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The Information Entropy Prisms on Riverine Water Quality Evolution

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Information entropy theory has been largely applied in hydrological modeling and engineering optimization. Recently the entropy description and explanation of reactive solute mixing and transport process has received increasing attentions. Literatures mainly focus theoretical analysis on hypothetical cases, however, the direct observation and calculation with field datasets are hardly reported.

This work studied the change of information entropy in surface water solute transport system with field data. A comprehensive information entropy based analysis framework were proposed, which works like a combined optical system with Optical Sources-Filters-Prisms-Images. We established four basic probability space, leading to four basic information entropy indexes: Dilution index (E), Flux index (F), Spatial entropy index (Gx), and Temporal entropy index (Gt).

The evolution characteristic of information entropy in one-component solute diffusion system is studied by using the method of discrete information entropy analysis. In the system boundary definition of fixed observation, the information entropy appears a peak in time and space dimension, and the peak value of information entropy appears in the first 20%-30% of the fixed observation interval, while in the system boundary definition of dynamic observation, information entropy decreases continuously with the increase of time and space distance. Through the local sensitivity analysis of the hydrodynamic parameters of the above analytical solutions, it is found that the sensitivity of information entropy H to diffusion coefficient D_x is relatively constant, and the greater the degradation coefficient k is, the more sensitive the monitoring time t is to k , the more sensitive the spatial change of information entropy is to the change of flow velocity u_x with the increase of distance, while the change of time is insensitive to u_x .

Furthermore, the evolution characteristic of information entropy in complex water quality process of rivers is studied. The Guangming section of Maozhou River in Shenzhen is taken as the research area. BOD-DO and nitrogen elements (NH₃-N, NO₃-N, Org-N) water quality process were selected, and one-dimensional S-P model and WASP_EUTRO water quality model were constructed respectively. After model calibration and verification, the changing characteristics of information entropy, mutual information and information transfer index are analyzed under the system

definition of fixed observation. It was found that the transformation reaction process gradually replaced the diffusion process in the complex water quality process as the main factor affecting the change of information entropy, and the information entropy change law in the single component diffusion process no longer exists in the complex water quality process.