Research on Combined Sewer Overflow During and After Rainfall by Nagoya City

Whole term	2004.7～2006.3	

(Purpose)

In order to quantitatively grasp the pollutant load dispersion phenomenon resulting from the Combined Sewer Overflow (CSO) in outflow waters and the effects of the combined sewer system improvement measures on outflow waters, Nagoya City and the Japan Institute of Wastewater Engineering Technology have been conducting a monitoring study of outflow waters (rivers and seas), creating a pollutant dispersion simulation model, and implementing a quantitative assessment of the effects of the pollutant load dispersion analysis on the outflow waters using the simulation model and the combined sewer system improvement measures and so on from 2004 to 2008.

(Result)

(1) Simulation model (tidal rivers)

The simulation model for the pollutant load behavior was created based on the vertical Two-dimensional (longitudinal) Water Quality Concentration Balance Law, since the behavior of pollutants in tidal rivers is greatly affected by (1) influent and effluent water quantity and influent water quality, (2) the waterway shape, (3) temperature, (4) density distribution based on the salt concentration and chemical reactions, and (5) disturbances in riverbed sediments.

The analytic values from this model indicated high reproducibility compared to the observed values from the monitoring studies.

[Water Quality Concentration Balance Law in Vertical Two-dimensional Flow]

$$\frac{\partial C}{\partial t} = -\frac{1}{A}\left|CuB\right|_{X_i}^{X_{i+1}} - \frac{1}{A\cdot\Delta Z}\left|CwA\right|_{Z_n}^{Z_{n+1}} - \frac{1}{A\cdot\Delta Z}{}_b\,C_b q_b + \frac{1}{A}\left|D_{cx}\frac{\partial C}{\partial x}B\right|_{X_i}^{X_{i+1}} + \frac{1}{A\cdot\Delta Z}\left|D_{cz}\frac{\partial C}{\partial Z}A\right|_{Z_n}^{Z_{n+1}} - \frac{1}{A\cdot\Delta Z}\left|Cw_oA\right|_{Z_n}^{Z_{n+1}} + R$$

C : Water quality concentration (BOD, COD, DO, T-N, T-P, Coliform group count, etc.)
A : Horizontal cross-sectional area of cell
u, w : Flow rate constituents in x- and z- directions
ΔZ : Cell thickness
Dcx, Dcz : Coefficients of concentration diffusion in x- and z- directions
w0 : Precipitation speed
R : Production and consumption items of water quality concentration

(2) Analysis results

The pollutant quantity in the lower layer downstream of Tidal River A was estimated at approximately 51.9km^2 in the drainage area following analysis of the actual rainfall (Zero rainfall hours: 115.5 hrs, Total rainfall: 29.4 mm, Max. rainfall per hour: 3.5 mm) for a period of 18 days since the initial rainfall for the "current situation" and the "future (combined sewer system improvement measures + sophisticated sewage treatment)".

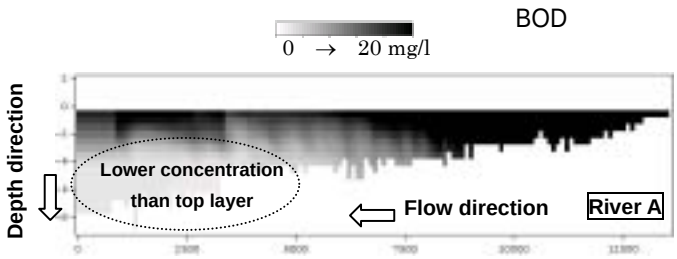
It was concluded that the pollutant load of BOD, COD, T-N, T-P and so on can be expected to decrease by 20 to 30% in the future.

On the other hand, pathogenic bacteria such as coliform, which are affected more than organic pollutants, can be expected to decrease by half. This analysis thus clarified the quantitative effects of this project through the combined sewer system improvement measures etc.

Moreover, the analysis made it clear that highly concentrated pollutants tend to accumulate in the upper layer of the river due to the halocline caused by the tide.

	Current Situation	Future
Overflow during/after rainfall	Direct discharge	6mm/ha accumulation
Intercepting rainwater	Deposit treatment	Enhancement of simplified treatment
Sewage during clear weather	Premium treatment	Advanced treatment A2O + Rapid filtration

	Current Situation	Future	
	Load	Load	Reduction Rate
BOD (kg)	1.95E + 05	1.28E + 05	34%
COD (kg)	1.69E + 05	1.25E + 05	26%
T-N (kg)	2.08E + 05	1.54E + 05	26%
T-P (kg)	1.13E + 04	9.04E + 03	20%
Coliform (MPN)	1.21E + 14	6.50E + 13	46%
Fecal coliform bacteria (MPN)	5.95E + 13	2.98E + 13	50%



(Summary)

Plans are being drafted to verify the effects of this project in all confluents in the city through the combined sewer system improvement measures and the sophisticated sewage treatment by modeling and analyzing outflow waters including seawaters.

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key words	Overflow during and after rainfall, Pollutant load, Tidal river, Diffusion runoff analysis