Sea and Fresh Water Conservation

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Sea water qualities are closely related to river water qualities. Therefore, the most important thing is to prevent fresh water pollution from a view point of sea water conservation. The Yodo River is the biggest river in the Kinki district which flows into the Osaka bay and the major water source for water industries serving 10 million people. Recently, the water has been polluted due to the rapid economic growth etc.. We wish to control the Yodo River water pollution, in cooperation with the organization concerened to sea water.

Many pollutants originated in land are discharged into sea area via rivers. It is no exaggeration to say that sea water qualities are closely related to river water qualities.

The Yodo River, which flows through the Osaka plain, is the biggest River in the Kinki district of Japan. Two regulations on water quality, Water Pollution Control Law(1971) and Law Concerning Special Measures for Conservation of the Environment of the Seto Inland Sea(1973), are applied to the effluents for the Yodo River. However many industrial, domestic and sewage treatment effluents flow into the River, as shown in Fig.1. Since 1960's, the River water has been rapidly polluted due to the increasing of influent amounts with rapid economic

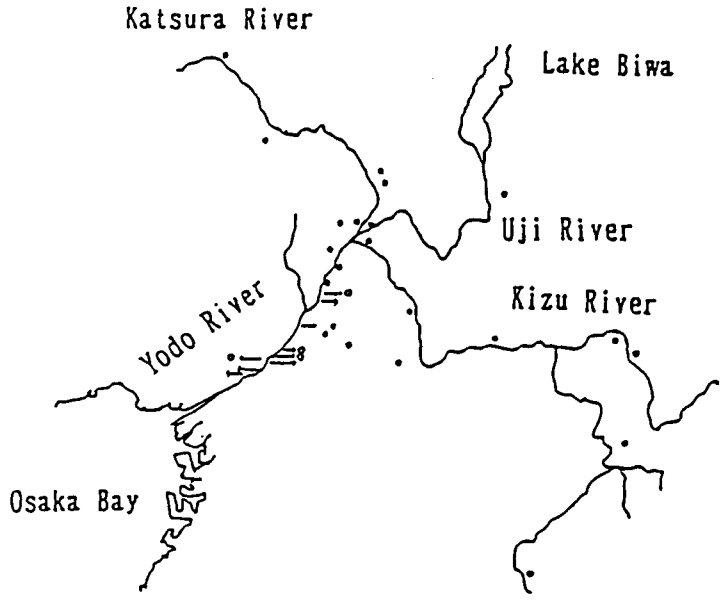

Fig. 1 Intake Points of Osaka Prefectural Waterworks(○), other Waterworks(→) and Sewage Treatment Plants(●) in the Yodo River Basin.

growth and population explosion. Annual average concentrations of total organic

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carbon (TOC), total nitrogen and total phosphate were 3.2mg/l, 1.81mg/l, 0.46mg/l, at Niwakubo point of the River in 1989, respectively. Total annual loads were estimated at the level of 2.8×10^4tons, 1.5×10^4tons and 0.4×10^4 tons, respectively.

The Yodo River is the major water supply source serving a population of 10 million people in the district. The River water pollution causes a deteriolation of drinking water quality. Water industries intaking raw water from the river organize the Yodo River Water Consultative Committee and the Yodo River Water Protection Committee in order to prevent water pollution and to exchange informations on the water qualities.

This report deals with the changes and future predictions of water quality and activities for the pollution protections by water industries. And then new organization which is named as Cooperation Network System for Sea and Fresh Water Quality Conservation will be proposed.

