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Reconnaissance Study for the Impact Evaluation of Acid Pollution at Miomotegawa River

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Abstract

This study was implemented to investigate the anion and cation concentrations of Miomotegawa river since it is one of the most important salmon rivers in Japan. A great number of salmons have returned to the river, and it was expected to contain relatively lower cation concentrations since granite is widely distributed in the river catchment area. The anion and cation concentrations of station 1 except NH_4^+ were higher than those of other stations. The concentrations of Na^+, K^+, Mg^{2+}, Ca^{2+},and Cl^- at station 2 were 8.61, 1.06, 1.84, 4.47, and 14.5mg/l, respectively. In the case of NH_4^+, $NO_3^-$and SO_4^{2-}, they were 0.04,2.99 and 5.31mg/l, respectively at station 2 of down stream. However, at station 5 of upstream, they were 0.01, 1.37 and 4.08mg/l, respectively, which were relatively lower than that of downstream.

Key words : : Miomotegawa river, salmon, calcium and magnesium cation.

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I. INTRODUCTION

In northern Europe and America, acidification of freshwater has wiped out populations of salmon fishes such as the Atlantic salmon (*Salmo salar*), brown trout (*Salmo trutta*), and brook trout (*Sulvelinus fontinalis*) from a great number of lakes and rivers.[1] Acute exposure to low pH directly kills fish by means of a discharge of sodium and chloride ions from body fluid. The cause of pH decline is believed to have been due to the depositing of acidic substances into lakes in excess of their neutralization or buffering capacity. [1]At present, rapidly expanding industrial activities in East Asia have led to a continuous increase in the amount of emission of acidic pollutants. [2] Rain at acidic level of pH (about 4) has often precipitated through Japan, but acidification of Japan's lakes and rivers by acidic deposition has not yet been observed, due to the country's soil buffering capacity. However, it has been clarified that extremely weak acidity such as in the pH 6 range is sufficient to depress prespawning behavior of land-locked sockeye salmon Oncorhynchus nerka. [3] Additionally, juveniles of chum salmon O. keta significantly avoid areas of pH lower than 5.8.

Basic cations were released from soil by chemical weathering neutralize acid derived from atmospheric pollution or produced by the decay of organic matter. They are also taken up by plants and discharged into streams.[4] It is known that there are many mountainous inland watersheds that are sensitive to acidde position in Japan. In this study, only a part of the whole area was investigated. Also not enough information of anion and cation concentrations or even basic alkalinity data of inland watershed have been accumulated.

In Niigata prefecture region, located near the Sea of Japan, a forest ecosystem is affected by wet & dry acid deposition and long-range trans boundary air pollutants from the Chinese continent due to northwest seasonal wind during the winter. Miomotegawa river in Niigata prefecture is one of the most important salmon rivers. Salmon populations of about two hundred thousand have been caught with a much larger salmon population returning every year. Also, most area of the catchments of Miomotegawa river, a widely distributed zone along the riverside, is surrounded by granite that has lower acid-neutralization capacity. Furthermore, there are many fresh rivers (Kajigawa, Ochiborigawa, Tainasigawa, Aragawa and Katsugigawa) and lakes (Okumiomotegawa and Sarutako) in Niigata prefecture, the so called water city, will be surveyed in FY 2002. Therefore, the reconnaissance study for the evaluation of the acid pollution is needed.

In this study, in order to investigate the water quality of Miomotegawa river, the concentrations of anion and cation were measured.

II. MATERIALS AND METHODS

1. Sampling site

As shown in Table 1, an eight sample stations were chosen. Figure 1 is sampling site In Niigata prefecture region, Japan. The station 4, 5, 6 and 8 of river is upstream and 2, downstream. Station 1 was estuarine and station 3 was a streamlet not connected to Miomotegawa River.

Table 1. Description of sampling stations.

