Advanced estimation of CSO occurrence and overflow volume from outfall chambers and pumping stations in Tokyo

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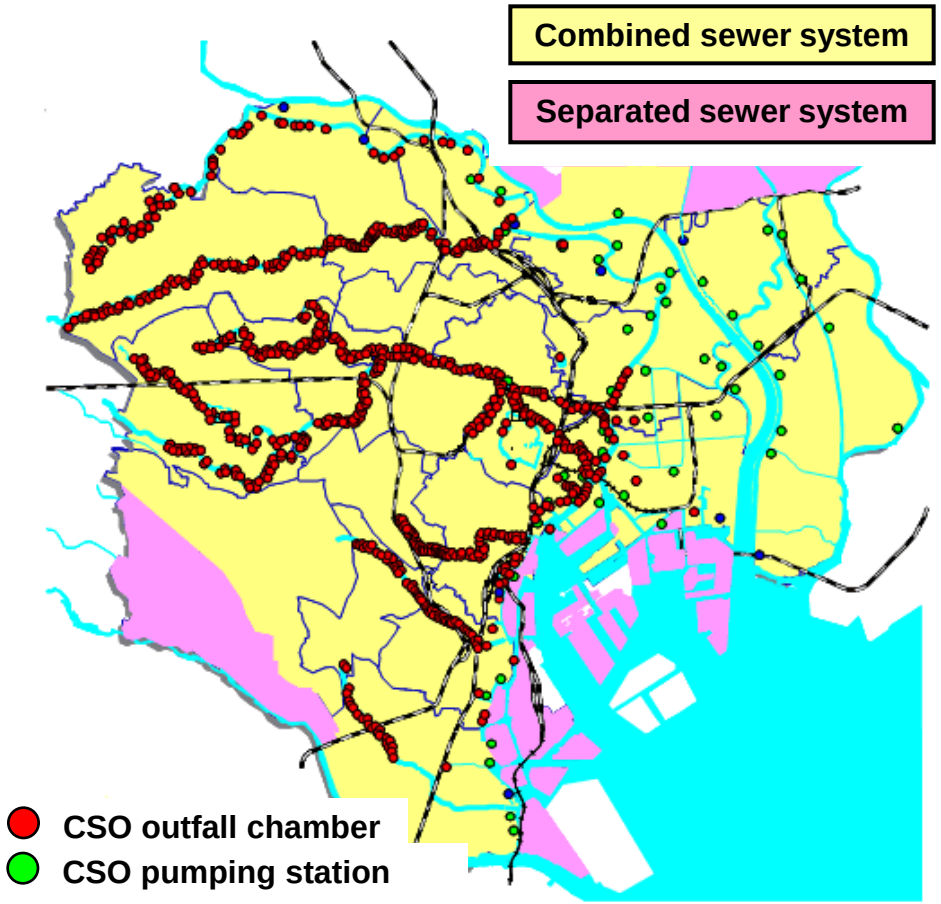
SHIMIZU CORPORATION 清水建設

東京大学 THE UNIVERSITY OF TOKYO

The 9th International Conference on Urban Drainage Modelling
Belgrade, Serbia, 4-6 September 2012

Background (Current situation of CSO problems in Tokyo)

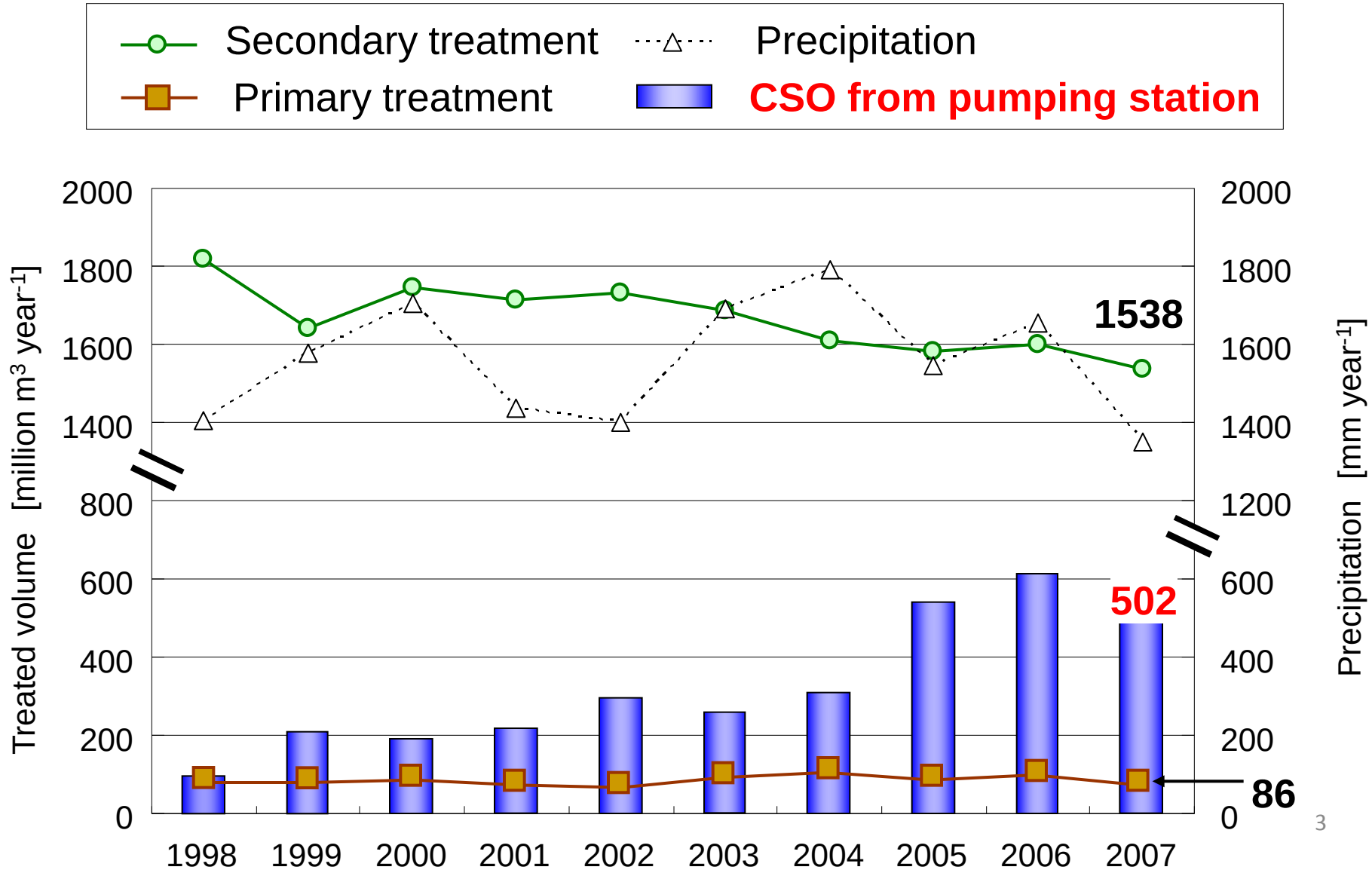
- In receiving waters, there is concern about Combined Sewer Overflow (CSO) impact on health risk and hygiene issue at water front with water amenity activities



Ref. Ministry of Land, Infrastructure and Transport

- CSO events in Tokyo: about 30 times per year
- BOD loading by CSO accounts for about 40% of total loading on receiving water
- In Tokyo, there are about 800 CSO outfall chambers and many pumping stations along urban rivers and in the coastal area.

