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Detailed Numerical Modelling of Inland Navigation's Impact on Sediment Suspension

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ABSTRACT

Inland navigation is an eco-efficient and cost-effective transport mode, consuming less fuel, emitting less CO2, and offering greater safety than road transport. However, larger vessels with powerful propulsion systems pose environmental challenges, including sediment resuspension and riverbank erosion.

This study investigates these phenomena using a verified and validated hydro-sedimentary model based on Computational Fluid Dynamics (CFD). The originality of this work lies in the accuracy representation of the flow around an inland vessel, including its propulsive system. It is worth noting that the hydrodynamics surrounding a vessel navigating in confined waters are highly complex (Caplier et al., 2019). Additionally, the study consider two types of sediments cohesive and non-cohesive and analyzes influence of some parameters such as the depth-to-draft ratio (h/T), vessel speed, water depth, and sediment particle size. Previous work has already been published, investigating the coupling of a CFD model with a transport equation to represent sediment behavior. However, the cohesive nature of sediment was not addressed in that study (Kaidi et al., 2021).

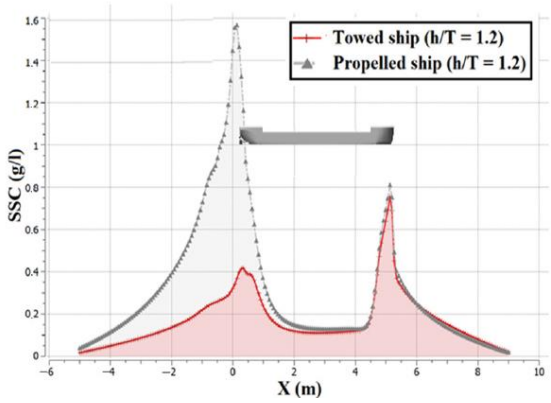

Figure 1 : Suspended Sediment Concentration (SSC) along the channel (midline of the propeller) for towed and propelled ships (Kaidi et al., 2021).

The results of this study provide a detailed understanding of the hydrodynamic processes around vessels under various configurations. A comparison between the numerical results and experimental data shows good agreement. Various scenarios were tested, and a detailed analysis was conducted to evaluate the influence of the aforementioned parameters on the concentration of suspended sediments, allowing for the assessment of the individual effects of each factor.

References

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