Evaluation of CSO Impact on Receiving Water Quality in Tokyo Coastal Waters

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Introduction

Combined sewer overflow (CSO), which contain not only stromwater but also untreated wastewater containing pathogens and toxic compounds, is a major water pollution concern for large cities in Japan. Coastal area is important for water-amenity space for urban citizens. Urban coastal environment should be conserved for recreational purpose as well as natural environment. Monitoring data is essential to understand the impact of the CSO to the water-amenity area. However, there have been limited research on integration of CSO monitoring and numerical simulation to investigate the impact of CSO on coastal area. Numerical model of *Escherichia coliform* (*E. coli*) is helpful to discuss the pathogenic pollution. Model analysis can also suggest to identify the locations of critical pollutant source and to explore effective countermeasures to reduce the CSO impact. An extensive monitoring was conducted on *E. coli* distribution at a coastal region in Tokyo Bay after a CSO event by longitudinal and vertical samplings along the river inflow streamline. In order to evaluate the spatial and temporal pathogenic pollution quantitatively, the numerical model describing the fate of *E.coli.* derived from CSO as the pathogenic indicator was calibrated.

Materials and methods

Figure 1 shows the model calculating area and locations of pump stations, waste water treatment plants and monitoring stations. Water sampling was conducted at 4 stations (St.1-4) at 7 times, which were on Nov. 11th(ebb and flood tide), 12th(ebb and flood tide), 14th(ebb tide), 21st(flood tide) and 28th(flood and ebb tide), 2007. About 27 mm of precipitation (3.5 mm of maximum hourly precipitation) was observed in the past 24 hours before the first sampling.

The model is composed of a 3-dimensional flow simulation model and water quality model for evaluating the fate of *E. coli*. The flow simulation model developed by Koibuchi and Sato (2010) was applied for this study, which was based on the sigma-coordinate system.

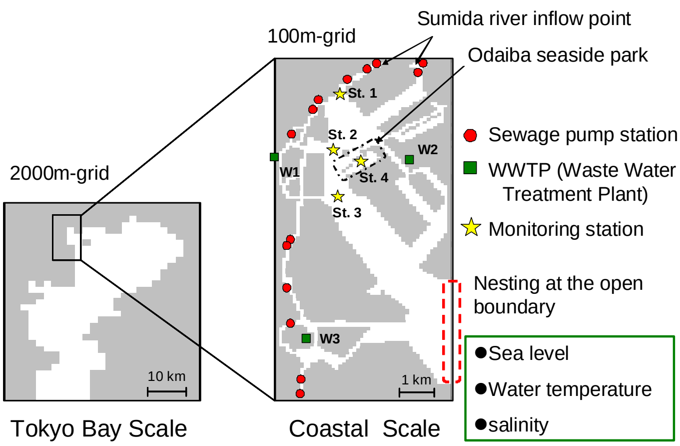

Figure 1 Model calculating area and locations of pump station, WWTP and monitoring station.

Results and discussion

At St. 1, the *E. coli* concentration decreased over time due to dilution with uncontaminated riverwater inflow. However, the *E. coli* concentration fluctuated at St. 2, 3, and 4. We can discern two types of temporal variation. One is variation between ebb and flood tides and another is movement of polluted water masses to downstream in the estuary area. At St. 2 on Nov. 11th, the *E. coli* concentration was lower during ebb tide than during flood tide. In contrast, the concentration was higher at ebb tide than flood tide at St. 3 on Nov.12th. During the sampling period of 24 hours from Nov. 11th and 12th, polluted water masses might move up and down from St. 1 and 2 and then reach to St. 3.

Analyzing the variation of *E. coli* concentration at St. 2 and 3, we can find two possible polluted water mass by CSO discharge. The primary mass with higher contamination was located from river inflow to St. 1 on Nov. 11th and the second mass with medium contamination seemed to stay around or between St. 2 and 3. There is one of the biggest WWTP (W1) and several pumping stations located in canal region which is connected with the coastal area including St. 2 and 3. As well as river inflow load receiving CSO discharge at upstream, there might be additional CSO loads by discharge of primary treated wastewater and from pumping stations in this region, which shows that these pollutant sources should be properly considered to conduct model simulation of *E. coli* behavior in the coastal area.

At all stations, simulation results overestimated the *E. coli* concentration in surface water during several days after the rainfall event except for first sampling data at St. 1. The simulation results strongly reflected the river inflow condition. A possible reason was improper boundary condition of *E. coli* at river inflow point. However, the simulated *E. coli* concentrations for the bottom water were agreed well with the monitoring.

Conclusions

The extensive monitoring showed clear evidence of fecal pollution caused by the CSO at a seaside park as well as the river inflow streamline after a 27 mm rainfall event. Two types of temporal variations in the *E. coli* concentration in the coastal area were observed. One is variation between ebb and flood tides and another is downward movement of polluted water mass by river inflow. We found two possible polluted water mass by CSO discharge which were river inflow receiving CSO discharge at upstream and discharge of primary treated wastewater and from pumping stations in the coastal area.

Spatial and temporal changes of *E. coli* concentration were simulated using 3-dimensional water quality model. This simulation suggested that *E. coli* loading from the river can have a great impact with time lag in increase of *E. coli* concentration at the Odaiba seaside park as well as river inflow streamline. However, the simulation results overestimated the *E. coli* concentration in surface water during several days. Since the simulation results strongly reflected the river inflow condition, it is necessary to elaborate the input condition of pollutant load from river inflow so that sufficient model calibration could be achieved for *E. coli* behavior prediction in the coastal area.

References

Koibuchi and Sato (2010), cSUR-UT: Library for Sustainable Urban Regeneration Vol. 3, “Advanced Monitoring and Numerical Analysis of Coastal Water and Urban Air Environment”, Springer, Chapter 3, pp.33-69.