Measuring the eco-efficiency of wastewater treatment plants under data uncertainty

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Abstract

Eco-efficiency assessment is a useful tool for improving the sustainability of wastewater treatment plants (WWTPs). However, it is a complex task that requires the integration of several performance indicators into a single index. Data envelopment analysis (DEA) is established as a highly effective methodology for achieving this as it permits the integration of the service value, resource consumption and environmental impact variables as the desirable outputs, inputs and undesirable outputs, respectively. However, traditional DEA models omit uncertainties in the data that are likely to result in biased conclusions. This study pioneers the assessment of the eco-efficiency of WWTPs while accounting for the data uncertainty and integrating the greenhouse gas emissions as an undesirable output. The DEA-tolerance model was applied to compute the eco-efficiency scores for 729 scenarios for each facility tested for identifying the best- and worst-case scenarios. The WWTPs were also ranked based on their eco-efficiency scores. The results demonstrated the importance of integrating data uncertainty in eco-efficiency assessments; the performances of the WWTPs change notably based on the evaluated set of scenarios. The proposed methodological approach provides a reliable and robust framework for supporting decision-making processes..

Keywords

Eco-efficiency, Wastewater treatment, Uncertainty, Undesirable output, Data envelopment analysis, Performance.