS, then they have to pay a fine (less than 1 million yen) or are sentenced to an imprisonment (less than 1 year).

iv) Monitoring: the industrial sectors monitor their pollutant load discharged from their factories. In addition, the prefectural governments monitor the water quality in the targeted water.

v) Review and revise: analysis and evaluation of the performance of the reduction plan, and periodic revisions of the reduction plan accordingly.

Only as a supportive information, the loads of COD, T-P and T-N from roughly partitioned sources into the Seto Inland Sea are shown (Fig. 21) under the limit of the fact that the socio-economic conditions are different between the coastal area of the Seto Inland Sea and the area facing the NOWPAP marine region.

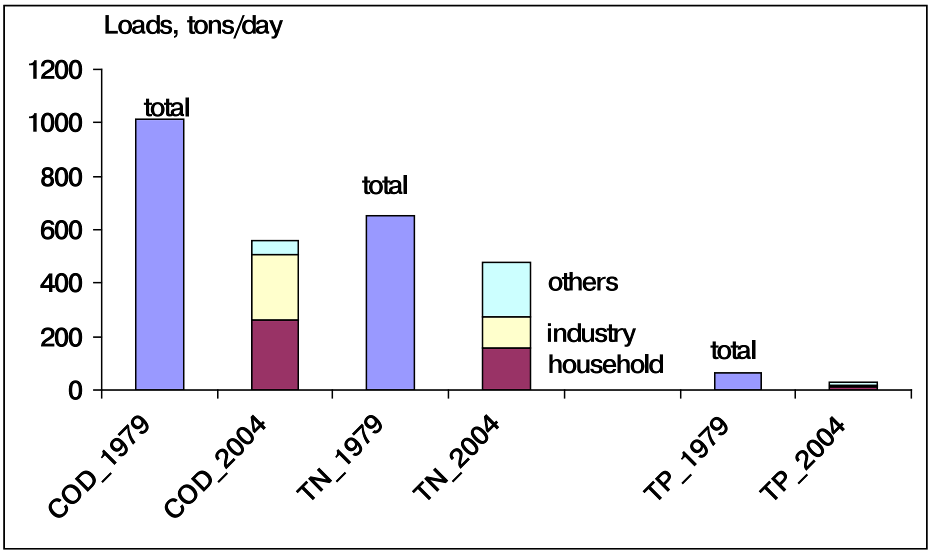



Figure 22. The change of loads of COD, TN and TP from the land based sources to the Seto Inland Sea from 1979 to 2004 and contribution of household and industrial sources.

The loads of $COD_{Mn}$, and TP to the Seto Inland Sea area show clear tendency of 2 times decrease from 1979 till 2004. Decrease of TN loads was not so significant (Fig. 22), probably due to high proportion of non-point sources in the TN delivery.

The amount of wastewater discharge from different sources solely for the area facing the NOWPAP are not available. We can show here the source-specific discharge of wastewater for the whole Japan area in FY1998 from the "Results of Comprehensive Survey on Water Pollutant Discharge" conducted by the Ministry of Environment as a proxy with the limitation due to the fact that the distribution of industries are basically uneven (Table 6.2).

Table 6.2 Discharge of wastewaters from the different land based sources and industries of the whole Japan for FY1998.

| | **Discharge, $10^6$ m$^3$/day** | **Discharge, $10^6$ m$^3$/year** |
|---|---|---|
| Water supply service | 33.61 | 12,269 |
| Other domestic supply and services | 5.98 | 2,181 |
| Food & Beverage | 3.47 | 1,265 |
| Textile & Clothing | 0.96 | 351 |
| Lumber & Furniture | 0.02 | 8 |
| Paper - Printing | 7.56 | 2,758 |
| Chemical - Ceramics | 29.27 | 10,682 |
| Steel-Metal | 22.25 | 8,120 |
| Machinery | 2.66 | 971 |
| Agriculture | 0.17 | 61 |
| Electropower service | 219.6 | 80,151 |
| Mining | 0.28 | 103 |
| Others | 0.99 | 362 |
| Total | 326.8 | 119,282 |

Source: "Results of FY1998 Comprehensive Survey on Water Pollutant Discharge (in Japanese)" after the Ministry of Environment.

