Research article

Considering Environmental Standards Based on Soils and Water Quality in the Biotopes around Urban Areas in Japan

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Abstract Biotope, where the ecosystems have been lost due to industrial development and urbanization, should be restored to rehabilitate the organisms of the original inhabitants. Although there are more than 1,500 school biotopes in Japan, few research have been conducted for evaluating their soil and water quality. Compared to lakes and rivers, biotopes have problems as there is less data on soil and water quality. Furthermore, there were no 'environmental standards for biotopes,' so it was hard to evaluate if their soil and water conditions are appropriate for biotopes. Accordingly, the aims of this study are to determine soil and water quality in several biotopes and to develop a draft of environmental standards for biotopes. Various surveys were conducted by disseminating questionnaires to elementary school students on current management systems and their perception of the function of biotopes. Also, soil and water samples were collected from a public park and four elementary schools in Tokyo and Kanagawa Prefectures for quality analysis. As biological characteristics, coliforms and *E. coli* were measured from soil samples. Also, total nitrogen (TN), total phosphorus (TP), pH, EC, SS, coliforms and *E. coli* were measured from water samples. The results of TN and TP tended to increase in summer due to the increase in algae. The school that keeps bantams and goats near the biotope detected coliforms and *E. coli*. The excrement of these animals may cause contamination. However, the results from the questionnaire survey indicated that the water appears to be clean. Accordingly, there was a difference in their perception and water quality condition. Therefore, the draft of environmental standards, TN and TP values may be consistent with the standards for the lakes, although there are size differences between lakes and biotopes. However, the standards on coliforms and *E. coli* should be more restricted, since children often play with biotopes.

Keywords biotope, environmental standards, *E. coli*, Tokyo

INTRODUCTION

Biotopes are places designed for the restoration and rehabilitation of organisms that have been lost by industrial development and urbanization. The term 'biotope' was introduced by a German scientist in the early the 20th century and additional concept of 'biocenosis' was formulated in German. This concept ('ecosystem = biotope + biocenosis') became accepted in German, French, Russian and other Europe gradually. The new interpretation of the term ('biotope = habitat + community') appeared in the United Kingdom in the early 1990s while classifying 'marine habitats' of the coastal zone. Since then, this meaning was also used in international European environmental documents (Olein and Ducrotoy, 2006).

In Germany, biotopes have been attracting attention since the 1970s, when environmental problems happened by industrialization became more serious. In Japan, biotopes have been made in

various places since the end of the 20th century, including water areas such as tidal flats, wetlands, lakes, and rivers, as well as forests and grasslands. This concept, which had begun in Germany and other European countries, has spread to Japan. Recently in Japan, schools, NPOs, NGOs, and companies have been making various efforts to make biotopes. Not only naturally occurring biological environments, but also artificially created spaces can be said to be biotopes. Since they are environmentally closed water systems, they are prone to water pollution and need to be improved. Although there are more than 1,500 school biotopes in Japan since 2002 by Ministry of Education, Culture, Sports, Science and Technology, few research have been conducted for evaluating their soil and water quality. Also, research for biotopes is not more than that for lakes and rivers. In Japan, the environmental standards for lakes and rivers were made by Ministry of the Environment but not suitable to biotopes.

OBJECTIVE

The aim of this study is to investigate the biotopes' soil and water quality, as well as to understand the public's perception of it, in order to develop a draft of environmental standards for biotopes.

METHODOLOGY

Soil and water samples were collected at 4 different locations: Kuwabukuro Biotope Park, Toho Gakuen Primary School, Aikawa Elementary School, Todoroki Elementary School, and Komatsugawa Elementary School, which are in Tokyo and Kanagawa Prefectures. These schools were nominated for Biotope Competition by Ecosystem Conservation Society, Japan. Since the biotope in Komatsugawa Elementary School doesn't have the area for water, only soil was sampled.

The sampling was conducted in three seasons April to May (spring), July to September (summer) and November (autumn). From soil samples, biological characteristics such as coliform and *E. coli* were measured. For water samples, the biological and chemical characteristics such as total nitrogen (TN), total phosphorus (TP), pH, electric conductivity (EC), suspended solids (SS), *E. coli* and coliform were measured. Water velocity was also measured in each biotope. TN and TP were measured by the spectrophotometric method and coliforms and *E. coli* were used in the dilution plate method. Additional surveys were conducted by disseminating the questionnaire sheets to 70 students in Toho Gakuen Primary School on current management systems and their perception of the function of biotopes.

