Estimation of Manganese Concentrations from Archived Raw Water Data in Small-scale Water Systems

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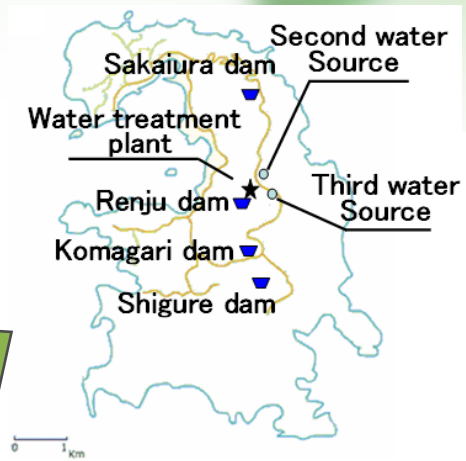
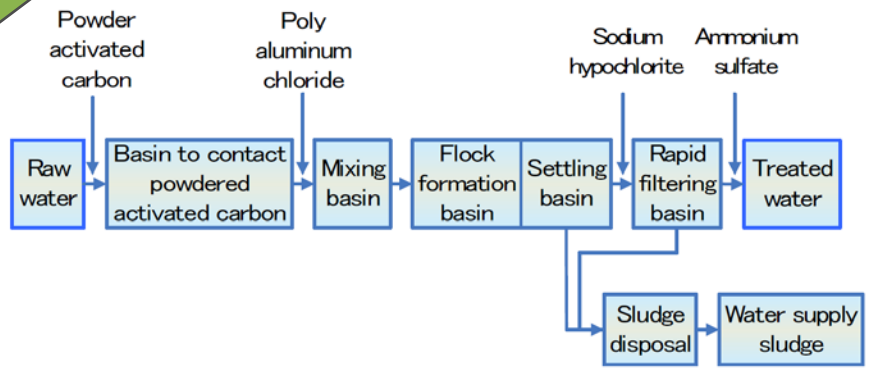
Introduction





Water quality of raw water

- high manganese concentration
- high TOC concentration
- high turbidity
- high chromaticity

Introduction

Inflow of high manganese concentration

- To cause chromaticity
- To cause tastes, odors by reacting with chlorine
- To cause black tint in the water

operating state of Water treatment plant

- When measurement of water quality is stable.
- The majority of water quality measurements are not conducted.

