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## **DEVELOPMENT OF A MODEL-BASED DECISION SUPPORT SYSTEM FOR WATER TREATMENT IN SMART MICRO WATER GRID**

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A multi-criteria decision support system (DSS) based was designed and developed to select optimum combinations of water treatment unit processes in micro water grid (MWG).

### **INTRODUCTION**

Micro water grid (MWG), which is a subset of smart water grid (SWG), is a novel concept for decentralized water management system for residential, industrial, commercial, and institutional buildings or towns [1, 2]. MWG aims at achieving specific local goals, such as reliability, diversification of water sources, and cost reduction. Unlike micro electricity grid, MWG has not been well-established, leading to a problem of initial design and operation. Thus, a MWG system requires a “smart” infrastructure for water treatment, water distribution, and system control

In this study, a decision support system (DSS) was designed to select optimum combinations of water treatment unit processes in MWG. To begin, key questions on water treatment in MWG systems were identified. Then, the knowledge-based system was developed based on the inputs from experts in related research fields and the prediction of treatment efficiency from theoretical model.

### **MODELING APPROACH**

A multi-criteria decision analysis for MWG was carried based on a scoring method [3, 4]. The Analytical Hierarchy Process (AHP) was applied to calculate the scores for each alternative based on pairwise comparisons. Three types of MWG systems were initially considered, including residential, commercial, and recreational applications. The weighting factors were estimated from a survey to a group of experts in academia and industry.

A decision-tree was created for an expert system of water treatment combinations in MWG systems. Treatment efficiency of pollutant by each water treatment combination was used for developing the knowledge base. The expert system was then developed using a web-based

platform, allowing an easy access to people who needs assists for design and operation of water treatment system in MWG.

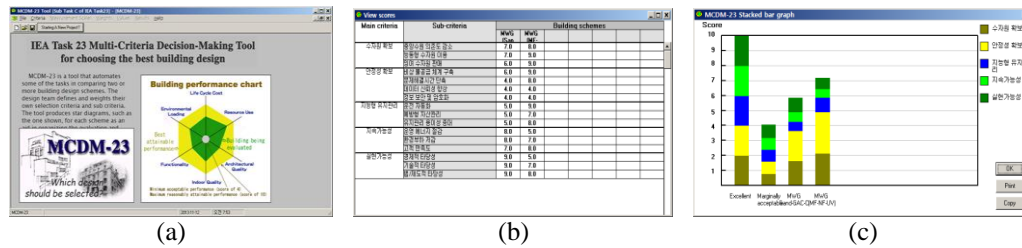


Figure 1. Multi-criteria analysis for strategic decision making of MWG

## MATERIALS AND METHODS

A series of experiments were carried out to obtain the model parameters for each unit process (i.e. media filtration, microfiltration, GAC, nanofiltration, chlorination, UV). Figure 2 shows the schematic diagram of experimental equipment for obtaining data on treatment efficiency by water treatment combinations. The 1<sup>st</sup> stage is used for removal of suspended solids and the 2<sup>nd</sup> stage is used for removal of organic matters. The 3<sup>rd</sup> stage, which is optional depending on the application, is used for disinfection.

Various feed waters containing rainwater, secondary effluent, ground water, and river water were used. Table 1 summarizes the examples for combinations of water treatment unit processes.

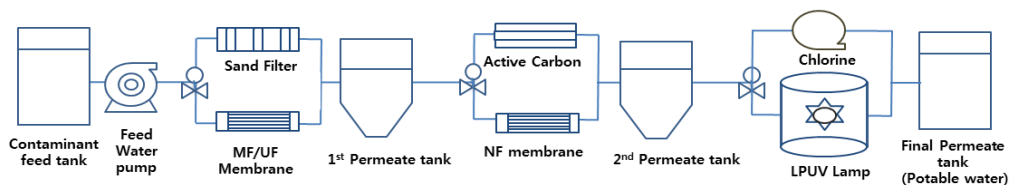


Figure 2. Combinations of water treatment unit process for MWG

Table 1. Summary of water treatment combinations considered in this study

Name	1 <sup>st</sup> stage	2 <sup>nd</sup> stage	3 <sup>rd</sup> stage
Feed	-	-	-
SD	Sand filtration	-	-
MF	Microfiltration	-	-
SG	Sand filtration	GAC	-
MG	Microfiltration	GAC	-
SN	Sand filtration	NF	-
MN	Microfiltration	NF	-
MGC	Microfiltration	GAC	Chlorination
MGU	Microfiltration	GAC	LPUV