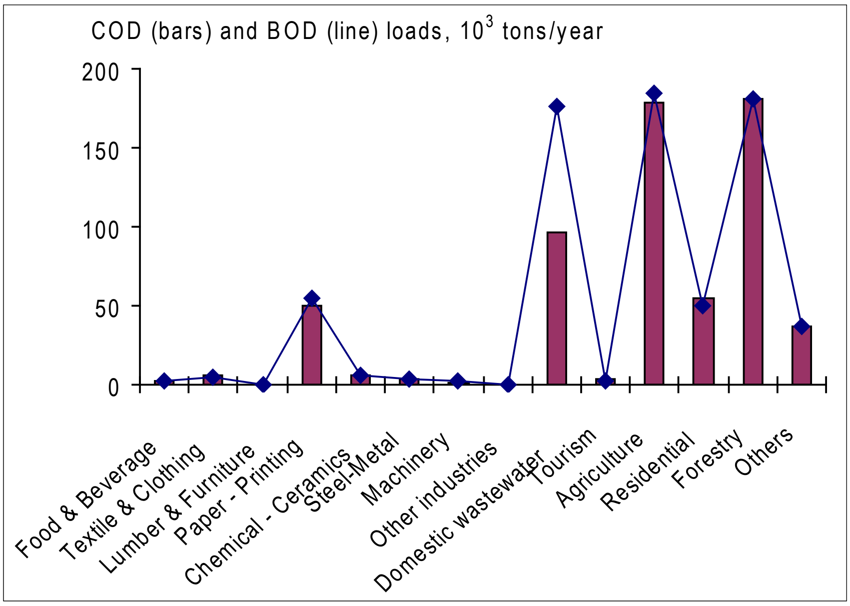
Among these sources, discharges from the electric power supply is distinguishingly large. The water supply service, the chemical industry and the steel industry are the next large contributors. It should be noted that the amount of wastewater may not be an essential indicator for the evaluation of human impact to the environment. Nor the concentration of substances in the wastewater alone could not be essential. Historically, the Total Pollutant Load Control System (TPLCS) was introduced to correct the such defects to regulate the absolute quantities of emissions. Discharge of the total amount of substances sometimes may not be perfect considering that the temperature of the wastewater from electric power supply may affect the fisheries ground.

The values of the industry-specific discharges of BOD, $COD_{Mn}$, T-N and T-P for the area facing NOWPAP region (the prefectures shown in Table 3.2) have been estimated by the North Pacific Region Environmental Cooperation Center (NPEC) using the "Emission Factor Method" for the FY 1998 only (Table 6.3). The amount of discharge from each source was calculated as the product of this factor and the dimension of each source. The units of the dimension of the sources are, for example, the human population using a treatment system against the domestic wastewaters, the amount of monetary-based production rate of each industry, the seeping rate from unit area of each land-use form, and so on. This method would be the best available tool although it should be noted that the deduction of each emission factor contains some uncertainty by rounding up the detail of the process. We can suppose that despite the obvious decrease of the summary loads of COD, BOD, TP and TN during last decade, the contribution of different industries did not change very much, and we can use the data from 1998 as a proxy. At the same time it is clear that updating of such information could be very desirable.

Table 6.3 The loads of BOD, COD, TN and TP ($10^3$ tons/year) from the land based sources within Japanese prefectures relevant to the NOWPAP region for the 1998.

| | **BOD** | **COD** | **T-N** | **T-P** |
|---|---|---|---|---|
| Food & Beverage | 1.9 | 2.1 | 2.0 | 0.7 |
| Textile & Clothing | 4.3 | 5.6 | 2.2 | 0.2 |
| Lumber & Furniture | 0.2 | 0.2 | 0.2 | 0.3 |
| Paper - Printing | 55.3 | 50.3 | 2.6 | 0.4 |
| Chemical - Ceramics | 5.8 | 6.4 | 8.5 | 1.4 |
| Steel-Metal | 3.3 | 3.3 | 15.9 | 0,4 |
| Machinery | 1.9 | 1.7 | 1.6 | 0.5 |
| Other industries | 0.2 | 0.1 | 0.3 | 0.1 |
| Domestic wastewater | 176.7 | 97.0 | 43.1 | 4.3 |
| Tourism | 2.5 | 3.3 | 2.8 | 0.1 |
| Agriculture | 185.0 | 179.1 | 74.0 | 7.0 |
| Residential | 50.0 | 55.1 | 7.7 | 1.4 |
| Forestry | 181.1 | 181.1 | 31.5 | 2.5 |
| Others | 36.9 | 36.9 | 6.4 | 0.5 |
| Total | 705.4 | 622.2 | 199.0 | 19.9 |

The contribution of the different industries and other human activities to the loads of COD, BOD, TN and TP is not coincided with the contribution of wastewater volumes (Table 6.3 and 6.2), reflecting the different concentration of chemical substances in the wastewaters generated by the different industries. The rather clean cooling wastewaters generated at the electricity power production and wastewaters generated by the water supply service are the main reason of this discrepancy between wastewaters loads and contaminants (COD, BOD, TN and TP) loads. The contribution of all other industries to the loads of different contaminants is somewhat similar (Fig. 23 by the data from Table 6.3). The enlarged contribution of domestic wastewaters to the BOD load, and metallurgy to the TN load are the exception. Other exceptions include enlarged contribution of chemical, food/beverage, residential wastewaters to the TP loads (Fig. 23). These exceptions despite their minor values give useful information about needs and possibilities to decrease the loads of contaminants by the future actions.



