C-3.1 Prediction of acidification and its effects on the catchment ecosystem in Japan

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Abstract Acidification of the rivers and lakes by the acid deposition was checked in Japan. Buffering capacity of the watershed in 7 metamorphous belts is usually smaller than those in other watershed on the basic bed rock. Probability of acidification of rivers and lakes were checked by measuring alkalinity and other items of water quality. It was found that the mountain lakes, Sugoroku-ike and Washiba-ike in the Northern Alps of Japan, have catchment of almost no buffering capacity, where weakly acidic rain causes immediate acidification of the lake water. Almost all river waters measured, however, had alkalinity of more than 0.15 meq/l, which means that the probability of acidification of river water is very little in Japan.

Monitoring of the river and lake waters was carried out in Nikko area of Tochigi Prefecture, Bibai area of Hokkaido Prefecture and Northern Alps area of Nagano Prefecture. Purpose of this periodical frequent measurement lasted for more than 2 months were to detect pH falls by the snowmelt acidic shock which had been shown to cause sometimes serious acidification in the beginning of snowmelt. A typical pH fall by snowmelt acidic shock was observed for 10 days in a small stream of Bibai area, but only once and any more after this. Geology of this catchment is characterized by the very thin soil layer on the unpenetrative clay. No sign of pH fall was detected in the other points selected above.

Key Words acid deposition, terrestrial, acidification, buffering capacity

1. Introduction

An appreciable amount of acidic deposition was observed near the large cities throughout Japan during the survey of the Japan Environment Agency from 1982 to 1986. Acid loading was found comparable to those observed in Europe and North-eastern America, where serious damages have been recognized. However, no evidences for the acidification of surface waters by the acidic deposition were confirmed. After this survey, probability of acidification of the surface waters in Japan was desired to be clarified.

Geological and climo-agrological conditions which play a significant role in supporting the buffering capacity of the catchment were considered along with the amount of acidic deposition observed throughout the country. General survey of river water alkalinity had reasonably suggested that smaller buffering capacity of the catchment is distributed in the 7 metamorphous belts where acidic rock as granite or rhyolite appears in the bed. On the other hand, many and long studies[1,2] on the effects of acidic deposition had already been continued in Europe and north-eastern America. Their results suggested clearly that geochemical survey focused on finding catchments of the weakest buffering capacity, and frequent periodical monitoring focused on the snowmelt acidic

shock should be the significant points of this study.

2. Research Objection

The purpose of this research is to check the probability of acidification of the surface water also in Japan which was not detected during the survey carried out by the Environment Agency. Estimation of the time before starting the acidification was also objected if necessary. Clarification of the effects of the acid deposition on the terrestrial ecosystem would be the fundamental program when the surface water acidification were positively predicted.

Study was planned focusing on the two points; (1)to find out catchments of the weakest buffering capacity, and (2)to check the sign of pH fall by the snowmelt acidic shock.

3. Research Method

For the subject on the first point, rivers and lakes in the 7 metamorphous belts were targeted after the review of geological and climo-agrological conditions in Japan. Alkalinity should be the main index to discuss the possibility of the surface water acidification on the basis of geochemical mechanisms. Gran's method was employed for the most reliable measurement of small alkalinity and acidity in the same procedure. Improvement in data treating and computer aided automation was made on this method. In situ pH, electric conductivity (EC) and water temperature were measured with handy type meters. Water samples were gathered and chilled in the plastic bottle for the laboratory analysis. Soils and bed rocks were observed at the sampling site. Alkalinity and other items of water quality were measured in the laboratory with titrator, autoanalyzer for nutrients, ICP spectrophotometer and ionchromatography. Values of alkalinity were discussed concerning the neutralization of deposited acid.

For the subject on the second point, submersible monitor was prepared.