Annual Variations of the Water Qualities

Fig.2 shows the annual variations of concentration of NH_4-N, BOD, $KMnO_4$-

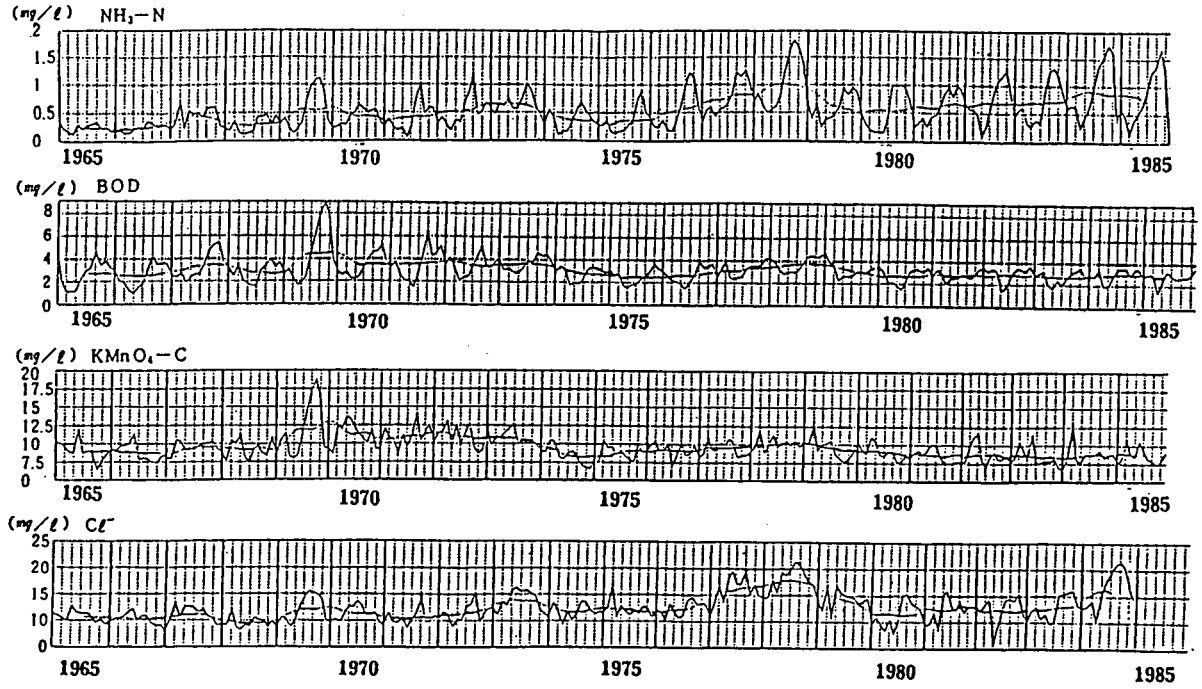

Fig. 2 Annual Variations of Water Quality at Niwakubo Point
(··· Moving Average; 12 Months)

consumption and chrolide at the point of Niwakubo. The outline of the quality changes will be described below.

NH_4-N . NH_4-N has been gradually increasing. Up to 1970, seasonal variaton was not so high and the annual average was some 0.2mg/l. However, after 1970, the concentration difference between winter and summer began to appear. These seasonal difference became even stronger after late 1970's. Annual average has been reaching at the level of 1.0mg/l.

BOD . BOD changes contrasted with NH_4-N fluctuation. Up to 1970, seasonal variations were clearly distinguished, low in summer and high in winter. However these difference has been decreasing since 1970 and there are no fluctuations in the BOD concentration. The annual average concentration was some 3.0mg/l.

$KMnO_4$-Consumption . $KMnO_4$-consumption remaines stable, some 12mg/l.

Chloride. Chloride concentration was 10mg/l in 1970, but increased to 20mg/l in 1980.

According to previous mentioned quality variations, the situations of the water quality can be divided into the following 3 periods of time. 1) period of unpolluted(up to 1970). 2) period of rapid deteriolation of water quality due to rapid industrialzation and population growth(from 1970 to 1980). 3) period of improvements of water quality due to enacting of the Water Pollution Control Law, increasing of sewage served population and changes of industrial structures (after 1980).

Fig.3 and 4 show periodgrums of NH_4-N and $KMnO_4$-Consumption which were

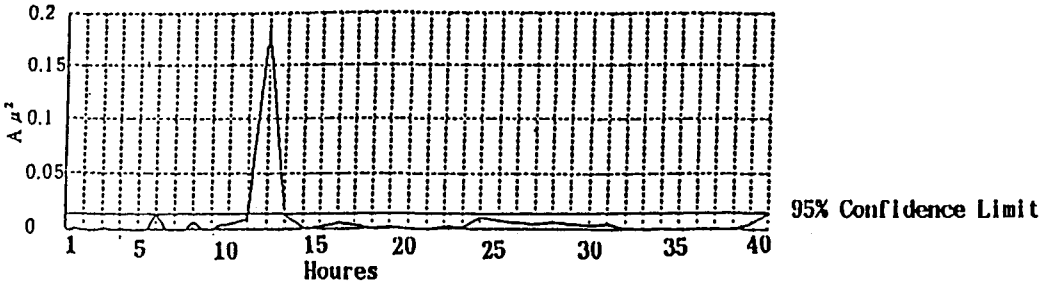

Fig.3 Periodgrum of NH_4-N (Niwakubo Point:1975-1984)

