Optimized fuzzy inference system to enhance prediction accuracy for influent characteristics of a sewage treatment plant

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HIGHLIGHTS
• A new approach for developing the influent parameters prediction model
• Optimize FIS with different meta-heuristic algorithms to model influent parameters
• Introducing new approach for evaluating the performance for low and peak values
• Prediction accuracy for low and peak concentration have been examined

GRAPHICAL ABSTRACT

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Sewage treatment plants (STPs) keep sewage contamination within safe levels and minimize the risk of environmental disasters. To achieve optimum operation of an STP, it is necessary for influent parameters to be measured or estimated precisely. In this research, six well-known influent chemical and biological characteristics, i.e., biochemical oxygen demand (BOD), chemical oxygen demand (COD), Ammoniacal Nitrogen (NH₃-N), pH, oil and grease (OG) and suspended solids (SS), were modeled and predicted using the Sugeno fuzzy logic model. The membership function range of the fuzzy model was optimized by ANFIS, the integrated Genetic algorithms (GA), and the integrated particle swarm optimization (PSO) algorithms. The results were evaluated by different indices to find the accuracy of each algorithm. To ensure prediction accuracy, outliers in the predicted data were found and replaced with reasonable values. The results showed that both integrated GA-FIS and PSO-FIS algorithms performed at almost the same level and both had fewer errors than ANFIS. As the GA-FIS algorithm predicts BOD with fewer errors than PSO-FIS and the aim of this study is to provide an accurate prediction of missing data, GA-FIS was only used to predict the BOD parameter; the other parameters were predicted by PSO-FIS algorithm. As a result, the model successfully could provide outstanding performance for predicting the BOD, COD, NH₃-N, OG, pH and SS with MAE equal to 3.79, 5.14, 0.4, 0.27, 0.02, and 3.16, respectively.

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