Salt intrusion and effective longitudinal dispersion in man-made canals, a simplified model approach

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Abstract

Salinization threatens coastal freshwater bodies, but little is known about this phenomenon in man-made canals. Here, salt intrusion and effective longitudinal dispersion in such canals are investigated, where the Ghent-Terneuzen Canal in Belgium-the Netherlands is used as a prototype example. A calibrated, width-averaged model is employed to quantify the sensitivity of these quantities to forcing conditions. This model performs better than a calibrated, cross-sectionally averaged model with a constant longitudinal dispersion coefficient, because density-driven advection of salt, which turns out to be important in man-made canals, is explicitly resolved. It is found that, in equilibrium, discharge at the upstream boundary is more important than exterior salinity for salt intrusion and effective longitudinal dispersion. Furthermore, the time-dependent salinity response to an increase in freshwater discharge is faster than that to a decrease in discharge. In contrast, the time it takes the system to adjust to a change in the exterior salinity does not depend on the sign of that change. From these results, a parametrization of the effective longitudinal dispersion coefficient is developed, which explicitly accounts for the horizontal salt transport by the density-driven current. A cross-sectionally averaged model that uses this effective longitudinal dispersion coefficient successfully simulates the salt dynamics of the width-averaged model.

Keywords

Salt intrusion, Idealized modeling, Dispersion parametrization, Ghent-Terneuzen Canal, Freshwater management

Elsevier, Estuarine, Coastal and Shelf Science 298 (2024)
108654https://doi.org/10.1016/j.ecss.2024.108654