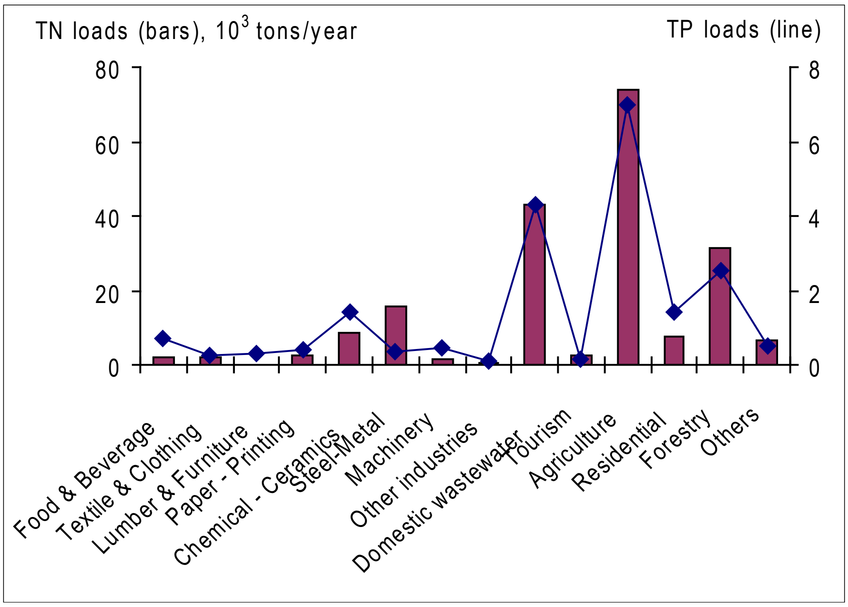




Figure 23. Loads of BOD and COD (upper part), and TN and TP (lower part) from several land based sources for FY1998 from the Japanese prefectures within NOWPAP region

Wastewater generation in **Korea** in 2002 reached 2,91 billion tons and increased up to 3.35 billion tons in 2005, but sharply decreased down to 2.27 billion tons in 2006. Of the total wastewater produced, nearly 30% or 891 million tons/year are discharged into rivers and coastal marine habitat. There is, however, a clear difference in levels of treatment. The best treatment management is seen on the south coast (only 12% is untreated sewage). On the other hand, on the east coast more than 85% of the wastewater is discharged into rivers and the sea (Table 6.4). The effectiveness of wastewater treatment, as assessed by BOD load, is much better and runs from 1 to 25%, and is 14% nationwide (Table 6.4).

The number of wastewater discharge facilities in Korea greatly increased from 1993 to 2006 (Table 6.5). The number of facilities increased by more than 100% over the 2003 number. However, generation and discharge rate variations generally do not follow the facility increment. Nevertheless, the discharge rate of wastewaters has increased since 2004 by 28% (Fig. 24).

Table 6.4. Wastewater Discharge by River Basins and Coasts of Korea (2002)

| River basins, coasts | Wastewaters, $10^6$ tons/year | | BOD load, tons/year | |
|---|---|---|---|---|
| | Generated | Discharged | before treatment | after treatment |
| Hang River | 240.5 | 100.4 | 101,835 | 1,095 |
| Nakdong River | 304.8 | 219.4 | 163,520 | 2,555 |
| Geum River | 132.1 | 62.4 | 76,650 | 1934.5 |
| Yeongsan River | 14.2 | 9.9 | 5,840 | 127.8 |
| Seomjin River | 3.3 | 2.2 | 1,460 | 40.2 |
| Other rivers | 176.3 | 78.1 | 106,215 | 1,387 |
| East Coast | 180.3 | 166.1 | 112,055 | 1,277.5 |
| West Coast | 675.3 | 135.1 | 242,360 | 2,226.5 |
| South Coast | 1,180.8 | 116.8 | 62,415 | 1,825 |
| **Total** | **2,907.6** | **891.3** | **879,650** | **12,410** |

More than 50% of total waste discharge facilities are concentrated at the watersheds of the Han and Nakdong Rivers, resulting in high loads of anthropogenic pollutants flowing into the marine environment via these two rivers. In addition, about 25% of facilities are located in the western and southern coastal zones, which have many industrial complexes. These represent another potential point source that could affect marine ecosystems in the NOWPAP region.

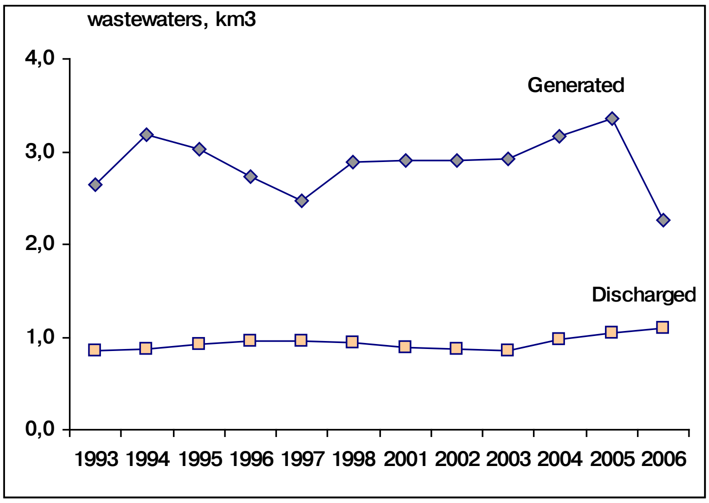



Figure 24. Inter annual change of generated and discharged wastewaters in Korea

Table 6.5 Numbers of waste water discharge facilities in Korea and its waste water generation and discharge

