

Control of pollutant runoff during storm events using a retention pond - a case study in Lake Biwa Basin, Japan

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Introduction

Lake Biwa, which is the largest lake in Japan, has some river water treatment facilities for its tributaries developed by the Lake Biwa Water Quality Concentration Program (LBWQCP). Moriyama River Water Treatment Facility was constructed in 1997 under LBWQCP. This study aims at obtaining knowledge on mass balance and characteristics of pollutants in a stormwater retention pond of the facility. Surveys during storm events were done for both of inflow and outflow water to/from of the retention pond. From results of the surveys, runoff characteristics by storms and their effective control were examined especially in terms of PAHs.

Methodology

This facility consists of three sections, i.e. pre-treatment, a stormwater retention pond and a vegetation pond. During dry weather, river water is taken into the pre-treatment facility, and sent to the vegetation pond. During storms, river water is taken into the retention pond, and sent to the vegetation pond after 12-hour sedimentation in the retention pond.

When both 5.0 mm/h of rainfall intensity and 20 NTU of turbidity are observed simultaneously, the retention pond begins to take river water until full. Clear water at the top layer in the retention pond after 12 hours sedimentation of solid pollutants is discharged to the vegetation pond (Figure 1). Surveys on both inflow and outflow water of the retention pond were taken during storms between April 2008 and December 2010. The retention pond operated for 34 storms during the period, and 13 of the 34 storms were surveyed (Table 1).

At the surveys, a water level gauge and a turbidity meter were installed and automatically recorded data in the retention pond. In addition, the inflow water was collected at 20-minute intervals for 8 hours, at a retention pond inlet. The outflow water was collected at 1-hour intervals for 24 hours. The collected samples were combined in proportion to the inflow/outflow water volume (i.e. flow rate). SS, TN, DN, TP, DP and PAHs measured.

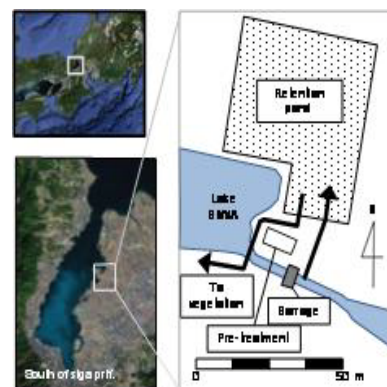


Figure 1 Outline of Moriyama River Water Treatment

Table1 Summary of surveys on inflow/outflow water to/from a stormwater retention pond (13 events).

	Precipitation		Water volume		SS		TN		TP		2-3rings PAHs		4rings PAHs		5-6rings PAHs	
	mm		km ³		mg/L		mg/L		mg/L		ng/L		ng/L		ng/L	
	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.
inflow					6.62	701	1.16	10.23	0.09	1.70	3.1	730	0.70	1045	1.42	1014.0
outflow	13.0	57.0	12.2	21.4	1.70	48	0.30	4.85	0.05	0.86	1.3	268	0.37	183	1.82	39.5

Result and Discussion

Figure 2 shows a result of the survey at 14th November 2009. Pollutant concentration in the inflow and the outflow water fluctuated in response to the rainfall. SS and PP decrease in 3-5 hours from the beginning of the inflow down to the same level as the outflow water because of rainfall-stop and sedimentation. A similar tendency is shown for PN, while there is little difference between the inflow and the outflow water for TN. This means that it is difficult to expect an effective removal of soluble forms which occupy a large portion of TN. PAHs are classified into three types by the number of benzene rings, i.e. 2-3 rings, 4 rings and 5-6 rings. All types of PAHs show similar tendencies like other solid pollutants, but the PAHs concentrations are not stable.

