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Analytical solution of the equations describing tidal dynamics in alluvial estuaries: a basis for a biogeochemical classification of estuaries

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Alluvial estuaries are characterized by a strong coupling between tidal hydraulics, salinity intrusion, biological, chemical and morphological processes. These processes are driven by a wide array of forcing mechanisms and interact on very different temporal and spatial scales. As a result, the understanding of these physical-biological interactions is still limited and a biogeochemical classification of alluvial estuaries is thus seriously compromised. However, the use of simple but generic reactive-transport models can advance our understanding of the estuarine biogeochemical functioning and can ultimately provide a synthetic view of the controlling mechanisms.

In this study, fully explicit analytical solutions are provided for the hydrodynamics of tidal flow in alluvial estuaries. These solutions are directly linked to the geometry of the respective system and thus provide insights into its hydrological functioning on the basis of easily obtainable information. The combination of these analytical equations with a biogeochemical model provides a framework for a process-oriented exploration of the system's biogeochemical response as a function of the estuarine geometry. In this paper, these equations are presented and discussed, and illustrations of combined application in biogeochemical modelling are given.