Background (Report of CSO volume in Tokyo)



Background (To improve the CSO countermeasure)

- In order to reduce the amount of CSO effectively, it is expected to carry out the countermeasures considering the CSO from outfall chambers as well as pumping stations.

  However, overflows situation from outfall chambers is not fully-comprehended.

- It is difficult to comprehend the situation of whole outfall chambers only by monitoring when the drainage area is so large and complex such as Tokyo 23 wards.

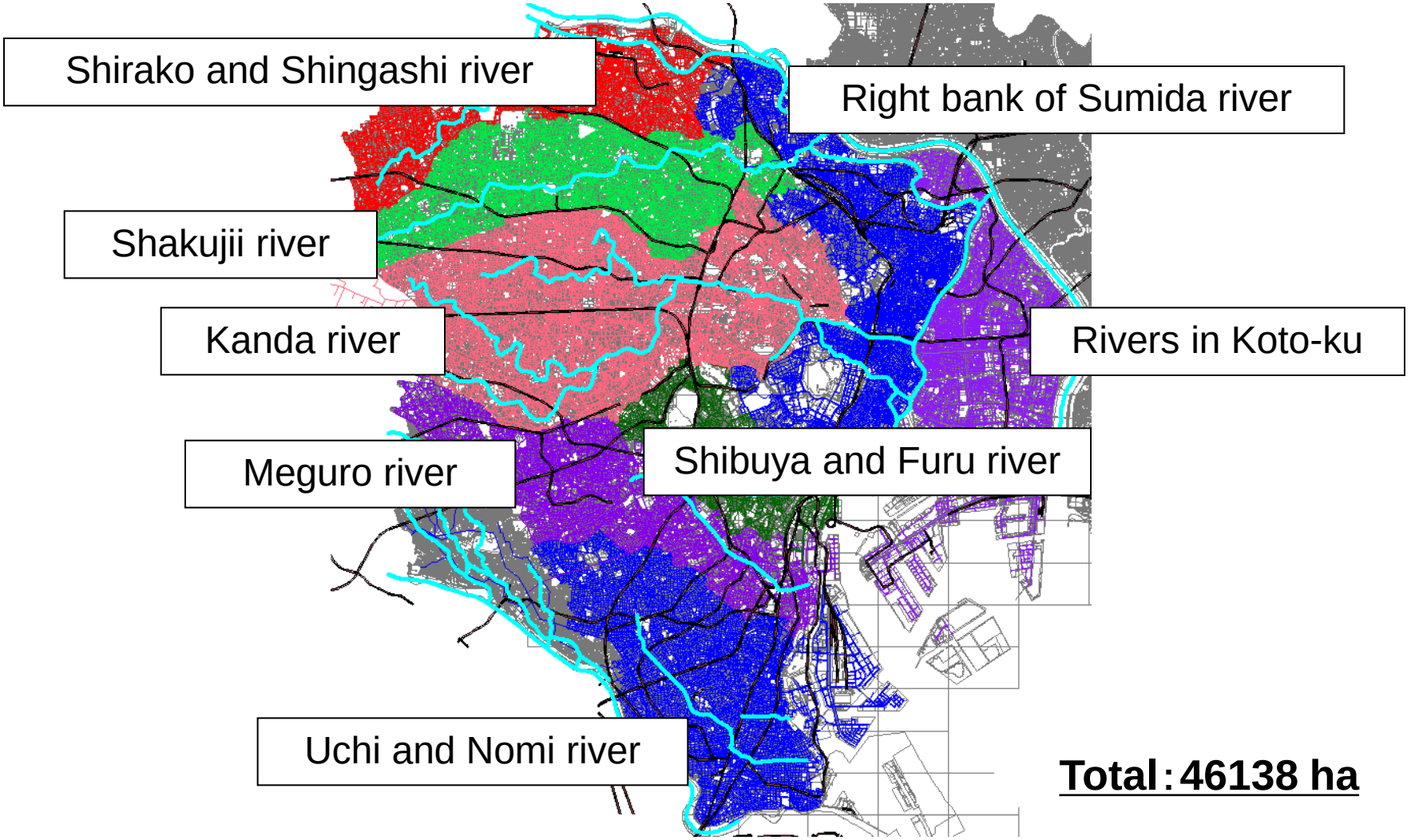
  The model simulation is more useful to comprehend the overflow volume and its occurrence time at each outfall chamber.

Objective

- **To calculate the CSO volume from outfall chambers and pumping stations.**

1. **Calibrate the runoff model simulation by observed data**
2. **Check the sensitivity of parameters and the effect of rainfall condition on model output.**
3. **Apply the calibrated model simulation to drainage systems of whole Tokyo 23 wards**

Simulation conditions (study area)



Total：46138 ha

Simulation conditions (The number of outfall chamber and pumping station)

Drainage area	Area（ha)	The number of outfall chamber	The number of pumping station
Kanda river	9,438	334	1
Shakujii river	4,812	154	0
Right bank of Sumida river	5,744	94	20
Shibuya and Furu river	2,678	81	1
Meguro river	4,824	66	2
Shirako and Shingashi river	3,481	62	5
Uchi and Nomi river	9,900	27	6
Rivers in Koto-ku	5,261	10	9
Total	**46,138**	**828**	**44**

[SEMIS data in 2009]