| Year | No. of waste water discharge facillities | Generation | Discharge |
|---|---|---|---|
| | | (1000 m³/day) | |
| 1993 | 26,702 | 7,259 | 2,316 |
| 1994 | 25,299 | 8,741 | 2,375 |
| 1995 | 28,012 | 8,296 | 2,511 |
| 1996 | 39,939 | 7,469 | 2,618 |
| 1997 | 37,621 | 6,753 | 2,614 |
| 1998 | 48,876 | 7,906 | 2,555 |
| 2001 | 51,469 | 7,966 | 2,442 |
| 2002 | 53,851 | 7,971 | 2,363 |
| 2003 | 55,405 | 7,991 | 2,350 |
| 2004 | 39,012 | 8,682 | 2,687 |
| 2005 | 40,409 | 9,184 | 2,866 |
| 2006 | 45,163 | 6,215 | 3,021 |

Industry generated most of the wastewater in Korea, and only 0.6% of generated wastewaters is night soil and 1.7% is livestock wastewater. Figure 24 shows the number of wastewater generation facilities of each industrial category, with transport, food, non-metal, and metals industries having the highest numbers, in that order. Transport facilities alone comprise 38% of total industrial wastewater facilities.

Figure 26 shows wastewater generation and discharge by each industry, with the metals industry generating the most. Although transport industry facilities are large, their generation rate is not comparable to that of other industries.

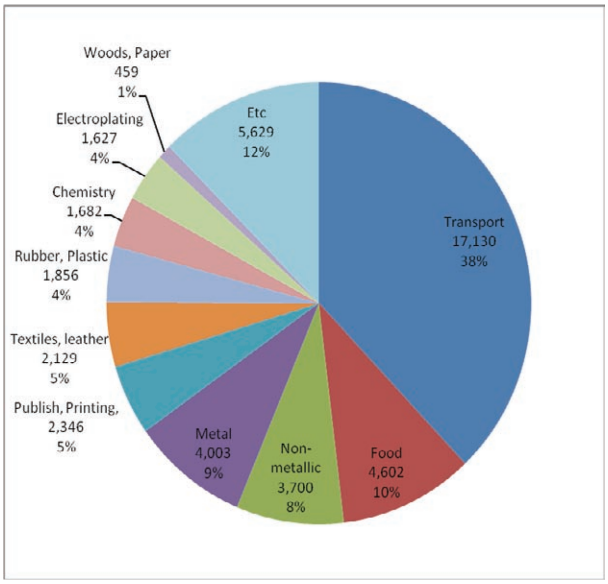



Figure 25. The possibility of wastewater generation facilities in the different i
ndustries in Korea (unit: 1000 m$^3$/day)

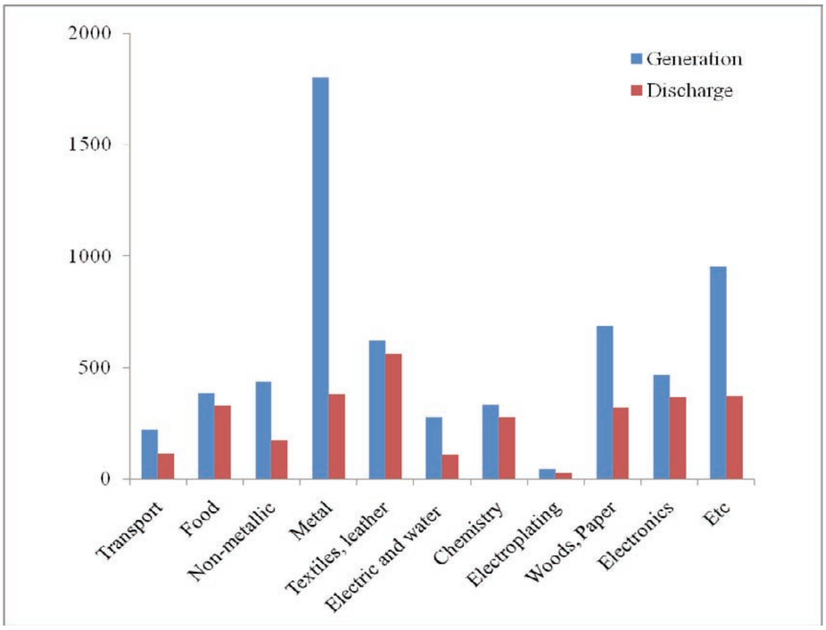



Figure 26. Wastewater generation and discharge by each industry in Korea (1000 $m^3$/day)

In **Russia** volume of wastewaters from the official statistic data (Natural Resources and Protection of Environment…, 2007) allow to evaluate the input of some contaminants with waste waters from the different districts of Primorski Krai. These data with some modifications according to the expert assessment are presented in Table 5.19. Joint analysis of Table 5.19 and 5.11 gives some conclusions (Fig. 26).