RESULTS AND DISCUSSION

In the most sampling sites, SS indicated high values during the summer. The presence of algae in the water resulted higher SS values. For Todoroki, tap water was introduced at any time, lower SS were observed than other sites. As some biotopes are closed, the pH values sometimes exceeded 8.0 (Fig. 1). In Kuwabukuro and Aikawa, SS and EC were high, as they received rainwater directly.

Figure 2 showed the results of total nitrogen (TN) and total phosphorus (TP) in each season in 5 biotopes. The indicators of eutrophication are the value higher than 0.2 mg/L for TN and higher than 0.02 mg/L for TP (Kudo and Watanabe, 2014). Based on the criteria of TN and TP values, Toho, Kuwabukuro and Aikawa were identified as eutrophication. The accumulation of nutrients from surface runoff with rainfall and dead vegetation may promote eutrophication. Nitrogen and phosphorus are nutrients for phytoplankton, phytoplankton also increases with nutrients in biotope. Additionally, organic pollution happened with organic matters such as dead plants and animals.

From the results indicated in Fig. 2, TN and TP as well as SS tended to increase in summer due to the increases in algae. Although the water in the Kuwabukuro, which has an area at 1,800 m^2, is connected with river water, the water velocity observed was 0 m/s as well as other biotopes. TN during the summer in the biotope of Toho Gakuen Primary School was 9.18 mg/L. It was because of the pesticide applied for eliminating rats during the summer. Also, Aikawa indicated the highest in TP, as no in-flow was observed in this biotope.