Station Number	Location	Remark
1	The sea of Japan of the estuary	Saline water
2	Downstream of Miomotegawa river	
3	A streamlet of north Murakami	
4	A tributary of Miomotegawa river	
5	Midstream of Miomotegawa river	
6	Miomotegawa dam	
7	Takijinja fall	
8	Sediment of Miomotegawa dam	

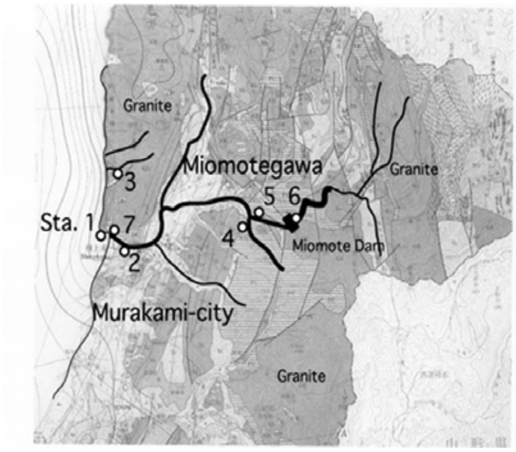

Fig. 1. Sampling site in Miomotegawa river in Niigata prefecture region, Japan.

2. Analyzing parameters

Analysis apparatuses are shown in Table 2. Acid-buffering capacity was estimated by the pH decrease on adding acidic solution of 0.005mol/l and 0.05mol/l in the samples step-by-step acid-neutralization. The change of pH by adding 0.005 and 0.05mol/l sulfuric acid is just indication of decreased pH and pH value when sulfuric acid is added that is easier and simpler method than that of alkalinity of standard method.

Table 2. Analysis apparatus.

Parameters	Analysis apparatuses
pH	pH meter (Horiba, LOT7120679)
Conductivity	Conductivity meter"
Anion and cation	Ion chromatography (Dionex500 Ion chromatography)

Ⅲ. RESULTS AND DISCUSSION

According to official salmon catch statistics, 197,999 fish were caught in 1880, but only 18,805 fish in the year 2000. A dramatic increase was observed from 1946, when only a few thousand fish were caught annually for 3 decades. The fish catch recovered from 1980 to approximately 20,000 fish per year. Water qualities for 12 years (1988~1999) analyzed by Environmental Science Research Niigata was examined to verify the effect on the aquatic environment of the water quality of Miomotegawa River.[5,7] Average concentration of T-N and T-P were 0.25 and 0.007mg/l, respectively, and the conductivity, pH, and temperature of water were 49us/cm, 7.0, and 18.30°C, respectively. Nutrients are necessary to determine T-N and T-P concentration to prevent damages in water use caused by eutrophication of lakes and reservoirs. Salmon and trout are common in oligotrophic lakes in Japan. However, carp and roach are known to be abundant in eutrophic lakes. Fishery class 1 in terms of T-P, corresponds to the water quality to maintain the population of salmon and trout. The standards for fisheries class 1 were established as T-P 0.01mg/l and T-N 0.2mg/l based on the T-P and T-N in Lake Chuzenjiko and Biwako in which trouts are being maintained.[6)]

Miomotegawa river is one of the most important salmon rivers in Niigata prefecture region, Japan. A number of salmon have returned to the river, and it was expected to contain relatively low cation concentrations since granite is widely distributed in the river catchments area. Therefore, in order to investigate the water quality of Miomotegawa river, the anion and cation concentrations were measured. The anion and cation concentrations in the water collected from Miomotegawa river and from the other sampling sites are shown in Table 3. The anion and cation concentrations of station 1 except NH_4^+ were higher than those of other stations. The concentrations of Na^+, K^+, Mg^{2+}, Ca^{2+},andCl^- at station 2 were 8.61, 1.06, 1.84, 4.47, and 14.5mg/l, respectively. In the case of NH_4^+, NO_3^- and SO_4^{2-}, they were 0.04, 2.99 and 5.31mg/l at station 2 of downstream but at station 5 of upstream, the concentrations were 0.01, 1.37 and 4.08mg/l, respectively, which were relatively lower than that of downstream. Most of parameters of station 6 at Miomotegawa dam, upper stream, were relatively low concentration. It means that some dry deposition of acidic pollutant have flowed into the water body.

