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Nitrogen removal from free surface constructed wetlands with different inlet-outlet configurations

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The inlet-outlet configuration of a constructed wetland is an important design feature that affects the removal of different types of pollutants. The performance of a wastewater wetland can be quantified by a hydraulic efficiency index representing the combined effect of detention time and degree of mixing. In this study, a two-dimensional numerical model was used to simulate the velocity field and the transport of a continuously injected tracer in 5 hypothetical wetlands with different inlet-outlet configuration. Results show that efficiency metrics related to retention time, e_v, and degree of mixing, e_d, vary in response to different configurations. The results were coupled with a calibrated concentration removal model to obtain the removal efficiency of Nitrogen (N). It is found that the nutrient reduction rate varies for different configurations and vegetation densities. This study further shows that a corner-to-corner inlet-outlet configuration improves nutrient removal, and that a multiple-inlet system is the best design solution, maximizing nutrient removal efficiency. Such an improvement can be explained by the resulting flow patterns, leading to longer retention time and lower risk of short-circuiting. It can be concluded that the choice of an optimal inlet-outlet configuration and the presence of a sufficiently high vegetation density can significantly improve the ability of wetlands to process pollutants, and are therefore important design aspects. The results of this work can help designing wetlands that are more efficient by utilizing optimal inlet-outlet configurations.