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Classification of CSO Outlets Based on Overflow Behavior under Different Rainfall Conditions

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1. Introduction

CSO happens 30-50 times every year in Tokyo, which impacts on water quality at coastal area of Tokyo Bay (Kojima et al., 2011). For the more effective countermeasures, it is necessary to comprehend and predict the CSO behaviors. However, there are few studies which investigate the detailed behaviors of CSO at various outlets in a draiange area and evaluate effect of rainfall characteristics on CSO occurance, though previous study used rainfall volume to predict CSO discharge (Schroeder et al., 2011). The objectives of present study are 1) to conduct simulation to obtain CSO behaviors and to categorize outlets based on the CSO behaviors, and 2) to categorize rainfall events by rainfall parameters and CSO behaviors respectively to demonstrate possiblility of predicting different types of CSO behaviors by rainfall characteristics.

2. Materials and methods

The study area is the Shingasi drainage area in Tokyo. The CSO occurrence and its behaviors at each outlet were simulated by InfoWorks CS (Version 10.0) with employing 117 rainfall events data recorded in 2007. The 67 outlets were categorized by the cluster analysis based on volume, frequency, duration time, and responding time of CSO overflow, which were considered as CSO characteristic parameters. These CSO parameter data were obtained by the whole year simulation. The 117 rainfall events were categorized by two ways. One is based on rainfall parameters and another is on CSO characteristic parameters obtained by simulation respectively. Rainfall parameters were rainfall volume, hourly maximum intensity and duration time. CSO characteristic parameters on basis of each event were total overflow volume of whole drainage area, number of outlets discharging overflow, average responding time and average duration time of overflow.

Similarity index was applied to compare the similarity between the two categorizations of rainfall events. The formula is shown as below:

$$SI = 2N / (N1+N2)$$

where SI is the similarity index, N is the number of rainfall events shared in two groups, N1 is the number of rainfall events in group categorized by rainfall parameters and N2 is the number of rainfall events in group categorized by CSO parameters.

3. Results and discussion

The 117 rainfall events were simulated to obtain the CSO characteristic parameter. The one outlet discharged the largest overflow volume (about 1,766,000 m^3/year), which accounted for more than 25% of annual overflow volume in the Shingashi drainage area. The 67 outlets were separated into six groups (G1-G6) with significant features (Fig. 1). The outlets in G2 didn't discharge CSO even if it rained heavily. It was found that the G3, G4 and G5 indicated larger overflow volume, but they were separated by overflow frequency.

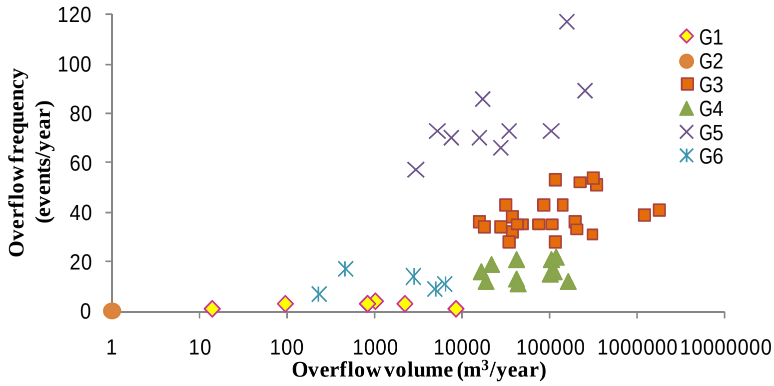

Fig. 1 The relationship between overflow volume and overflow frequency for each group categorized by four CSO characteristic parameters

The 117 Rainfall events were categorized into nine rainfall groups (RG1-RG9) by rainfall parameters and ten groups (RG1*-RG10*) by CSO characteristic parameters. Table1 shows the similarity index of the two categorizations. The group pair of RG3-RG4*, which were minor rainfall events, has strong correlation with high similarity index value (0.75). Also, the group pairs of RG7- RG8*, RG8-RG9* and RG9-RG10*, which were extreme rainfall events, have strong correlations with the similarity index value more than 0.75.

Table 1 Similarity index of two groups from two categorizations with rainfall and CSO characteristic parameters

	RG1	RG2	RG3	RG4	RG5	RG6	RG7	RG8	RG9
RG1*	0.00	0.00	0.00	0.22	0.00	0.13	0.00	0.00	0.00
RG2*	0.17	0.21	0.00	0.00	0.00	0.05	0.00	0.00	0.00
RG3*	0.00	0.47	0.14	0.00	0.00	0.00	0.00	0.00	0.00
RG4*	0.00	0.02	0.75	0.00	0.00	0.00	0.00	0.00	0.00
RG5*	0.45	0.00	0.04	0.20	0.00	0.03	0.00	0.00	0.00
RG6*	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00
RG7*	0.00	0.00	0.00	0.00	0.11	0.53	0.00	0.00	0.00
RG8*	0.00	0.00	0.00	0.10	0.00	0.00	0.75	0.00	0.00
RG9*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
RG10*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00

4. Conclusions

In this study, the 117 rainfall events were simulated to obtain the CSO characteristic parameter and all outlets were categorized by CSO characteristics parameter. The results shows the most contributed outlets and implies priority of control for outlets. The rainfall events were categorized by rainfall parameters and by corresponding CSO cahracteristics parameter respectively. Similarity comparisons of two categorizations indicated that small and extreme rainfall events have strong correlations to CSO behaviors, which illustrates that it is possible to predict different types of CSO behaviors by different rainfall conditions.

5. References

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