Table 3. Results of water quality analysis. Unit: mg/l

Station Number	Na^+	K^+	Mg^{2+}	Ca^{2+}	NH_4^+	Cl^-	NO_3^-	SO_4^{2-}
St. 1	6470	260	772	250	0.00	10100	33.2	1450
St. 2	8.61	1.06	1.84	4.47	0.04	14.5	2.99	5.31
St. 3	16.0	1.22	3.42	4.22	0.00	29.5	5.70	5.70
St. 4	6.68	0.72	2.13	3.48	0.00	11.89	2.89	4.23
St. 5	4.83	0.89	1.09	3.91	0.01	6.64	1.37	4.08
St. 6	4.25	0.76	1.04	4.17	0.01	5.70	1.05	3.73
St. 7	19.8	1.13	3.03	2.79	0.00	34.4	3.86	6.64

Figure 2 is concentrations of Ca^{2+} and Mg^{2+} of Miomotegawa river water and comparison of other rivers. The concentrations of Ca^{2+} and Mg^{2+} of Miomotegawa river water were lowest values that are 3.91mg/l and 1.09mg/l, respectively. In the case of calcium, Tonegawa was 13.3mg/l; Ishikarigawa, 9.4mg/l; Shinanogawa, 10.2mg/l; Yoneshirogawa, 8.3mg/l; Nakagawa, 15.8mg/l that is greatest one in 13 rivers, Chikugogawa river, 9.2mg/l; Yuragawa, 6.4mg/l; Kinogawa, 12.9mg/l, Yoshiigawa river, 7.4mg/l; Biwako lake, 8.5mg/l; Kasumigaura lake, 16.6mg/l and Yamanaka river, 8.3mg/l. In the case of Mg^{2+}, Kasumigaura lake water was highest as 5.9mg/l, and next was 4.3mg/l of Nakagawa river. It was found that the concentrations of Ca^{2+} and Mg^{2+} of Miomotegawa river water were one third and half value of other rivers and lakes. The concentrations of most anion and cation of down stream were higher than that of the upper stream.

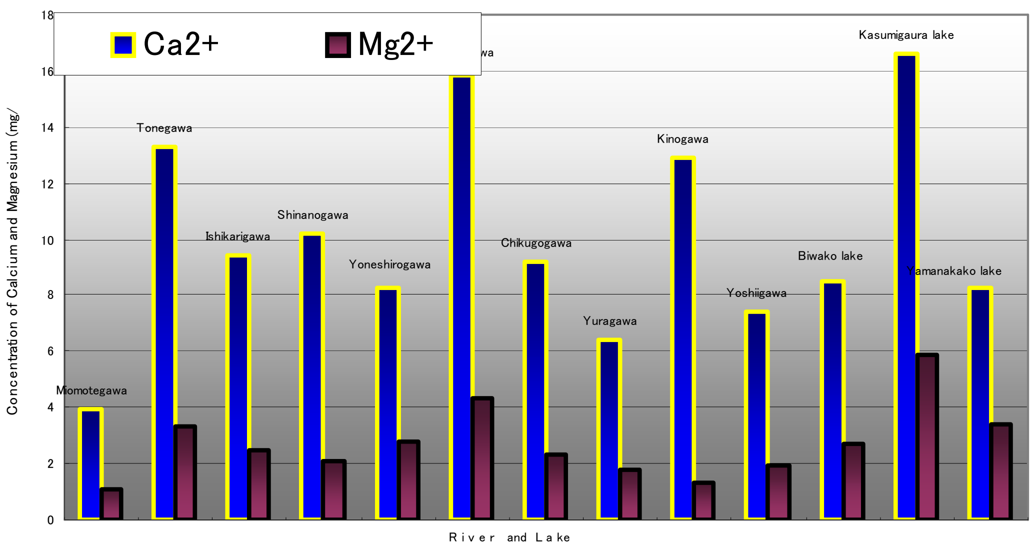

Fig. 2. Concentrations of Ca^{2+} and Mg^{2+}.

IV. CONCLUSIONS

We have expected that Miomotegawa river water has a low acid-neutralization capacity and low cation concentration even though pH is typically around 7, with no seasonal depression, since a huge size of granite is widely distributed in the river catchments. It was in accord with the result of water analysis, the concentration of Ca^{2+} and Mg^{2+} were much lower, approximately one third only at station 5, than in other major rivers and lakes in this country.

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