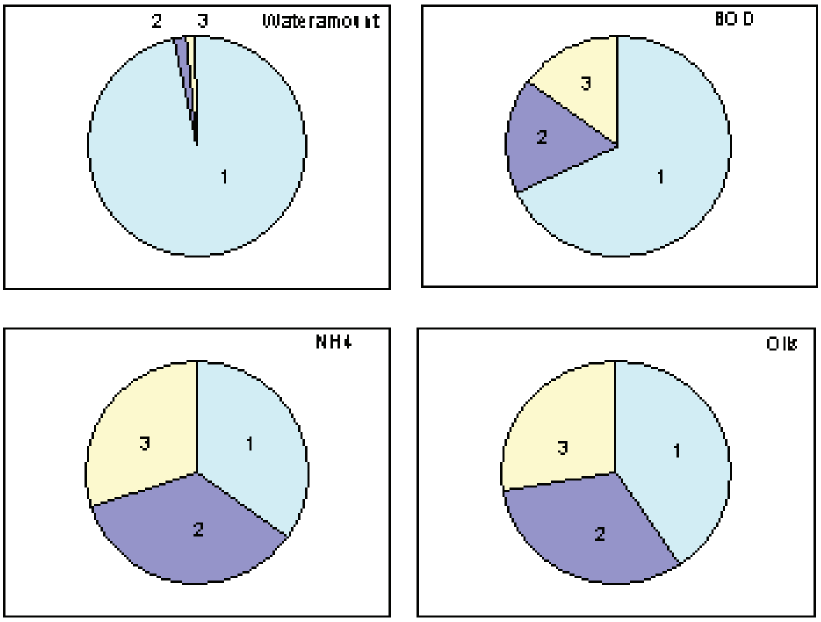



Figure 26. The contribution of water, BOD, ammonia and oils (petroleum hydrocarbons) amounts (fluxes) in the part of Russia relevant to the NOWPAP area. (1) river discharge; (2) total wastewaters; (3) wastewaters from Vladivostok-Artem-Ussurisk district.

Wastewater volume does not exceed 1-2% of river runoff, but contribution of pollutant inputs due to wastewater reaches up 20% for BOD and 46-50% for ammonia and petroleum hydrocarbons. Second point is a very contrast spatial distribution of wastewaters discharge: The Vladivostok-Artem-Ussurisk agglomeration gives 88% of wastewater inputs of above mentioned pollutants.

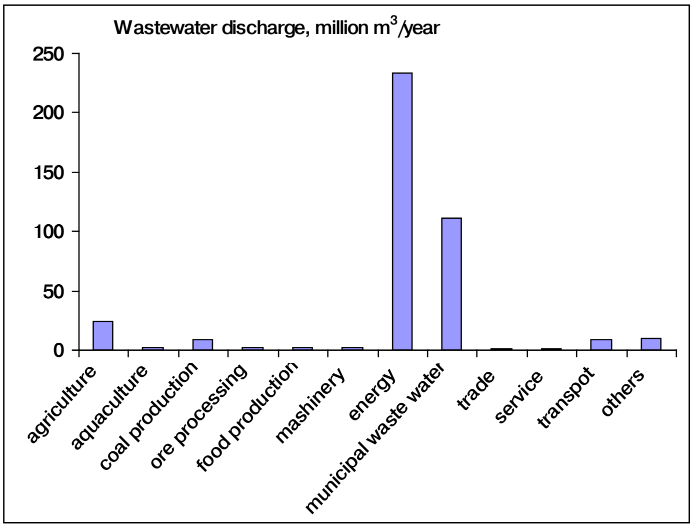



Figure 28. Wastewater discharge from the different industry in the Primorsky Krai (2007)

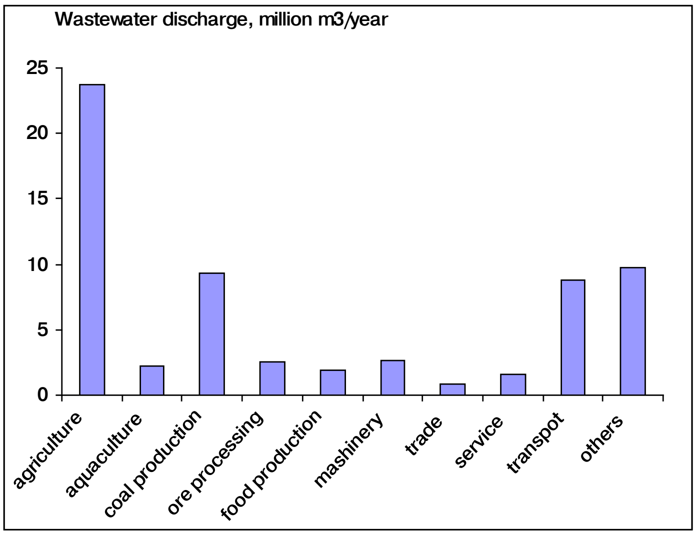



Figure 29. Wastewater discharge from the different industry in the Primorski Krai (2007) excluding power generation and municipal water usage.