4. Results and discussion

EC, water temperature, pH and alkalinity of lake and river water measured in the metamorphous belts are shown in Table 1. It was found that catchment buffering capacity of mountain lakes, Sugoroku-ike and Washiba-ike, is very small, and weakly acidic rain causes the pH fall of the lake water. Negative alkalinity (acidification) of Sugoroku-ike is listed in the table as an example. Yakushima Island has rivers in the secondary weakest catchment among surveyed rivers. Almost all values of alkalinity, however, were greater

Table 1. EC, water temperature, pH and alkalinity measured in metamorphous belts

date	sampling site	EC(uS/cm)	WT(C)	pH	alkalinity
(av.)	Yakushima Is.	27.4	8.6	6.8	38(ueq/l)
910315	Hoshinsui	28.3	7.7	6.6	10
(av.)	San-gun metamor.	37.6	10.2	7.4	218
900328	Naka R.(stream)	26.5	7.3	6.2	128
(av.)	Ryoke metamor.	87.	10.4	7.8	602
900326	Rokko Horakawako	48.7	12.0	7.6	161
(av.)	Hida metamor.	31.0	9.4	6.9	185
900829	Sugoroku-ike	7.1	----	5.8	-68(acid)
901103	Lake Kisaki	34.0	15.0	9.2	147
(av.)	Hidaka metamor.	31.0	1.7	7.6	208
910305	R. Rakko	21.3	4.1	7.3	148

than 0.1 meq/l, which means that the water itself can neutralize the same volume of acid rain of pH 4. It has been well known that catchment buffering capacity depend on geochemical mechanisms is usually much more powerful than those shown by the surface water alkalinity. Therefore, these results suggested that probability of acidification of the lakes and rivers is very little unless the amount of acid deposition increases.

Programmable auto-water sampler was prepared for the frequent periodical sampling to detect the pH fall during snowmelt. Submersible monitor for pH, EC and water temperature was placed in the water near the sampler. This experiment was carried out in Nikko area, Bibai area and Northern Alps(Japan) area. Sampler and monitor were placed before ice covered the lakes, left for 2 to 5 months and collected after snow disappeared. A typical pH fall for 10 days by snowmelt acidic shock seemed to be detected in a small stream of Bibai area in 1990 (Fig.1), but only once and no more after this. Geology of this catchment is characterized by a very thin soil layer on the unpenetrative clay, which causes very small buffering capacity. No signs of pH fall were detected in the other points.

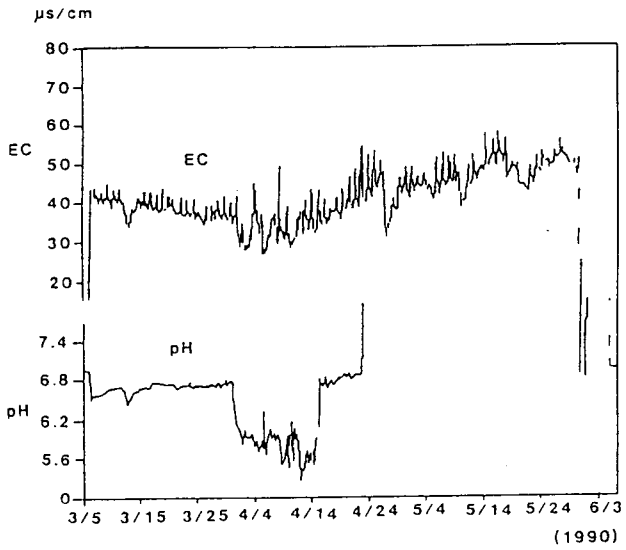

Fig.1 pH fall detected in Bibai

On the other hand, a large increase of alkalinity and concentration of several other elements were observed after a heavy rain of more than 100 mm per day in Nikko area. This observation can be repeatable. Geochemical mechanism of this phenomenon is very interesting although it is out of acidification. No signs for pH change by acidic rains were detected with continuous monitoring at Lakes Karigome-Kirigome in Nikko area.

Gran's plot method for the titration of alkalinity were improved in data treating by simulating the emf sift during measurement. One of the best runs of measurement showed that employed glass electrode

5. Conclusion

All the data observed in various areas of Japan suggested that the probability of acidification of the lakes and rivers in Japan is small. Catchments of very small buffering capacity were also found, but are limited in a small area and to special condition. Monitoring in the weakest catchment is very important and will be enough for a while in Japan. Main efforts for the environmental protection should be addressed to the exhaust-control measures in Asia.

References

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