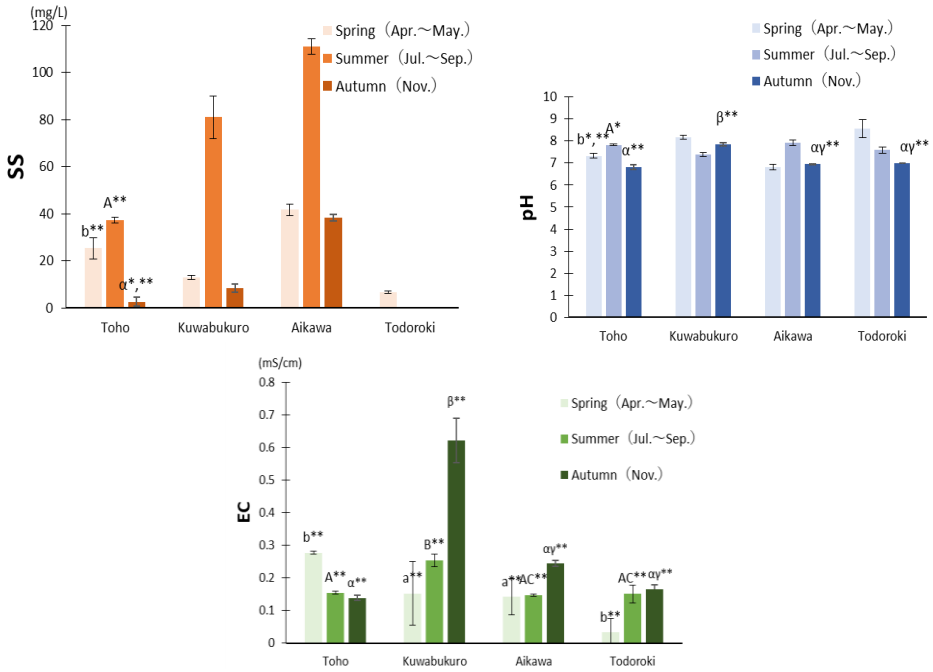

Fig. 1 Suspended solids (SS), pH and EC in biotopes

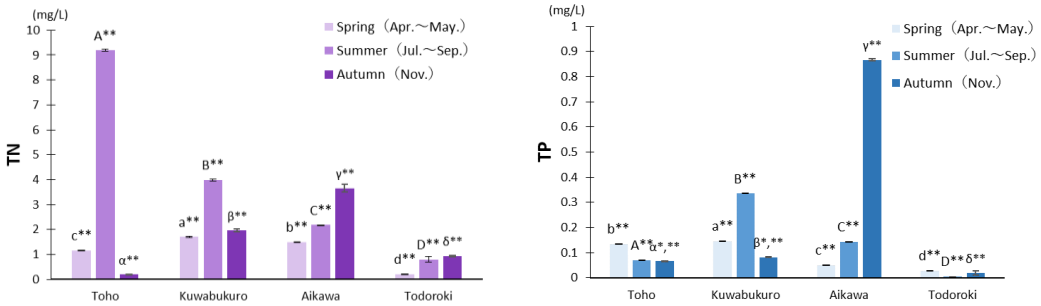

Fig. 2 Total nitrogen (TN) and total phosphorus (TP) in biotopes

Table 1 Coliforms and *E. coli* in biotopes

Sampling Area	season	Soil		Water	
		Coliform (cfu/g)	*E. coli* (cfu/g)	Coliform (cfu/ml)	*E. coli* (cfu/ml)
Toho	Spring	3.9×10^4	5.5×10^3	5.7×10^4	3.0×10^4
	Summer	7.2×10^3	ND	ND	ND
	Autumn	5.9×10^4	4.7×10^3	ND	ND
Aikawa	Spring	ND	ND	9.3×10^5	ND
	Summer	ND	ND	4.1×10^5	4.5×10^3
	Autumn	5.2×10^3	4.5×10^3	ND	ND
Todoroki	Spring	ND	ND	ND	ND
	Summer	ND	ND	ND	6.3×10^3
	Autumn	ND	ND	ND	ND
Kuwabukuro	Spring	ND	ND	ND	ND
	Summer	1.7×10^5	9.3×10^3	6.0×10^3	8.0×10^3
	Autumn	1.2×10^4	5.0×10^3	ND	ND
Komatsugawa	Spring	5.7×10^3	2.6×10^3	—	—
	Summer	1.4×105	1.3×105	—	—
	Autumn	5.1×10^5	1.2×10^5	—	—

ND : Non Detected, — : No sample

There were no water samples in Komatsugawa because this biotope doesn't have water areas. In all of the sampling biotope locations, animals such as goats, rabbits, chickens, and monkeys were kept or wild animals such as cats, birds and raccoon dogs were observed. Therefore, the excrement of these animals may affect the results of Table 1.

At Toho Gakuen Elementary School, no *E. coli* was detected in August 2021. In the case of Aikawa, there was no animal shelter, but wild animals often visited the biotope. Additionally, there is no history of changing the water in this biotope, accordingly the survival of coliforms and *E. coli* were detected. These results indicated high risks of contamination for humans, especially children. However, at the biotope in Todoroki Elementary School, no coliforms and *E. coli* were detected except during the summer, as the water in the biotope was changed several times per year using tap water. Additionally, wild birds were observed near a sampling point in Kuwabukuro Biotope Park since summer, so coliforms and *E. coli* were detected in summer and autumn.