The discharge of wastewaters within Primorsky Krai – the major Russian provinces faced to the NOWPAP area, is provided by different kind of economical activities. The electricity and heat production is a main of them in terms of wastewater discharge (Fig. 28). Municipal water usage, treatment and discharge are second ones. Other activities generate and discharge less than 15% of total amount of wastewater. It does not mean the harmless of wastewaters generated and discharged at the coal production or ore mining/dressing. The ecological threats and damages from these kinds of activity can be very severe, but rather local.

The agriculture, coal production and transport become most significant source of pollution, at the excluding of power generation and municipal water usage (Fig. 29).

# 7. Conclusions

In this report, the current situation with river and direct input of pollutants is analyzed in NOWPAP member states with focus on land based sources of pollution. Various natural and socioeconomic factors and human activities are considered as well as driving forces. In particular, the inter annual trends of water quality are described along with potential risk for the environmental changes of the NOWPAP region.

The total population of NOWPAP member states is stabilized during the last decade, though in Korea and China population slightly increased (0.3% annually), and in Japan and Russia gradually decreased (0.2% in Japan and 0.6% in Russia). The population density is very uneven: from 12 person/km$^2$ in Russia to 486 person/km$^2$ in Korea. The economic status and development is very different as well: GDP per capita varies from USD 35,834 in Japan and USD 26,057 in Korea to USD 6,547 in Russia and USD 2,812 in China.

The wastewater discharge amount is proportional to the population and reached up 5.97*10$^9$ m$^3$ in three Chinese provinces most relevant to the NOWPAP sea area, 1.10*10$^9$ m$^3$ in Korea and 0.41*10$^9$ m$^3$ in Primorsky Krai of Russia. But maximum wastewater discharge per capita – 93 m$^3$/year is observed in Russia compared with 22-25 m$^3$/year in Korea and China. This points out to the higher possibility of the local environmental "hot spots" in Russian Far East, and to the more spatially broad ecological problems in other NOWPAP countries.

Despite the stabilization of population growth the amount of wastewater discharge continued to increase in China and Korea during 2001-2007. In China this increase was more significant for municipal wastewater discharge (5% annual growth) than for industrial one (1% annual growth). In Korea industrial wastewater discharge increased 4% annually due to industrial development, while domestic waste generation was more stable from 1996 to 2007. The industrial waste generation rates by regions were in accordance with the distribution of industrial centers in Korea. In Russia the amount of wastewaters discharge has decreased 2.5% annually from 2003.

The contribution of different land based sources to the wastewater generation is different in the each NOWPAP member states. In Korea textile and leather production, metal processing, electronic and chemical enterprises, paper and food production are responsible for the generation of wastewaters, though it is difficult to distinguish the prevailing source. In Russia the power generation and municipal water treatment plants are two major sources of wastewaters.

The significance of wastewater discharge as a source of pollutants entering the coastal zone can be assessed by the comparison with the river discharge. In China wastewater volume contribution does not exceed 3% of river discharge though contribution of ammonia with wastewater can be as high as 31% and COD – 45% of river discharge. To carry out such assessment for Japan data on the wastewater discharge are needed. In Korea wastewater volume contribution comparing with rivers discharge is about 2%, reaching 17% for BOD. In Russia wastewaters also contribute about 2% of water discharge, but BOD contribution exceeds 20% , and amount of ammonia discharged with wastewaters is practically the same as river discharge.

In China less polluted and large rivers such as Yalu, Yellow and Yangtze continue to be relatively clean during last 5-7 years. In the more polluted rivers Hai, Daliao, Tumen, and Huai the annual means of chemical parameters were more variable. The water quality in the large uncontaminated Japanese rivers within NOWPAP area is characterized by 1.5-2 times lower concentration of $BOD_5$ and COD compare with large Chinese rivers. Decreasing trend of BOD and COD concentration was observed in the Japanese rivers with initially elevated levels of these parameters. In Korea temporal variation of water quality in major rivers and streams was negligible, however the rivers which with artificial dykes had higher nitrogen concentration. Concentration of heavy metals, PCBs and pesticides were significantly below the EQS. In Russia inter annual changes of chemical composition were different for different parameters. The COD and BOD did not demonstrate any clear trend except the continuously elevated COD in the polluted rivers. Annual means of phosphates have shown increasing trend during last 7 years in the polluted rivers, and, what is more important, in the pristine ones as well. However even these elevated concentrations of phosphate in the rather uncontaminated Russian rivers continue to be lower than in many Korean and Japanese rivers, but trend itself is alarming.

The inter annual changes of the river fluxes of chemical substances are determined by the variation of water discharge and by the variability of the concentration as well. At the west coast of Japan the inter annual variability of river fluxes of chemical substances is determined first of all by the level and variation of concentrations. But in Korea the variation of water discharge becomes the main factor controlling the inter annual changes of chemical substance loads.