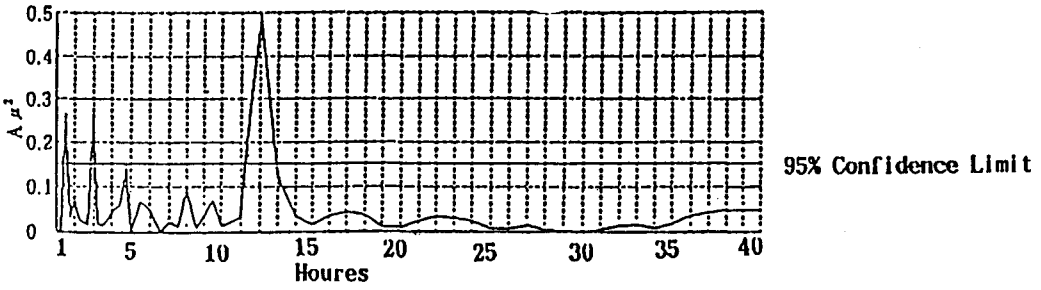

Fig.4 Periodgrum of $KMnO_4$-Consumption(Niwakubo Point:1975-1984)

analyzed by harmonic analysis. NH_4-N changes cyclically with 12 months. The maximum concentration occurs in February and the minimum in August. These cyclic changes are due to seasonal variations of sewage treatment ability. Although $KMnO_4$-Consumption shows a cyclical changes with 12 months, the amplitude of vibration is not so high. In addition to 12 month cycle, it shows a 3 month cycle. These changes are caused to increase of water flow with early summer and autumn rainfalls.

Sources of Pollutants

For the sake of developing a pollutants source model, the Yodo River basin was geographically divided into 9 watersheds as shown in Fig.5 (Saito et al.,1989, Saito et al.,1990). Model equation describing pollution discharge into the River was obtained as Eq-1, including parameters of land use, ratio of sewage served population, precipitation and so on.

$$L_i = \{X_i \cdot k_2 \cdot n_2 \cdot R_i + (1-x_i) \cdot L_{max\,i} (1-\exp(-k_i \cdot n_i \cdot R_i)) \} \cdot S_i + (N_i \cdot q_{mi} \cdot X_{wi}) \cdot C_m \cdot (1-S_{xi} \cdot S_y) + C \cdot Q_i$$

$$L_T = \sum_{i=1}^{9} (L_i) \qquad (1)$$

where i:block number, L_i :annual total load(g/year), X_i :ratio of the filtrative areas(-), R_i :annual totat precipitation(mm), S_i :area of each block, N_i :population in each area, q_{mi}:average amount of water supply(m^3/capita/year), X_{wi}:accounted-for water ratio(-), C_m :concentration of domestic waste water(g/m^3), S_{wi}:sewage served population ratio, S_y :removal rate by secondary sewage treatment, C:concentration of industrial waste water(g/m^3), Q_i :discharged flow from industries(m^3/year), L_T :total load(g/year) k_1,k_2:coefficient of outflow, n_1,n_2:effective precipitation(mm)

