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Modeling the effects of river regulation on macroinvertebrate community using a Bayesian Network

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There is a growing need for understanding the relationships between environmental factors and ecological status in streams. Due to the complex, stochastic nature of these relationships, data-driven approaches, such as statistical or machine learning methods are increasingly used to predict the ecological responses to changes in environmental factors. The Bayesian Network (BN), having the advantage of visualization and ease of communication, has been widely applied in numerous fields of science and engineering. The variables, if they have continuous values, used in a BN need to be discretized into a finite set of states. This process may lead to a significant loss in the model predictability when the variables are divided inappropriately. In general, the discretization is conducted based on simple rules, such as equal frequency or equal interval, or by expert elicitation. In this study, the classification tree method was used as an alternative so that the discretization would be compatible with multivariate data. We developed a BN model to predict macroinvertebrate taxonomic abundance in streams in response to environmental changes, with a particular focus on the changes in weir operation. The data for hydrological factors (stream width, mean stream depth, and mean current velocity), physicochemical variables (substrate type, ambient and water temperature, turbidity, and water quality variables), hydro-morphological factors (stream type, and type of current), land-use (dominant type, % riparian, and canopy cover type), and freshwater macroinvertebrate species (occurrence, dominance, variability and evenness) were collected twice per year during 2016-2017 in 2,099 sites along the four major rivers of South Korea. Our results indicated that water temperature and seasonal factors are more important than weir gate opening in determining the number of species occurrence and abundance of macroinvertebrates, although such responses varied substantially by site. The interpretation of the results had a limitation due to the limited monitoring period during the weir gate opening.