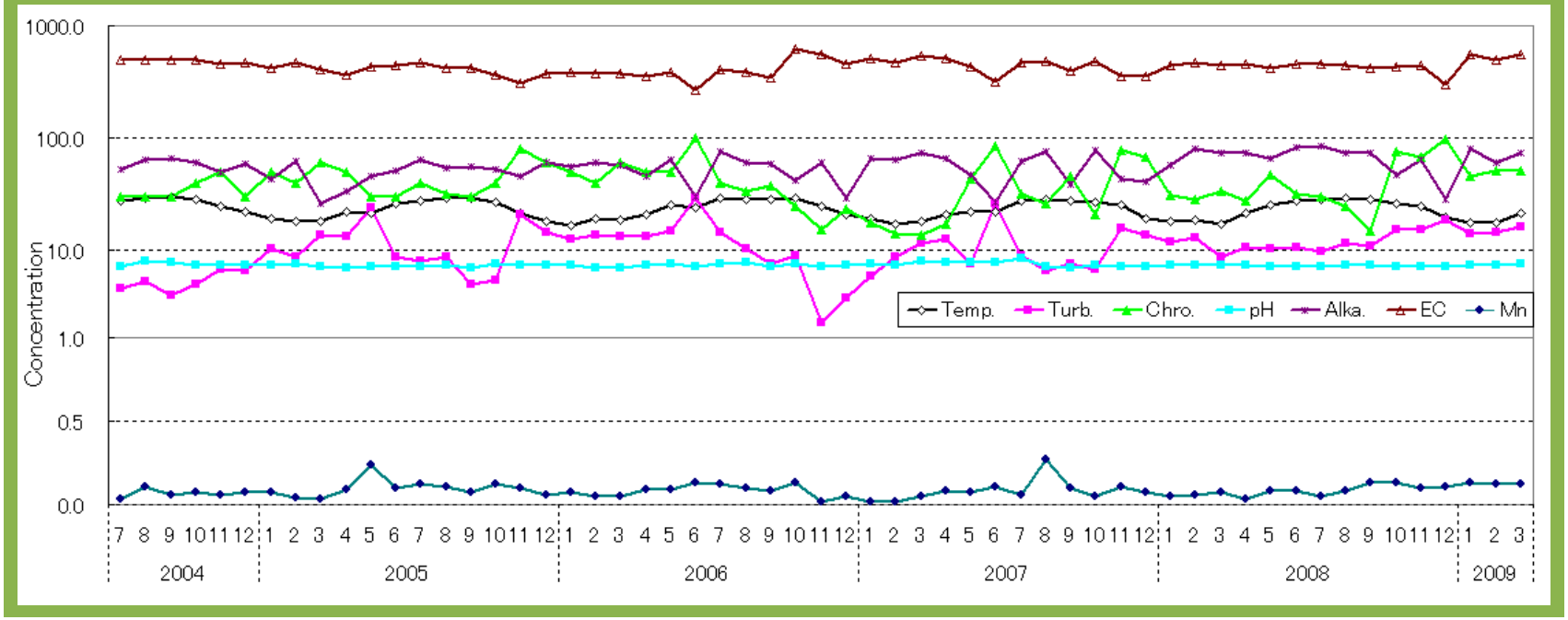
Therefore, deterioration of raw water quality such as Mn concentration are often uncertain

Objective

- To estimate concentration levels of manganese in raw water
- To provide a small-scale water system based on estimation result
- To establish the most appropriate manganese treatment system

Analysis method and data used

Monthly data of manganese and explanatory variables



Multiple regression analysis

$$\hat{y}_\alpha = b_0 + b_1 x_{\alpha 1} + b_2 x_{\alpha 2} + \cdots + b_p x_{\alpha p}$$

$$R = \frac{\sum_{\alpha=1}^{n} (y_\alpha - \bar{y})(\hat{y}_\alpha - \bar{y})}{\sqrt{\sum_{\alpha=1}^{n} (y_\alpha - \bar{y})^2 \sum_{\alpha=1}^{n} (\hat{y}_\alpha - \bar{y})^2}}$$

$$R^* = \sqrt{1 - \frac{n-1}{n-p-1}(1-R^2)}$$

Results and discussion

Correlation analysis

Explanatory variables	Relative coefficient with manganese	
	Not converted	After logarithmic conversion
Water temperature	0.288	0.332
Turbidity	0.374	0.422
Chromaticity	0.197	0.370
pH	-0.109	-0.051
Alkali level	-0.061	-0.097
Electrical conductivity	-0.096	-0.230

(n=57, r_{99}=0.335)