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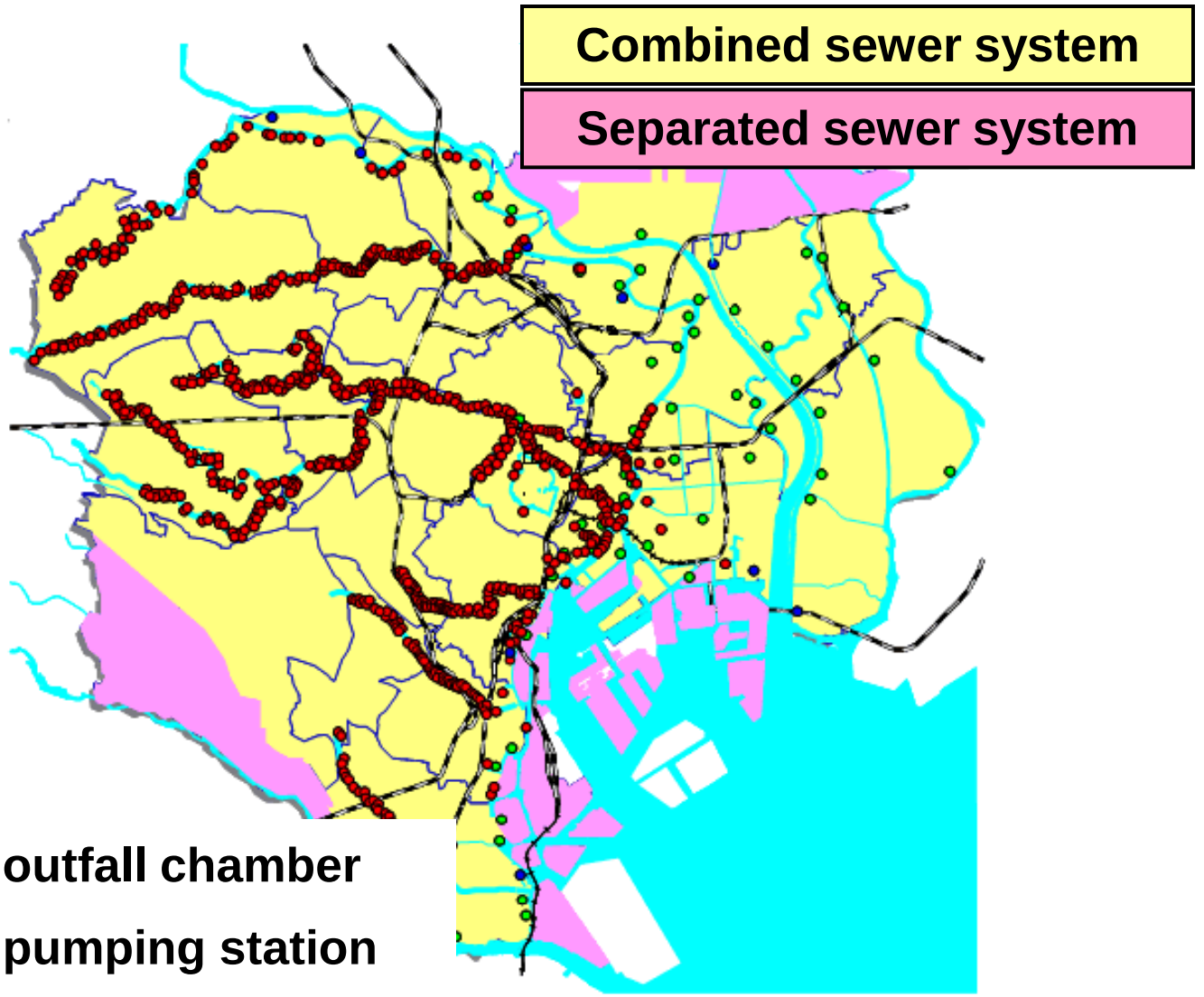

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Simulation conditions (Basic data)

- **The sewer pipes and networks data**

  SEMIS(SEwerage Mapping and Information System) data served by Tokyo Metropolitan Government

- **Land-use type data**

  Surface data were classified 8 types surfaces

- **Rainfall data**

  Rainfall distribution condition was considered using rainfall data by 56 precipitation stations

Simulation conditions (Basic data)

The sewer pipes and networks data

SEMIS(SEwerage Mapping and Information System) data served by Tokyo Metropolitan Government

Land-use type data

Surface data were classified 8 types surfaces

Rainfall data

Rainfall distribution condition was considered using rainfall data by 56 precipitation stations

Simulation conditions (Land-use type data)

- **Street level information about land-use type were served by Tokyo Metropolitan Government**

  ⇒ The distribution of land-use type is given runoff model parameters for each manhole catchment.

- **Impervious**

  Roof, Road, water surface, Impervious vacant space

- **Pervious**

  Railway, Green zoon, Crop and paddy, Pervious vacant space

Simulation conditions (Basic data)

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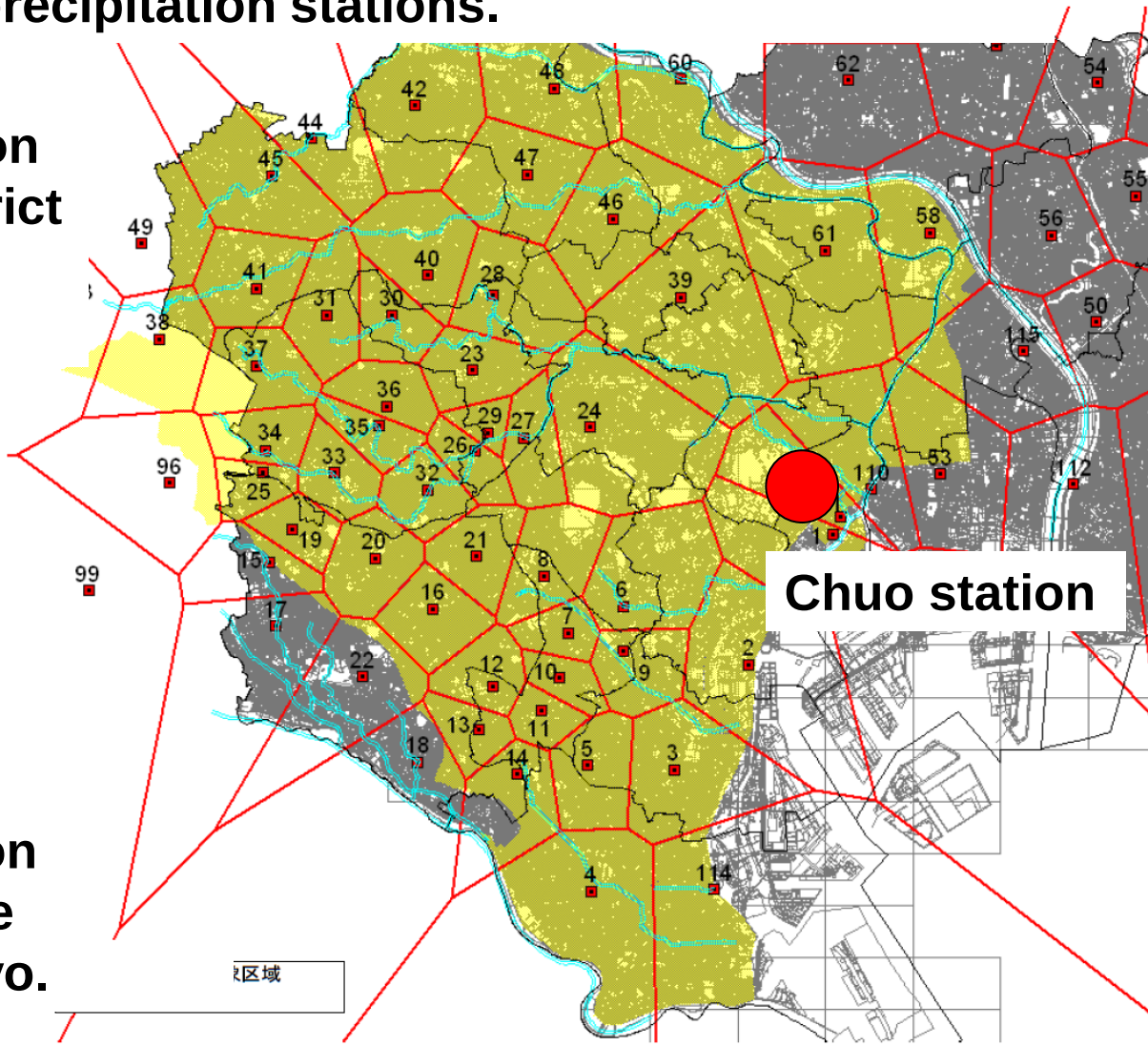
Simulation conditions (Rainfall data)

- Rainfall distribution condition was considered using rainfall monitoring data at 56 precipitation stations.
- Each rainfall information was given to each district subdivided by the Tiessen method.
- The data at Chuo station is one of representative weather station in Tokyo.