Table 2 shows a mass balance of pollutants in the retention pond surveyed at 14th November 2009. In this table, a removal percentage is calculated as a ratio of a difference between total inflow and outflow loads to the total inflow loads. The removal percentages are not high enough because of early decrease in the inflow concentration. Figure 3 shows relationships between a peak concentration of the inflow water and outflow concentrations. The outflow concentrations are stable in a certain low level despite the difference in the peak inflow concentrations. Ratios of an average outflow concentration to a peak inflow concentration are 0.89% - 19.0% for the event with the highest peak inflow concentration and 26% - 68% for the lowest peak inflow concentration. This means that more effective removal effect can be expected for the event with relatively higher inflow concentrations. But PAHs have relatively lower removal effect comparing with other solid pollutants like SS, due to their particle sizes and physical properties.

Table 2 Mass balance of inflow/outflow pollutants at a survey (14th November 2009).

	SS	TN	TP	2-3rings PAHs	4rings PAHs	5-6rings PAHs
Total inflow loads (kg)	548	35.5	3.76	3.08	0.34	0.15
Total outflow loads (kg)	343	29.6	2.63	2.23	0.17	0.08
Removal ratio* (%)	37.5	16.6	30.2	27.6	49.5	44.6

*Removal ratio(%)=(total inflow loads - total outflow loads) / total inflow loads × 100

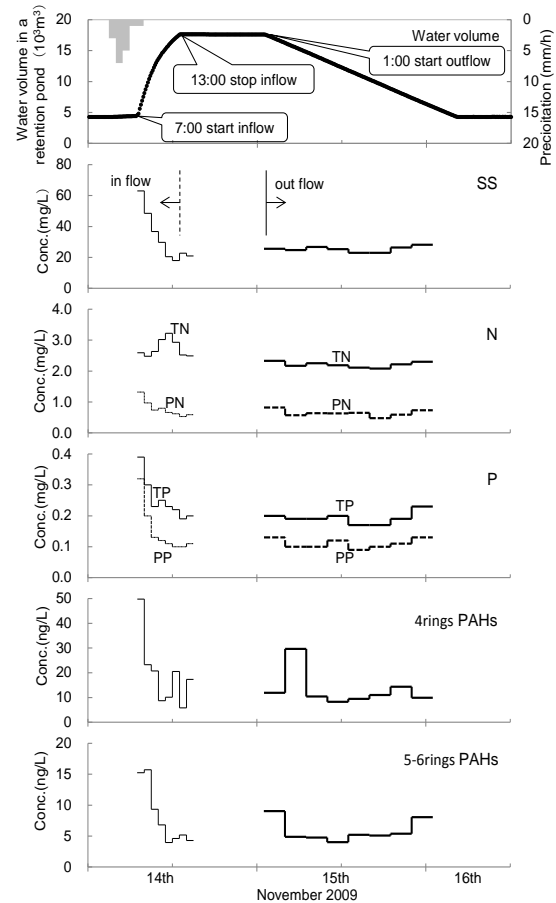


Figure 2 Results of a survey (14th November 2009)

The outflow concentrations are stable in a certain low level despite the difference in the peak

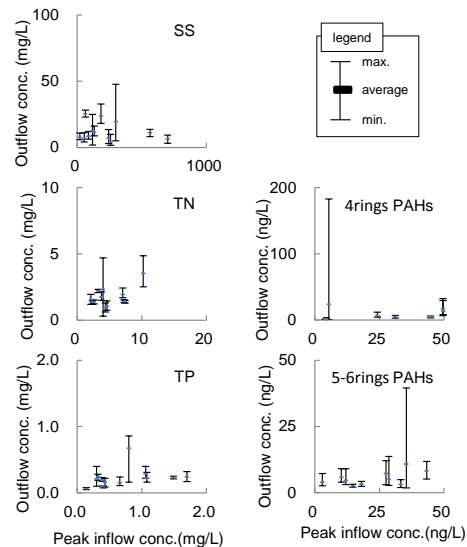


Figure 3 Relationships between peak inflow concentration and outflow concentrations.

Conclusions

Pollutant behaviour in the retention pond was surveyed during storm events and discussed in term of runoff control. In the results, some significant knowledge for the environmental management of runoff water has been obtained.

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