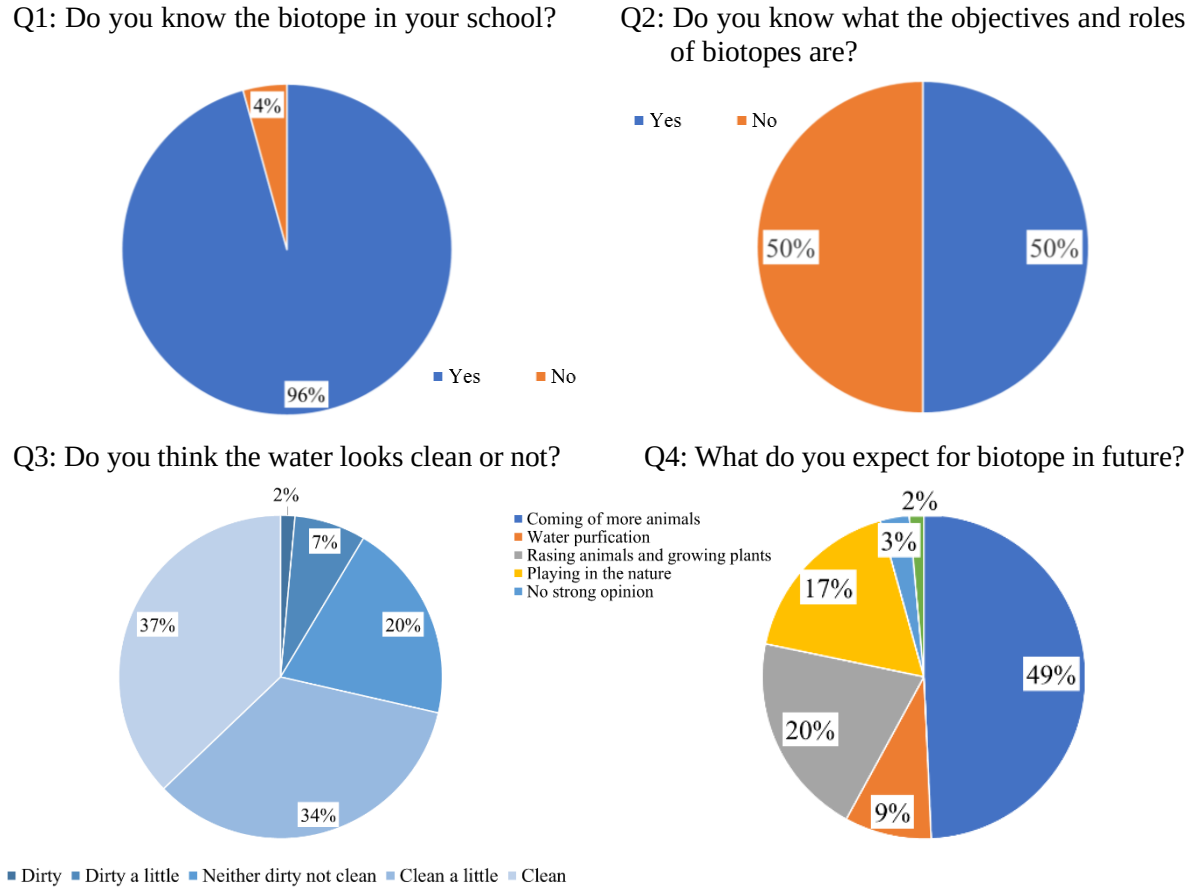

Fig. 3 Results of Questionnaire Q1, Q2, Q3, and Q4

According to Q1 in Fig. 3, almost all students in Toho Gakuen Primary School knew their biotope. However, only 50% of students understood the objectives and roles of the biotope from the results of Q2. They have been keeping bantams and goats near biotopes, and they have become the primary source of coliforms and *E. coli*. However, more than 70% of students thought the water looked almost clean from the results of Q3. Accordingly, there was a difference in their perception and water quality condition. From the results of Q4, it was clear that around 70% of students tended to be concerned with biodiversity and nature protection. In fact, the answers of water purification were only 17%. On the other hand, Q5 which was free answer question in the questionnaire. Certain number of respondents answered, 'I would like to ask the people who visits our biotope not to throw away garbage.' and 'I want to try water purification.' This indicated that they are willing to work on environmental issues including water pollution.

Table 2 Draft of environmental standards in biotopes

Evaluation	TN (mg/L)	TP (mg/L)	SS (mg/L)	pH	*E. coli* [90%] (cfu/100ml)
AA	0.2 or less	0.02 or less	1 or less	6.5 or more 8.5 or less	0
A	0.5 or less	0.05 or less	5 or less	6.5 or more 8.5 or less	20 or less
B	1.0 or less	0.10 or less	15 or less	6.5 or more 8.5 or less	300 or less
C	2.0 or less	0.20 or less	30 or less	6.0 or more 8.5 or less	1000 or less
D	3.0 or less	0.25 or less	45 or less	6.0 or more 8.5 or less	-
E	3.5 or less	0.30 or less	60 or less	6.0 or more 8.5 or less	-

On the basis of the experimental results, the draft of environmental standards for biotopes was proposed as shown in Table 2. The values of TN and TP may be consistent with the standards for the lakes, although there are size differences between lakes and biotopes. However, since children often play with water in biotopes, the standards for coliforms and *E. coli* should be more restricted.

CONCLUSION

School biotopes are prone to eutrophication due to the accumulation of nutrients with rainfall and dead plants because the water is not changed frequently (Kudo and Watanabe, 2014). The values of TN and TP showed that eutrophication is progressing. The sources of supplying nutrients are various, such as domestic wastewater, industrial wastewater, chemicals for water treatment, drainage through gravity outlets, dead vegetation from forests, carcasses and excrements of wild animals, underground water, sediments, aquatic animals and plants, rainfall, fallen ash, etc. In this case, the effective measures against increasing nutrients seem to be removing sediments and changing water frequently.

For the draft of environmental standards, TN, and TP values may be consistent with the standards for the lakes, although there are size differences between lakes and biotopes. However, the standards on coliforms and E. coli should be more restricted, since children often study and play with biotopes.

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