Simulation conditions (Runoff analysis)

Distributed model, InfoWorks CS (Version 10.0)

- **Initial loss**

  Road, Impervious vacant space ⇒ 2 mm

  Railway, Pervious vacant space, Green zoon, Crop and paddy ⇒ 6 mm

- **Horton model for pervious area**

Infiltration ability

	Initial infiltration rate [mm/hr]	Final infiltration rate [mm/hr]	Decay constant [1/hr]
Railway, Pervious vacant space	**10**	**1**	**1.8**
Green zoon, Crop and paddy	**50**	**2.5**	**1.8**

Results and discussions (Study point)

1. Calibration of runoff model simulation by observed data
2. The sensitivity of parameters
3. The effect of rainfall distribution
4. Calculation of CSO volume from outfall chambers and pumping stations.
5. Characteristics of drainage area about CSO volume from outfall chambers

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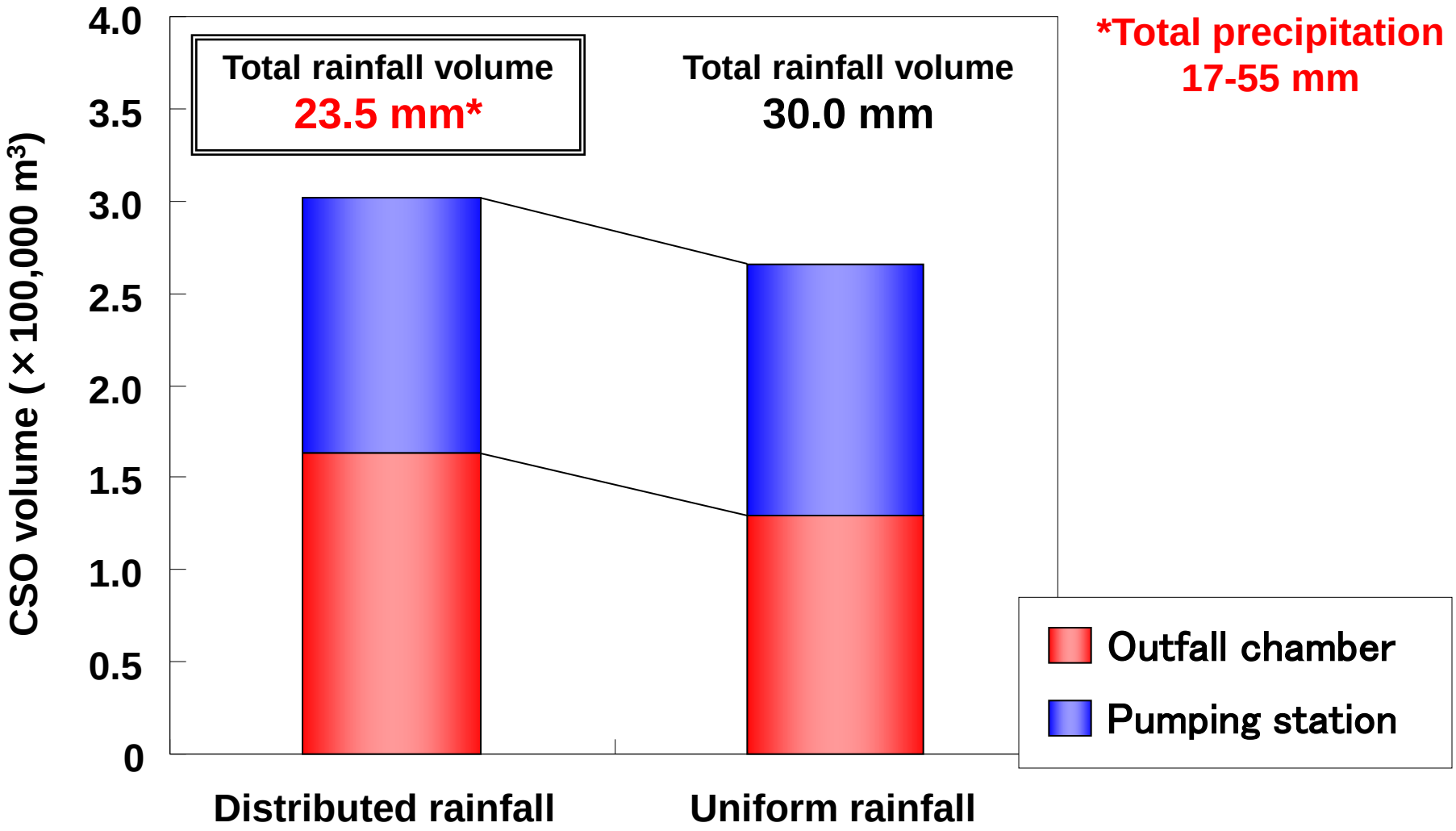
Results and discussions (The effect of rainfall distribution)

- Comparing the results using distributed rainfall data and uniform rainfall data (10-11, November, 2007)