The normalization of river fluxes by the length of coastal line is suggested for the comparison of areas (sub regions) with different river inputs and for the assessment of intensity of input from the land to the marine environment. Such normalized assessments were made for the whole NOWPAP region for COD, BOD, and TN thus allowing to distinguish the coastal areas where normalized inputs differ by 2-2.5 order of magnitude.

# 8. References

Basic Resident Register Population Handbook, March 31, 2002, Ministry of Internal Affairs and Communications. Japan

Bulletin of Offshore Environmental Quality People's Republic of China in Year 2002

Burnett, W. C., Bokuniewicz, H., Huettel, M., Moore, W. S. & Taniguchi, M. (2003): Groundwater and Pore Water Inputs to the Coastal Zone, Biochemistry, 66, 3-33.

Census Report, 2002, Population Estimate Annual Report, 2002, Ministry of Internal Affairs and Communications. Japan

China Environmental Statistical Annuals (2002). http://www.hlj.gov.cn; http://www.jilin.gov.cn; http://www.nen.com.cn

China Statistical Annuals (2001, 2002, etc.)

Chinese Cities Statistical Annuals (2001, 2002, etc.)

Chinese Counties Statistical Annuals (2001, 2002, etc.)

Chinese Environmental gazettes (2001, 2002, etc.)

Chudaeva V. A. Chemical Elements Migration in the Waters of Far East, Vladivostok, Dalnauka, 2002. 392 p. (in Russian).

Current Status of Marine Safety (September, 1987), Ministry of Land, Infrastructure and Transport, Japan

Environmental Policies 2003, International Affairs Office, Ministry of Environment, Republic of Korea, 2003, 35 p.

Environmental Quality Report of China in Year 2002

Environmental Statistic Data in Fiscal Year 2004, Ministry of the Environment, Japan

Environmental Statistics Yearbook, Ministry of Environment, Republic of Korea, 2004, 730 p.

Environmentally Sustainable Economic Growth, Ministry of Environment, Republic of Korea, 2005, 30 p.

Flowing Quantity Chronology, Ministry of Land, Infrastructure and Transport, 1998. Japan

Gaillardet J., J. Viers, B. Dupre. 2003. Trace Elements in River Waters, pp. 225-272. In Surface and Ground Water, Weathering and Soils (Ed. J.I.Drever). Vol. 5. Treatise on Geochemistry. Elseiver-Pergamon, Oxford.

Gavrilevsky A. V., T. A. Gavrilova, I. E. Kochergin. Complex Quantitative Assessment of the Sources Polluting the Sea Adjacent to Vladivostok. FERHRI Proceedings, Specialized Issue, 1998, p. 102-113. (in Russian).

Green Korea 2004, International Affairs Office, Ministry of Environment, Republic of Korea 2004, 83 p.

Hong G. H., S. H. Kim, and C. S. Chung. Contamination in the Yellow Sea Proper: a Review. Ocean Research, 1997. Vol. 19, # 1. 55-62.

Hong G. H., S. H. Kim, C. S. Chung. Contamination in the Yellow Sea Proper: A Review. 1997. Ocean Research, v. 19, N 1:55-62

Hong G. H., S. H. Kim, D. B. Yang, G. H. Lim. Atmospheric Input of Trace Metals Vver the Yellow Sea. In Health of the Yellow Sea. Seoul, 1998. P. 211-236.

Internet Home Page of the Ministry of the Environment. Japan. http://www.env.go.jp

Ittekot, V., C. Humborg and P. Schafer. Hydrological Alterations and Marine Biogeochemistry: a Silicate Issue, BioScience, 50, 776-782 (2000).

Japan Statistic Yearbook 2002, Ministry of Internal Affairs and Communications.

Japanese Climate Table, the Meteorological Agency, 2001.

Japanese River Water Quality Yearbook 2002, Japan River Society.

Kobayashi, J. 1960. A Chemical Study of the Average Quality and Characteristics of River Waters of Japan, Ber. Ohara Inst. Landwirtschaft Biol. 11(3), 313-358.

Korea Institute of Maritime and Fisheries Technology website, http://www.seaman.or.kr/en/

Lai Siyun, Du Pengfei, Chen Jining. Evaluation of non-point source pollution based on unit analysis. in: *Journal* *of Tsinghua* University *(Science and Technology)*, Vol.44, No.9, 2004, pp. 1184-1187.

Long-Year Data on Hydrological Characteristics and Fresh Water Resources. Watersheds of Sea of Japan and Ussuri River T.1, Vol. 21. L. Hydrometeoizdat. 1986. 387 p. (in Russian).

Maximum Permissible Concentration (MPC) of Chemical Substances in Water Used for Drinking, Bathing and Municipal needs. GN 2.1.5.1315-03 and GN 2.1.5.1316-03. Ministry of Health and Social Development. Moscow, 2003

Ministry of Environment website, http://eng.me.go.kr/user/index.html

Ministry of Marine Affairs & Fisheries website, http://www.momaf.go.kr/main

National Fisheries Research & Development Institute website, http://www.nfrdi.re.kr

National Institute for Environmental Research website, http://www.nier.go.kr

Natural Resources and Protection of Environment of Primorskii Krai, 2002. Federal Statistic Service. Primorskii Krai Branch. 2003. 75 p. (in Russian).