Consideration of the objective variable and internal correlation

Selection of water temperature and turbidity

Results and discussion

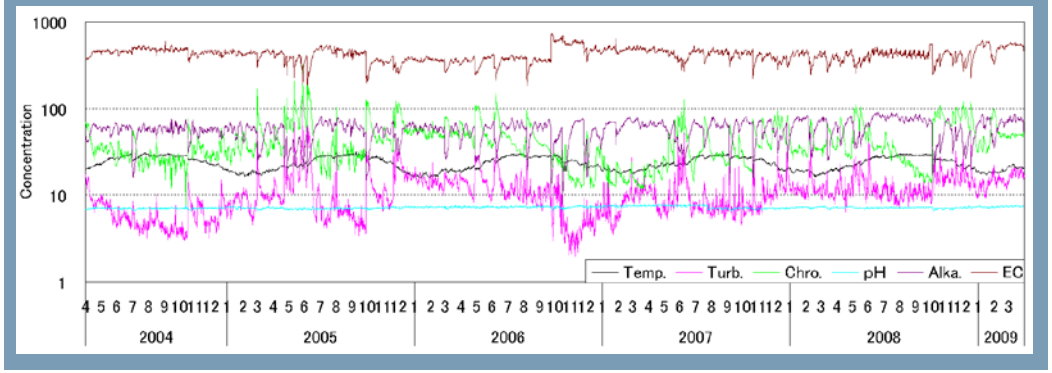
Multiple regression equation

$$y = 9.244 \times 10^{-5} x_1^{1.645} x_2^{0.667}$$

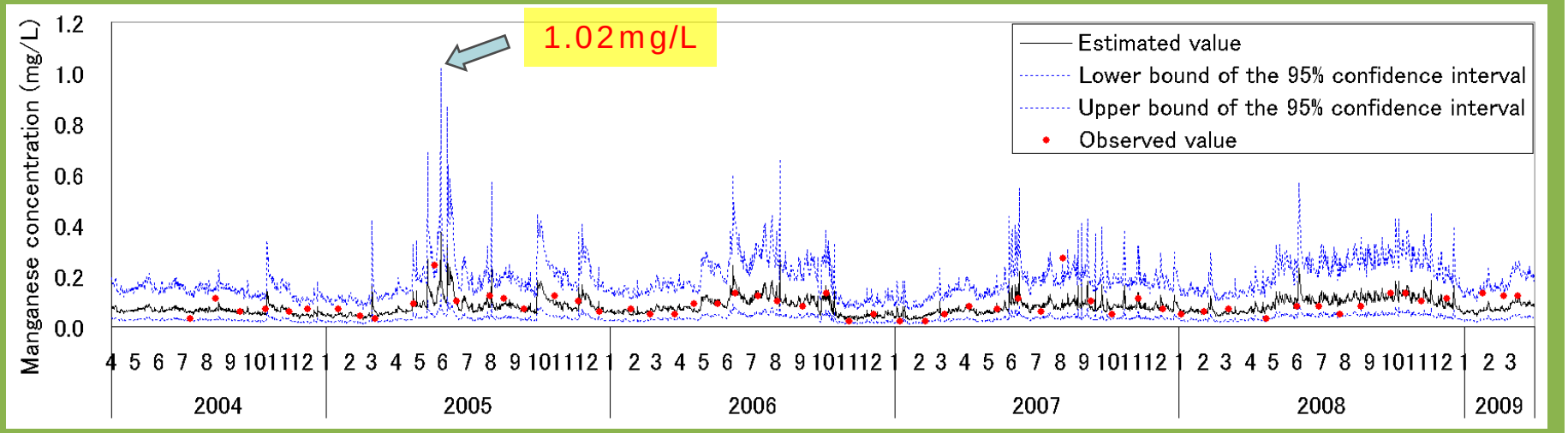
x_1 = Water temperature, x_2 = Turbidity

R^* = 0.665, (n=57)

Daily data of explanatory variables



Etimation of daily data of manganese concentration



Results and discussion

Chlorine oxidation	Potassium permanganate	Filtration by manganese sand	Slow filtration
Removal rate Approx. 90%	Removal rate Approx. 97.8%	Removal rate Approx. 97.3%	Removal rate Approx. 90%
Low price Slow oxidation THMs problems	Excellent removal High price	Excellent treatment	Approximately eight weeks are necessary for reclamation

Oxidation + Treatment with manganese sand

without pH control

Conclusions

- In case of estimated manganese concentration, maximum is 1.02mg/L at upper bound of the 95% confidence interval.
- We judged that “oxidation + treatment with manganese sand” illustrates an appropriate, effective, and economic method of manganese removal.
- Future studies include similar estimations of other material such as iron and organic matter that can affect the smooth operation of water treatment plants as well as to suggest general proposals for water treatment systems based on these results.


Thank You !