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OPTIMIZED USE OF WATER FROM MULTIPLE SOURCES IN MICRO WATER GRID SYSTEMS: A MODELING APPROACH

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A modeling approach for optimized use of water from multiple sources was investigated to enable practical implementation of smart water grid technology.

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INTRODUCTION

Micro water grid (MWG) is a novel approach to allow high reliability, diversification of water sources, low energy consumption, and cost reduction. Although it is not well-defined, it has potential for efficient management of urban water. MWG is suitable for use in small-scale buildings and towns, which have various uses of water produced from multiple source waters. Accordingly, design of MWG is challenging without proper tools to predict its performance.

This research focused on the development and application of a model for optimized use of water from multiple sources in MWG systems.

MODELING APPROACH

The model was comprised of two modules including strategy identification and mass balance calculator. The former assists in identifying strategy under the given natural and infrastructural conditions. The latter helps to determine water demand/supply and dimension of the water treatment system. Water from various sources including tap water, ground water, rainwater, reclaimed water, and desalinated water was considered in the model. As an initial input data, the water quality analysis data in Table 1 was used.

To optimize blending of multi-source waters, a matrix-based optimization strategy was suggested. The water quality information (WQ), blending ratio (BL), treatment cost (TC), and treatment efficiency (TE) were used as variables. The weighting factors for water quality parameters (COD, conductivity, UV_{254}, TOC, total coliform, total bacteria, and turbidity) were obtained based on AHP method. It allows the use of scoring method [1, 2]. Using the information on the multi-source waters, the optimization strategy for MWG was systematically investigated.

Table 1. Summary of multi-source waters

	COD (mg/L)	Conductivity (uS/cm)	pH	UV254	TOC (ppm)	Total Coliform (unit/1ml)	Total Bacteria (unit/1ml)	Turbidty (NTU)
Rain	2.9	36.9	6.51	0.018	1.27	57	193	0.93
Ground	5.9	592	7.48	0.012	0.96	None	1370	1.30
River	7.5	148.7	7.32	0.053	2.15	4000	3500	4.08
Waste	10.8	526	7.02	0.091	4.47	31400	None	2.44

$$WQ_i = (w_{rain,i}, w_{ground,i}, w_{river,i}, w_{wastewater,i}) \quad (1)$$

$$BL = \begin{pmatrix} b_{rain} \\ b_{ground} \\ b_{river} \\ b_{wastewater} \end{pmatrix} \quad TC = \begin{pmatrix} c_{rain} \\ c_{ground} \\ c_{river} \\ c_{wastewater} \end{pmatrix} \quad TE = \begin{pmatrix} e_{rain} \\ e_{ground} \\ e_{river} \\ e_{wastewater} \end{pmatrix} \quad (2)$$

RESULTS AND DISCUSSION

Based on the method, the optimum blending ratio could be estimated as a function of target water quality or treatment cost. In addition, the scoring method allowed the combination of two effects into one.

To implement this model in practice, a graphic user interface (GUI) were built under the Matlab environment. Results show that the simulation model was found to be effective to improve the performance of MWG by optimizing the use of multi-source waters. Based on the sensitivity analysis of the model, factors affecting the effectiveness of MWG could be also identified.

CONCLUSIONS

In this study, a model allowing the optimum use of water from multiple sources was developed and showed its potential for improving the efficiency of MWG.

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