OECD Environmental Performance Reviews – Korea, OECD Publishing, 1997, 198 p.

Office and Corporate, Statistical Investigation, October 1, 2001, Ministry of Internal Affairs and Communications. Japan

Research Group on the Study on the Effect of Nutrients Concentrations on Water Environment in Rivers (ed.) (2003), Foundation of River & Watershed Environment Management, 195p. (in Japanese, English translation is being prepared).

SCOPE(1999): International Silica Workshop on International Workshop on the Global Silica Cycle, Linkoping, Sweden, October3-5, http://data.ecology.su.se/scopesi/ScopeSI.htm).

Shulkin V. M., G. I. Semykina. Seasonal and Annual Variability of the Concentration and Output of Nutrients by the Razdolnaya River (Primorskii Krai). Water Resources, 2004, V.32, #4, p. 1-9. (in Russian).

Standard Operating Procedures for Marine Environment, Ministry of Maritime Affairs & Fisheries, 2005, 389 p. Republic of Korea,

Standard Operating Procedures for Water Pollution, Ministry of Environment, 2004, 355, Republic of Korea,

State Statistic Data on Industry and Agriculture of Primorskii Krai in 2002. (In Russian)

Tokunaga, T., T. Nakata, K. Mogi, M. Watanabe, J. Shimada, J. Zhang, T. Gamo, M. Taniguchi, K. Asai and H. Saegusa. 2003. Detection of Submarine Fresh Groundwater Discharge and its Relation to Onshore Groundwater Flow System: An Example from Off Shore Kurobe Alluvial Fan, Journal of Groundwater Hydrology, 45, 133-144 (in Japanese with English abstract).

Tripartite Environment Ministers Meeting among Japan, Korea and China, Ministry of the Environment, Japan, Ministry of Environment, Republic of Korea, State Environmental Protection Administration, People's Republic of China, 2004, 35 p.

UNEP Chemicals/GEF. Regionally Based Assessment of Persistent Toxic Substances. Central and North East Asia Regional Report, 2002.

Urban E.R., Jr., Bjorn Sundby, Paola Malanotte-Rizzoli, and Jerry M. Melillo (eds.) (2008). Watersheds, Bays and Bounded Seas -The Science and Management of Semi-Enclosed Marine Systems, Island Press, Chicago, 269 p.

Water Policies & Innovative Practices, Republic of Korea 2004, Ministry of Environment, Republic of Korea 2004, 27 p.

Website of EAS congress, http://www.pemsea.org/eascongress/eascongress.htm

White Paper of Northwest Pacific Region Environment, May, 2003, Northwest Pacific Region Environmental Cooperation Centre, Toyama, Japan

White Paper of the Ministry of the Environment "Quality of the Environment in Japan 2003"

Zhang J., 1995. Geochemistry of Trace Metals from Chinese River / Estuary Systems. An Overview. Estuarine. Coastal and Shelf Science, 41: pp. 631-658.

Zhang J., Z. G. Yu, S. Z. Chen, H. Xiong et al. Processes Affecting Nutrient Dynamics in the Yalujiang and its Estuary (1994-1996), North China. In: Health of the Yellow Sea. Eds. G.H. Hong, J. Zhang and B. K. Park. Seoul, 1998. pp. 149-189.

REGIONAL OVERVIEW
On River and Direct Inputs
Of Contaminants into Marine and Coastal Environment in NOWPAP Region
with Special Focus on the Land Based Sources of Pollution

РЕГИОНАЛЬНЫЙ ОБЗОР
Речной сток и прямой вынос загрязняющих веществ в прибрежные воды
региона северо-западной Пацифики (NOWPAP) с акцентом
на наземные источники загрязнения
(на англ.яз.)

Автор В.М. Шулькин
Ответственный редактор А.Н. Качур
Дизайнер Л.М. Кабалик

Отпечатано с оригинал-макета, подготовленного
в Тихоокеанском институте географии ДВО РАН,
минуя редподготовку в Дальнауке

Подписано к печати 03.05.2010 г. Формат 60х84/8.
Печать офсетная. Бумага офсетная.
Гарнитура Таймс. Усл.п.л. 10,0 Уч.-изд.л. 9,46.
Тираж 100 экз. Заказ 62.

Отпечатано в типографии ФГУП Издательство “Дальнаука” ДВО РАН.
690041, г. Владивосток, ул. Радио, 7

NOWPAP POMRAC

**Northwest Pacific Action Plan**
**Pollution Monitoring Regional Activity Centre**

**7 Radio St., Vladivostok 690041, Russian Federation**
**Tel.: 7-4232-313071, Fax: 7-4232-312833**
**Website: http://www.pomrac.dvo.ru**
**http://pomrac.nowpap.org**