Water Distribution Network Partitioning Based on Community Detection Algorithm and Multiple-Criteria Decision Analysis

Xuan-Khoa Bui*, Doosun Kang**

Abstract

Water network partitioning (WNP) is an initiative technique to divide the original water distribution network (WDN) into several sub-networks with only sparse connections between them called, District Metered Areas (DMAs). Operating and managing (O&M) WDN through DMAs is bringing many advantages, such as quantification and detection of water leakage, uniform pressure management, isolation from chemical contamination. The research of WNP recently has been highlighted by applying different methods for dividing a network into a specified number of DMAs. However, it is an open question on how to determine the optimal number of DMAs for a given network.

In this study, we present a method to divide an original WDN into DMAs (called Clustering) based on community structure algorithm for auto-creation of suitable DMAs. To that aim, many hydraulic properties are taken into consideration to form the appropriate DMAs, in which each DMA is controlled as uniform as possible in terms of pressure, elevation, and water demand. In a second phase, called Sectorization, the flow meters and control valves are optimally placed to divide the DMAs, while minimizing the pressure reduction. To comprehensively evaluate the WNP performance and determine optimal number of DMAs for given WDN, we apply the framework of multiple-criteria decision analysis.

The proposed method is demonstrated using a real-life benchmark network and obtained permissible results. The approach is a decision-support scheme for water utilities to make optimal decisions when designing the DMAs of their WDNs.

Keywords: Community detection algorithm, Multiple-criteria decision analysis, Network clustering, Water network partitioning

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* Member · Ph.D. Student, Dept. of Civil Engineering, Kyung Hee University · E-mail : khoabx@khu.ac.kr

** Member · Associate Professor, Dept. of Civil Engineering, Kyung Hee University · (Corresponding Author, E-mail : doosunkang@khu.ac.kr)