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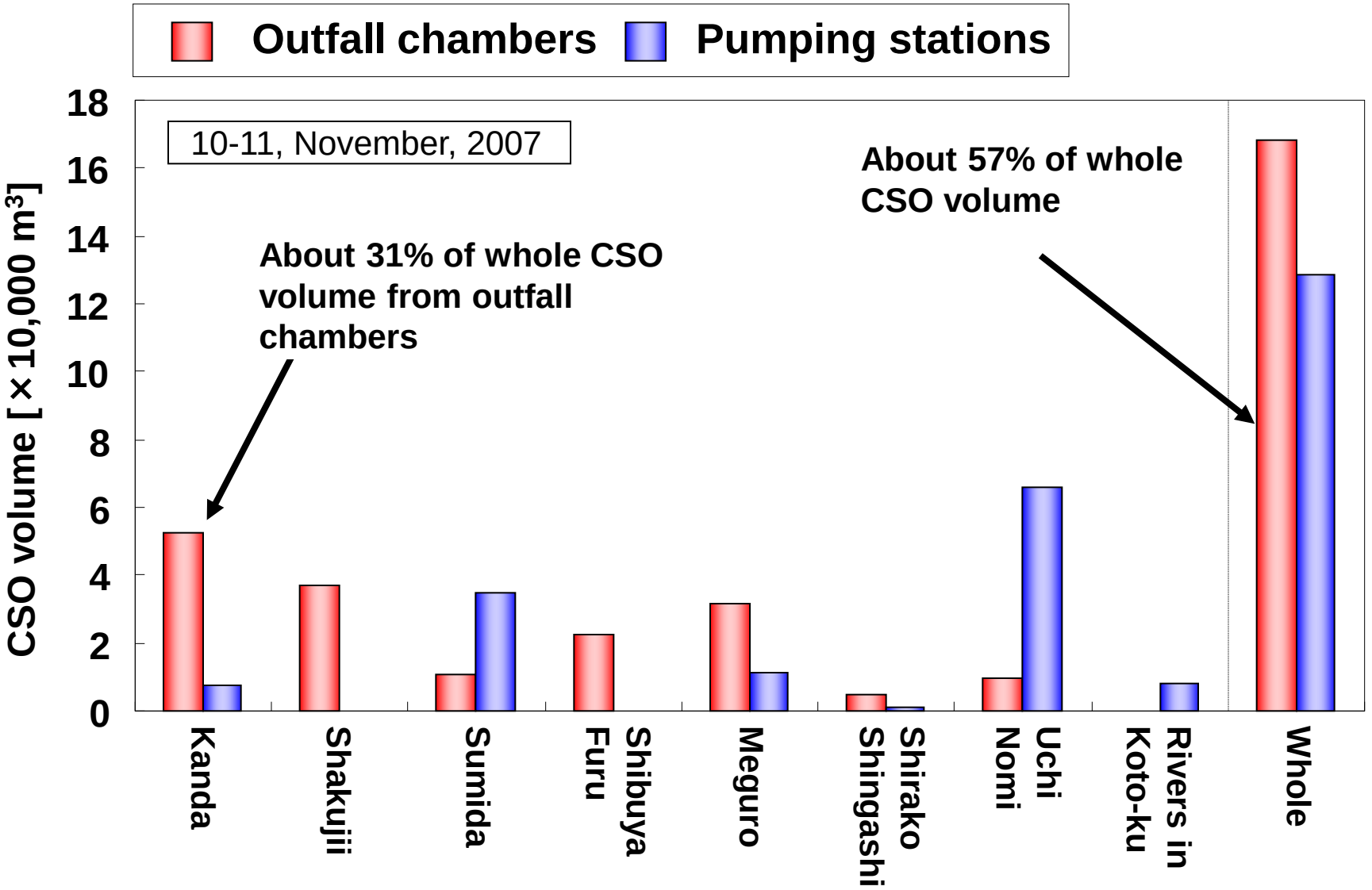
Results and discussions (Calculation of CSO volume)



Total precipitation: 17-55 mm, Intensity: 1-9 mm/5 min

Results and discussions (Study point)

1. Calibration of runoff model simulation by observed data
2. The sensitivity of parameters
3. The effect of rainfall distribution
4. Calculation of CSO volume from outfall chambers and pumping stations.
5. **Characteristics of drainage area about CSO volume from outfall chambers**

Results and discussions (Characteristics of drainage area)

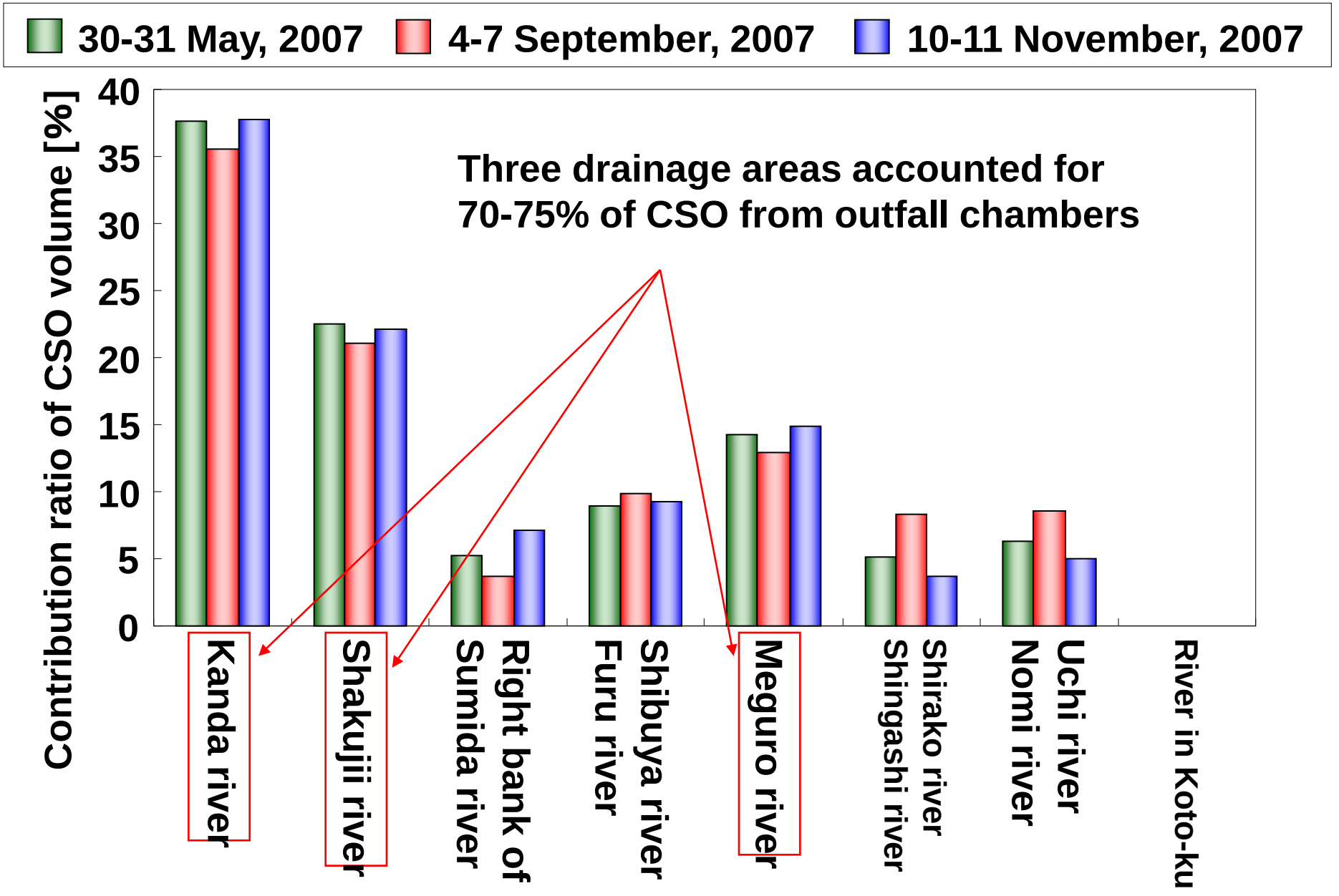
- Using uniform rainfall data to estimate the characteristics of drainage area from the viewpoints of CSO volume.
- Three rainfall data at Chuo station were applied
  - 30-31 May, 2007