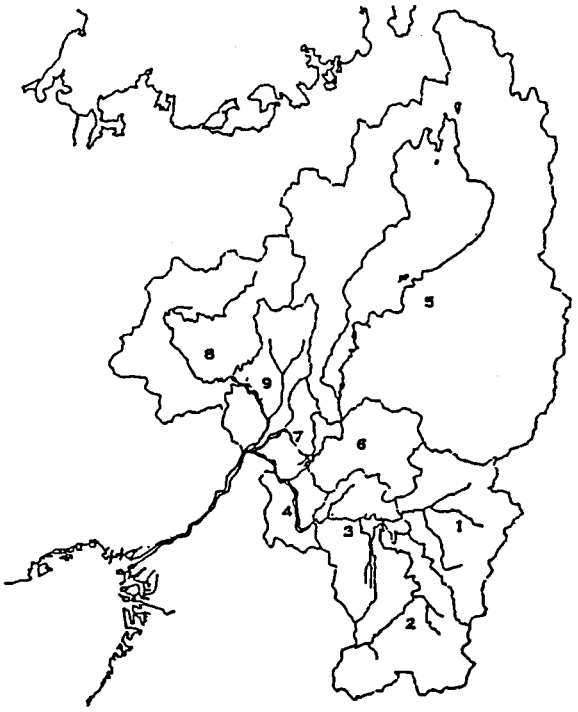

Fig.5 The Yodo River Basin
1:Upper Stream of Kizu river, 2:Nabari river, 3:kamo Area of Kizu river, 4:Tanabe area of Kizu river, 5:Seta river, 6:Amagase Dam, 7:Remainig Area of Yodo river,8:Upper Stream of Katsura river, 9:Down Stream of Katsura river

The loads distribution of TOC was estimated and is shown in Fig.6.

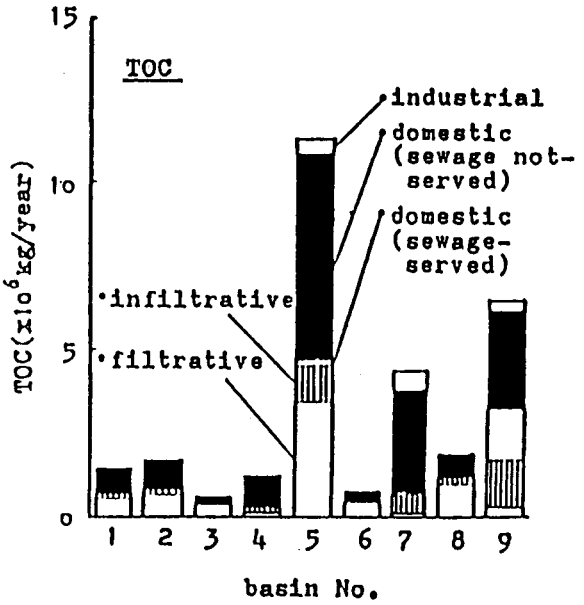

Fig.6 Loads Distribution of TOC in the Yodo River Basin

Annual TOC load was estimated at a level of $3x10^4$tons. Lake Biwa contributes 40% of total load and next to the Lake Biwa, Katsura river contributes 20% of total load. As for each source, load from sewage non-served areas indicated the highest contribution of 60%.

Activities for Pollution Prevention by Water Industries

As mentioned previously, there are two committees for pollution prevention with the Yodo River, i.e., the Yodo River Water Consultative Committee and the Yodo River Water Protection Committee. The former was established in July of 1958, in order to research the pollution mechanism of the River and to take counter-measures to the pollution. The affiliated organizations are the Local Construction Bureau of Kinki, the National Land Agency, the Ministry of International Trade and Industry, Water Resourses Public Cooperation and Water Indutries. The later was establised in August of 1965, in order to form network system for water troubles,i.e., oils and odors and to demand construction of sewage treatment plants for improvements of effluents from indutries , homes and so on. The affiliated organizations are Osaka Prefectural Government, Osaka City Hall, Hirakata City Hall, Neyagawa City Hall, Moriguchi City Hall, Suita City Hall, Am agasaki City Hall and Hanshin Water Supply Authority. These committees play an important role in the preventions of the quality. Although these two organizations are separate committee, there are important interactions among them.

Propose of Establishement of Cooperation Network System for the Conservation of Sea and Fresh Water

According to the source model for pollutants, TOC concentration will increase to some 4.7mg/l in next century. The ratio of increase is 42%. Major cause of TOC level rise is due to increase the domestic effluents from sewage non-served areas. It is advisable to construct sewage treatment plants from a view point of source control.

Sea areas are the last places where pollutants are discharged. As for water industries, it is advisable to conduct effluents into sea area directly, not via Rivers. However, from a view point of sea water conservation, it is not a practical way. Water industries have been emphasizing to construct sewage treatment plants. These assertation will be more and more important and necessary to promote intensively(Abe, 1990, Kurihara, 1990). We are sure that fresh water conservation will bring the effective results for sea water quality conservation.

Water industries have been protecting their own raw water. However the problem of water pollution of the Yodo River become severe in future. We intend to make further efforts to prevent the water pollution of the Yodo River. After this, We are trying to control fresh water pollution, in cooperation with the person and the organization concerened to sea water. Finally we propose to set up the new organization which is named as Cooperation Network System for the Conservation of Sea and Fresh Water.

We are looking for you to support us.

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