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

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Introduction

Background and aim

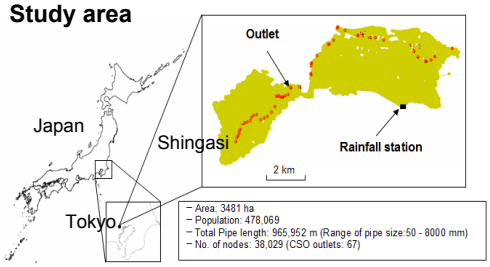
CSO impacts water quality on coastal area of Tokyo Bay during wet weather. We aim to classify and predict the CSO behaviors for the more effective countermeasures in future

Objectives

1) to simulate CSO behavior
2) to classify outlets based on CSO behavior
3) to classify rainfall events based on rainfall characteristics and CSO behavior respectively, so that demonstrate possibility of predicting CSO behavior by rainfall characteristics

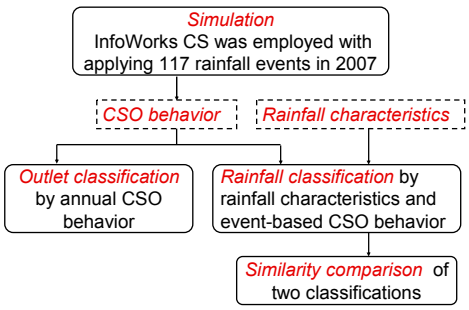
Study Area and Methods

Study area



- Shingasi drainage area has 67 Outlets spilling 30-50 CSO every year
- Impervious rate is 71%, indicating high possibility of CSO

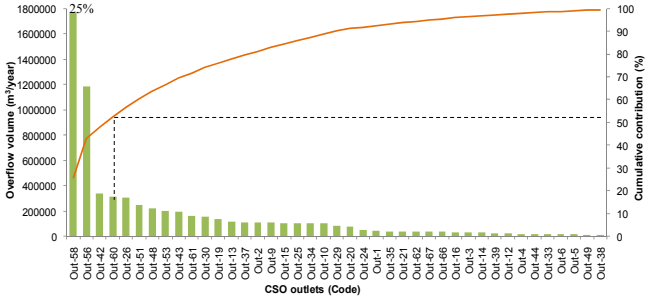
Methods



- CSO behavior: volume, frequency (No. of outlets with overflow), duration time, and responding time
- Rainfall characteristics: volume, intensity, duration time
- Classification method: cluster analysis
- Similarity comparison: similarity index

Results and Discussion

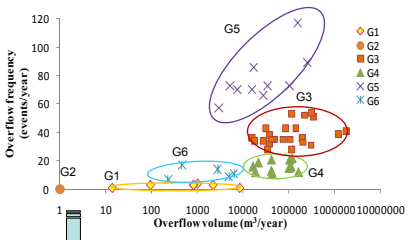
Annual CSO volume of each outlet



Annual overflow volume of each outlet ranking in descending order and cumulative contribution to annual overflow volume of the Shingashi drainage area, 2007

- Outlet-58 discharged the largest volume (about 1,766,000 m³/year) accounting for about 25% of annual discharge of whole drainage area
- Top four outlets contributed more than 50% of annual discharge

Outlet classification



- Figure shows overflow volume vs. overflow frequency
- Six groups (G1-G6) were well separated with significant features
- G2 didn't discharge CSO even if it rained heavily

Group	No. of outlets	Average ± Standard deviation			
		Annual volume (m³)	*Annual Frequency*	*Annual responding time (min)*	*Annual duration time (min)*
G1	7	1887±2910	3±1	189±152	81±53
G2	11	0	0	0	0
G3	23	2E5±4E5	39±8	5898±1500	8552±3946
G4	11	7E4±5E4	16±4	2938±1070	2856±668
G5	10	6E4±8E4	77±17	5289±2535	22659±4200
G6	5	2930±2672	12±4	1688±596	1845±907
Total	67				

- G3 has highest volume and duration time and G5 has highest frequency, which should be given control priority
- It is meaningful to study impacts from drainage area and network on CSO behavior

Rainfall classification

<Two classifications>

- Nine rainfall groups (RG1-RG9) were classified by parameters of rainfall characteristics and ten groups (RG1*-RG10*) were classified by parameters of CSO behavior

<Similarity comparison>

Similarity index of two groups from two categorizations by rainfall characteristics and CSO behavior

	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**

- High SI value means high similarity
- Four group pairs have SI values more than 0.75

SI = 2N / (N1+N2)
SI: similarity index; N: number of rainfall events shared in two groups;
N1 and N2: number of rainfall events in two groups

- Group pair of RG3-RG*4 shared 43 same rainfall events which are small rainfall and induced CSO with low total overflow volume (about 30 m³)
- Group pairs of RG7- RG8*, RG8-RG9* and RG9-RG10* are extreme events inducing high volume of CSO

Conclusions

- High volume and frequency outlet groups imply priority control for outlets
- Small and extreme rainfall events (about half of annual rainfall events) have strong correlations with corresponding CSO behaviors, which demonstrates possibility of predicting different types of CSO behaviors by rainfall characteristics

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