    Total precipitation: 22 mm, Intensity: 2 mm/5 min
  - 4-7 September, 2007

    Total precipitation: 140 mm, Intensity: 5 mm/5 min
  - 10-11 November, 2007

    Total precipitation: 30 mm, Intensity: 3 mm/5 min

Results and discussions (Characteristics of drainage area)



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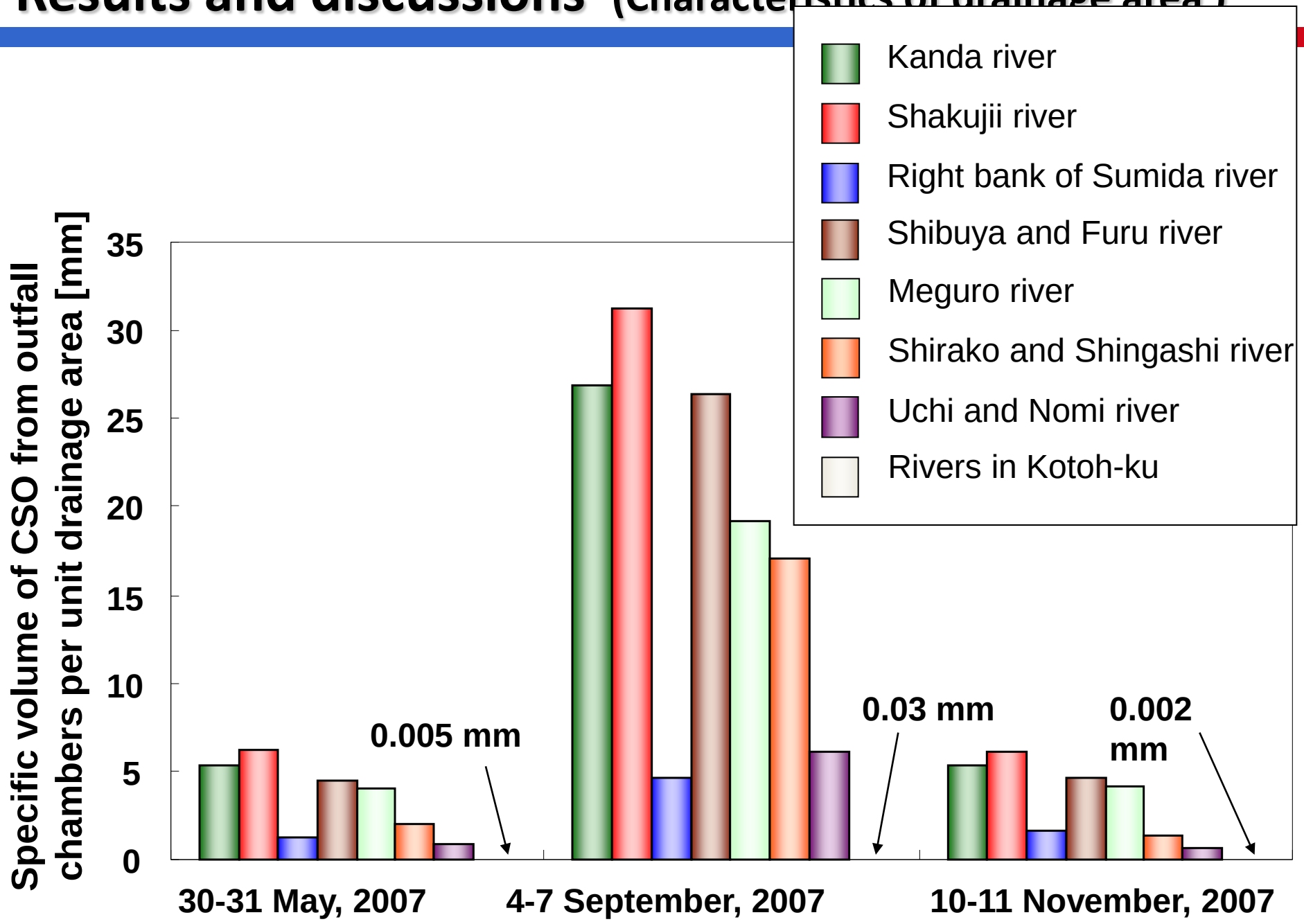


Conclusions and outlooks

- The simulation results showed that outfall chambers are non-negligible for CSO control as well as pumping stations.

- By using uniform rainfall data, the CSO volume from outfall chambers per unit by drainage area suggested that it is effective to carry out countermeasure for outfall chambers in Shakujii river drainage area.

- However, this study discussed only CSO volume, not water qualities.

  We should improve the model simulation with water quality.

Thank you for your attention

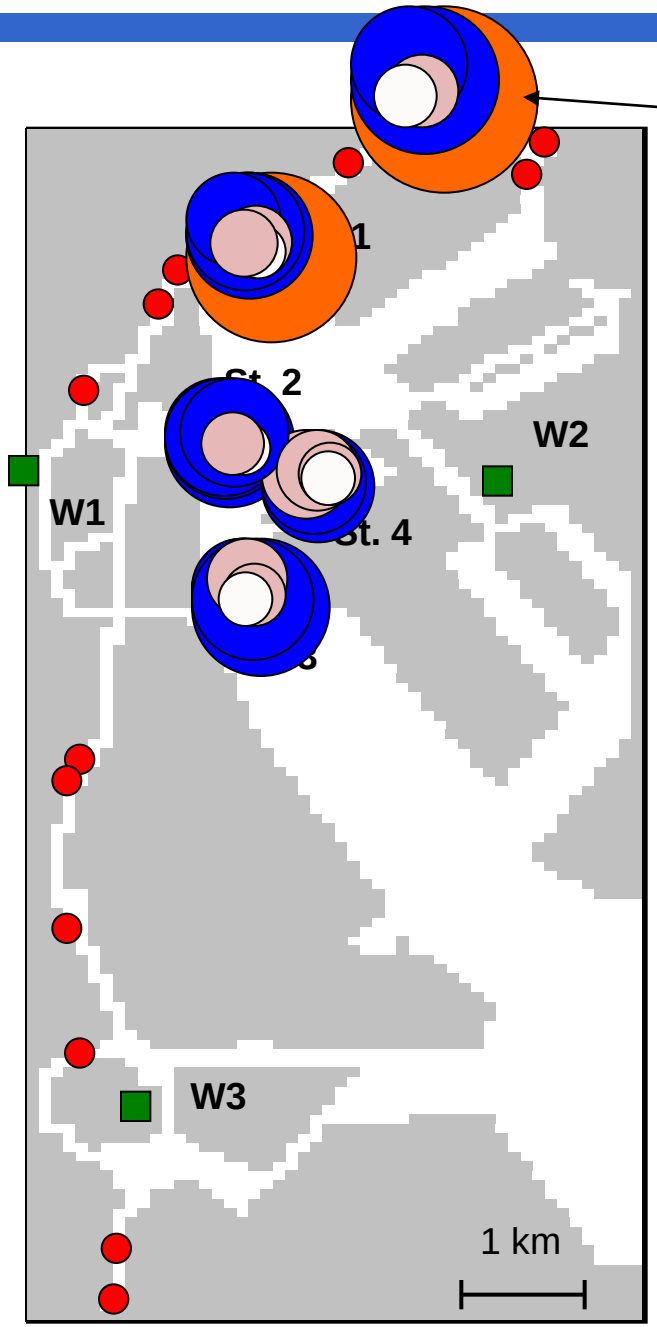
Distribution of E. coli concentration (Surface water)

