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A new methodology for determining dispersion coefficient using ordinary and partial differential transport equations

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ABSTRACT

The present study proposes a methodology for determining the effective dispersion coefficient based on the field measurements performed in Gwangju (GJ) Creek in South Korea which is environmentally degraded by the artificial interferences such as weirs and culverts. Many previous works determining the dispersion coefficient were limited in application due to the complexity and artificial interferences in natural stream. Therefore, the sequential combination of N-Tank-In-Series (NTIS) model and Advection-Dispersion-Reaction (ADR) model was proposed for evaluating dispersion process in complex stream channel in this study. The series of water quality data were intensively monitored in the field to determine the effective dispersion coefficient of *E. coli* in rainy day. As a result, the suggested methodology reasonably estimates the dispersion coefficient for GJ Creek with 1.25 m^2/s. Also, the sequential combined method provided Number of tank-Velocity-Dispersion coefficient (NVD) curves for convenient evaluation of dispersion coefficient of other rivers or streams. Comparing the previous studies, the present methodology is quite general and simple for determining the effective dispersion coefficients which are applicable for other rivers and streams.

Key words | adevection-dispersion-reaction model, dispersion coefficient, *E. coli*, N-tank-in-series model

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INTRODUCTION

Accidentally released toxic contaminants of effluent undergo complex mixing and dilution processes in a stream. The dispersion is critical in determining mixing and dilution of contaminant scalars and combined with various processes of molecular diffusion, turbulent diffusion, and transporting due to transverse or/and vertical shear in aquatic system. Therefore, this dispersion process is the most significant mechanism in aquatic environment; in particular, the dispersion coefficient has been increasingly recognized as the most important factor in water quality modeling. For this reason, many researchers including chemical, civil, and environmental engineers have studied the dispersion process in aquatic system; simple dispersion process in pipe flow and mixing in the open channels and natural streams, over the last five decades. As results, various conceptual and analytical approaches were proposed to compute the dispersion coefficient in streams and channels with a function of hydraulic and geometric parameters (Taylor 1954; Elder 1959; Fischer 1975; Asai & Fujisaki 1991; Tayfur & Singh 2005). Firstly, Taylor (1954) introduced the basic concept of longitudinal dispersion process in turbulent flow in a straight circular pipe. Taylor's concept was further extended to determine longitudinal dispersion coefficient in open channels. On the basis of laboratory experiments and Taylor's hypothesis, Elder (1959) suggested a model for determining the dispersion

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