Inferring causal effects of river regulation using propensity scores

Hyeong Chul Jeon and YoonKyung Cha

University of Seoul, School of Urban Sciences, Department of Environmental Engineering, Korea, Republic Of
(hgcun3@uos.ac.kr)

The construction of sixteen weirs across the four major rivers in South Korea, and the consequent increases in hydraulic residence time have been blamed for intensified harmful algal blooms and water quality deterioration. To evaluate the effects of weir construction on the water quality of generated reservoirs, several weir gates have been opened for the period of months to a year, and the response of water quality has been monitored. However, inferring causal effects of weir construction from observational data is limited, because water quality characteristics are also influenced by confounding factors, such as meteorological and hydrological factors, and external pollutant sources. When the distributions for confounding factors before and after the weir construction are imbalanced, which is highly likely, the estimates for the causal effects of weir construction based on observational data can be biased. To address this imbalance issue, we used propensity score-based methods, propensity score matching and subclassification. The propensity score can be defined as the probability of treatment, weir construction in this study, assignment conditional on observed confounding factors. For a given propensity score, the distributions for confounding factors would be balanced between treated and untreated groups. The propensity score matching matches an individual sample from the treated group to a similar sample from the untreated group based on the propensity score, while the subclassification generates a number of classes within which the propensity scores are similar among samples. Our results demonstrated that the propensity score matching was more effective than the subclassification in improving the imbalance. Moreover, due to the lack of sample size after the weir construction, the subclassification failed to generate a required number of classes (generally greater than four) for further analysis. The effects of weir construction estimated using the propensity score matching differed depending on weirs and water quality characteristics.