Two-dimensional transport of the pollutants: Transient tracer tests in an urban river

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Abstract The transverse mixing is more important in water-quality management than either vertical or longitudinal mixing, especially when dealing with a two-dimensional approach. In this study, a series of transient tracer experiments were performed based on the instantaneous injection of the ammonia solution and red ink into an urban river in the northeast of China, and a three-dimensional sampling device was designed to track the transport of pollutants, observe the behavior of real-time processes and collect trace data. The outcomes of the tests show that the concentration change in the transverse section was close to a normal distribution as the tracer was released into the center of the stream section. The theoretical formula of the transverse dispersion coefficient E_y was derived based on the relationships among the dimensionless coefficients, α_y, the friction term, u/u^*, channel aspect ratio, B/H, and specific gravity, ρ/ρ_0. α_y trended to increase as u/u^* and B/H grew in a log-log scale. In addition, the transverse dispersion coefficient was sensitive to the channel aspect ratio by comparing the standard regression coefficients of B/H and u/u^*. The average value of the transverse dispersion coefficient in the study was 0.0038 m2/s, but α_y was smaller than values estimated with the empirical formulas. The newly proposed theoretical formula can estimate the transverse dispersion coefficient of river, which may be of great help for the decision makers to select an appropriate emergency plan during an emergency and guarantee the socio-ecological security.