## RESULTS AND DISCUSSION

To begin, the multi-criteria decision analysis was performed to obtain the weighting factors. It was found that the weighting factors were different for different applications. For example, the increase in water resource was found to be the most important for residential MWG while water security and stability was the most important for industrial MWG.

The experiments were carried out to obtain the performance data for each water treatment combination. For example, Figure 3 shows how the optimum water treatment system was selected based on the results of treatment efficiency and the target water quality. Although the treatment efficiency is same, the optimum treatment system may be different for different target water quality.

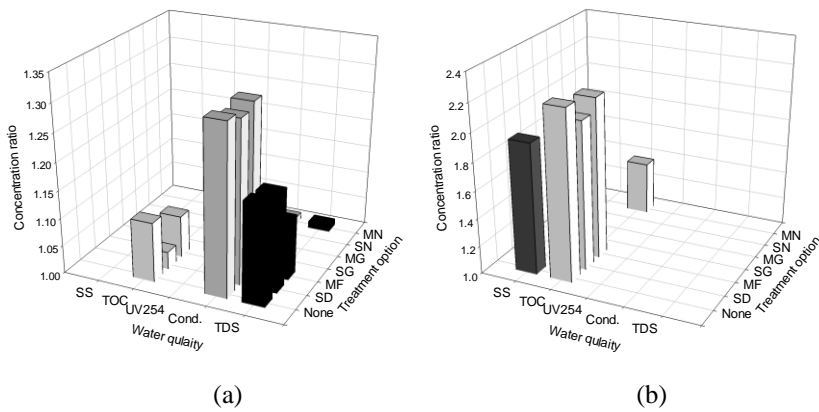


Figure 3. Selection of the optimum water treatment systems based on the concentration ratio of treated water quality to target water quality. Feed water: rainwater : groundwater : river water : wastewater = 1:1:1:1 (a) target water quality: TDS < 300 mg/L; conductivity < 250  $\mu$ S/cm; UV254 < 0.2; TOC < 2000  $\mu$ g/cm; SS < 5 mg/L (b) target water quality: TDS < 300 mg/L; conductivity < 250  $\mu$ S/cm; UV254 < 0.2; TOC < 2000  $\mu$ g/cm; SS < 5 mg/L

Based on all the results, the decision support system was developed as a form of web-based expert system. Figure 4 show the fundamental aspects of this system.

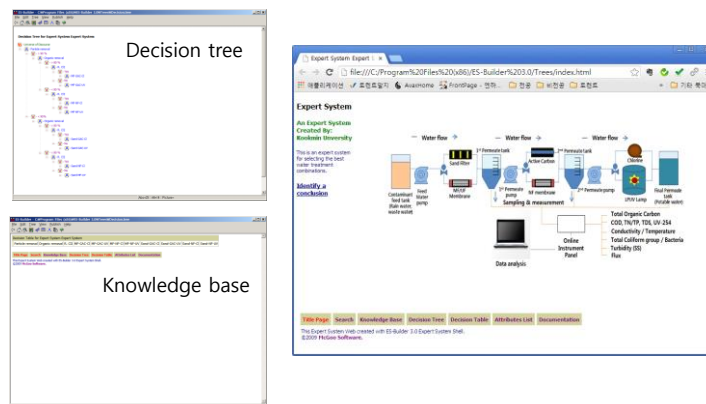


Figure 4. A web-based expert system for decision-supporting of water treatment combinations in MWG

## CONCLUSIONS

In this study, a decision support system was designed developed based a scoring method and experimental results. A rule-based system was also created. This system has potential to provide useful information for optimum selection of water treatment combinations depending on the type of application and target water quality. Studies are ongoing to reflect the effect of capital and operation costs.

## ACKNOWLEDGMENT

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