11 November (Ebb tide)

14 November (Ebb tide)

21 November (Flood tide)

28 November (Ebb tide)

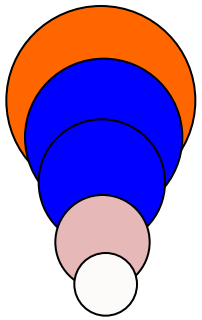


Sumida river inflow point

Sewage pumping station

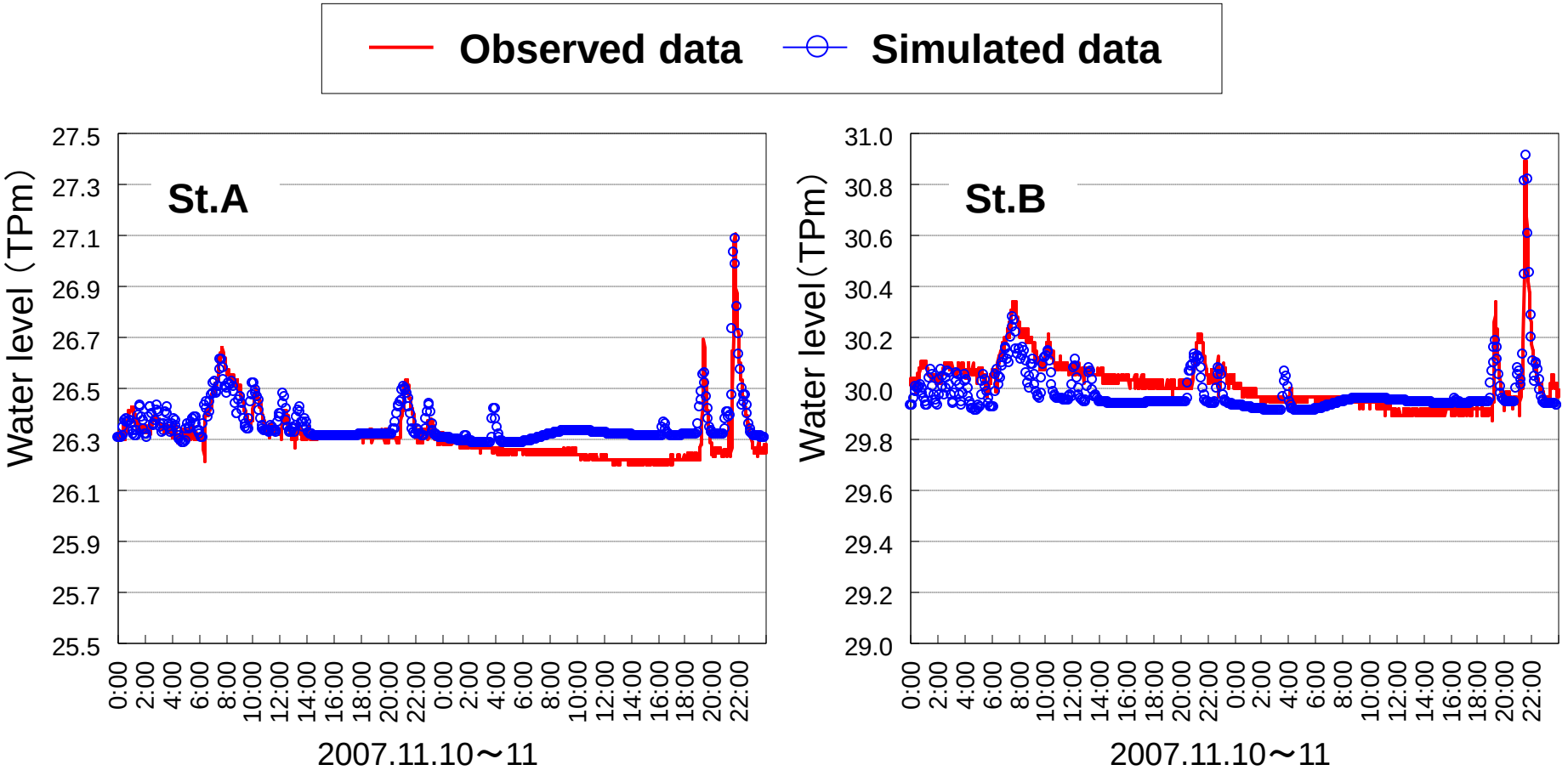
WWTP (Waste Water Treatment Plant)

Monitoring station



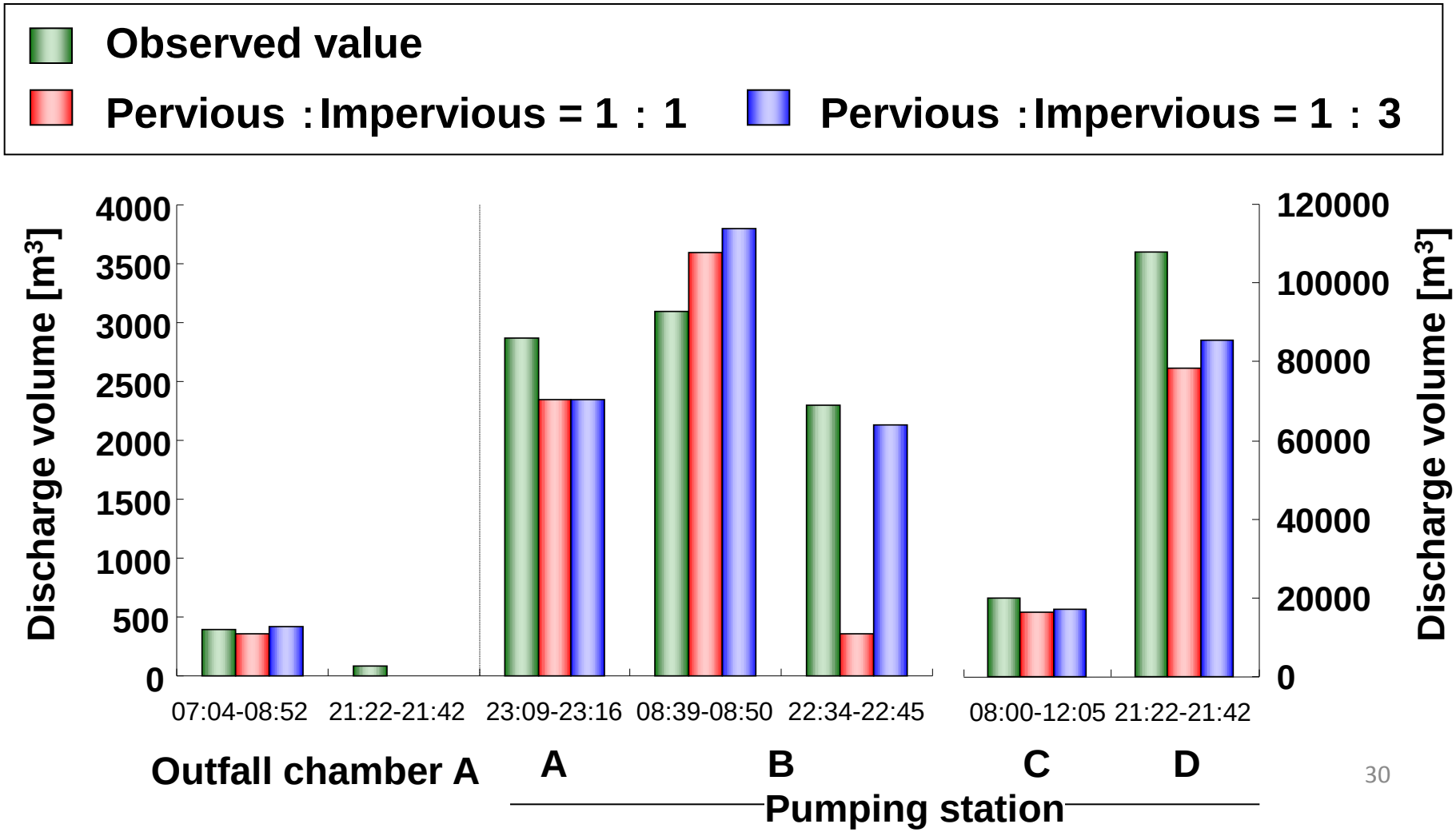
1.0×10^6
1.0×10^5
1.0×10^4
1.0×10^3
1.0×10^2
[CFU $100mL^{-1}$]

Results and discussions (Calibration)



Results and discussions (Calibration)

- Comparing the ratio of pervious vacant space to impervious vacant space



Total precipitation: 17-55 mm

Results and discussions (The sensitivity of parameters)

The case changing initial loss

Road, Impervious vacant space ⇒ 2 mm

Railway, Pervious vacant space, Green zoon, Crop and paddy ⇒ 6 mm

⇒ 0 mm

The case changing infiltration ability

	Initial infiltration rate [mm/hr]	Final infiltration rate [mm/hr]	Decay constant [1/hr]
Railway, Pervious vacant space	**10**	**1**	**1.8**
Green zoon, Crop and paddy	**50**	**2.5**	**1.8**
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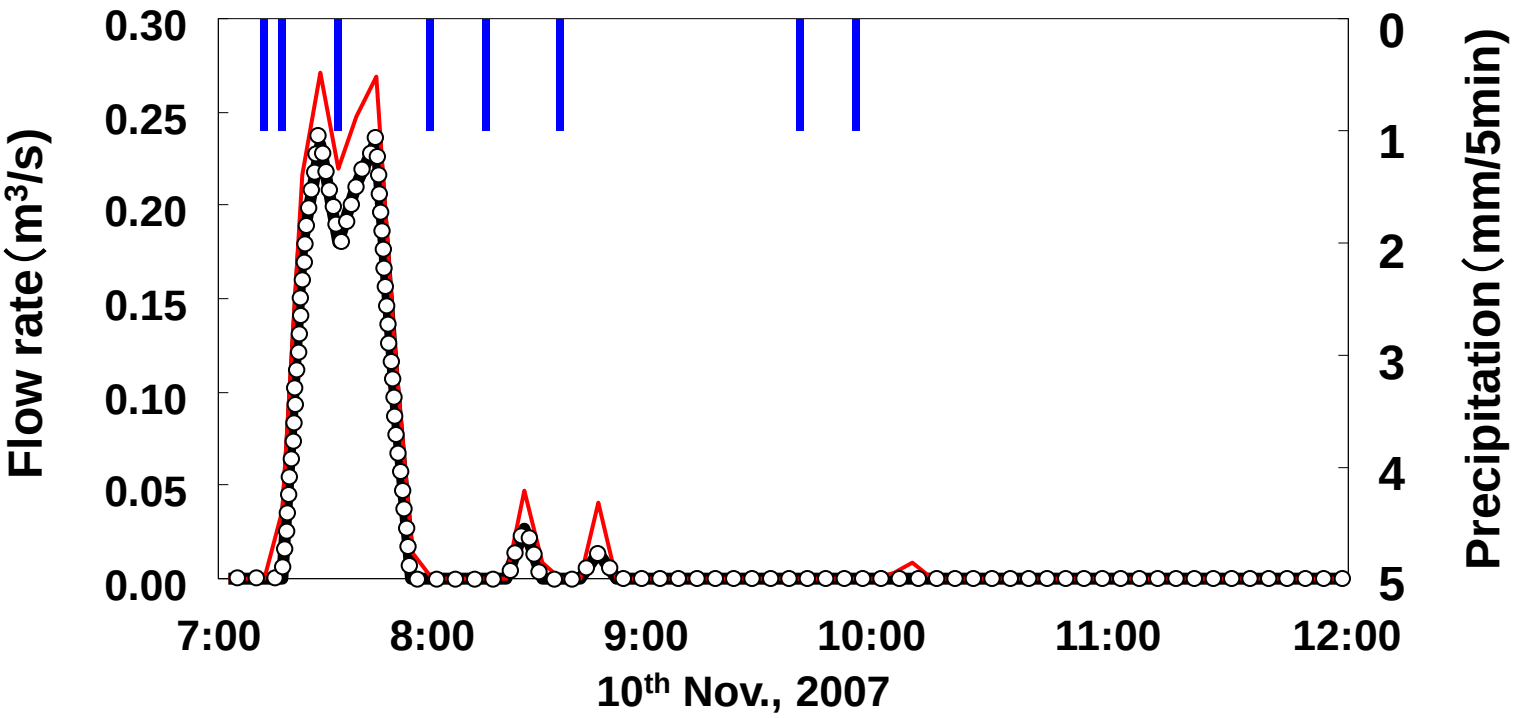

	Observed value	Basic case	The case changing initial loss	The case changing infiltration ability
CSO volume (m^3)	397	353	**360**	**449**