Conceptualization of Sediment Transfers Between Macrotidal Estuaries and Coastal Seas

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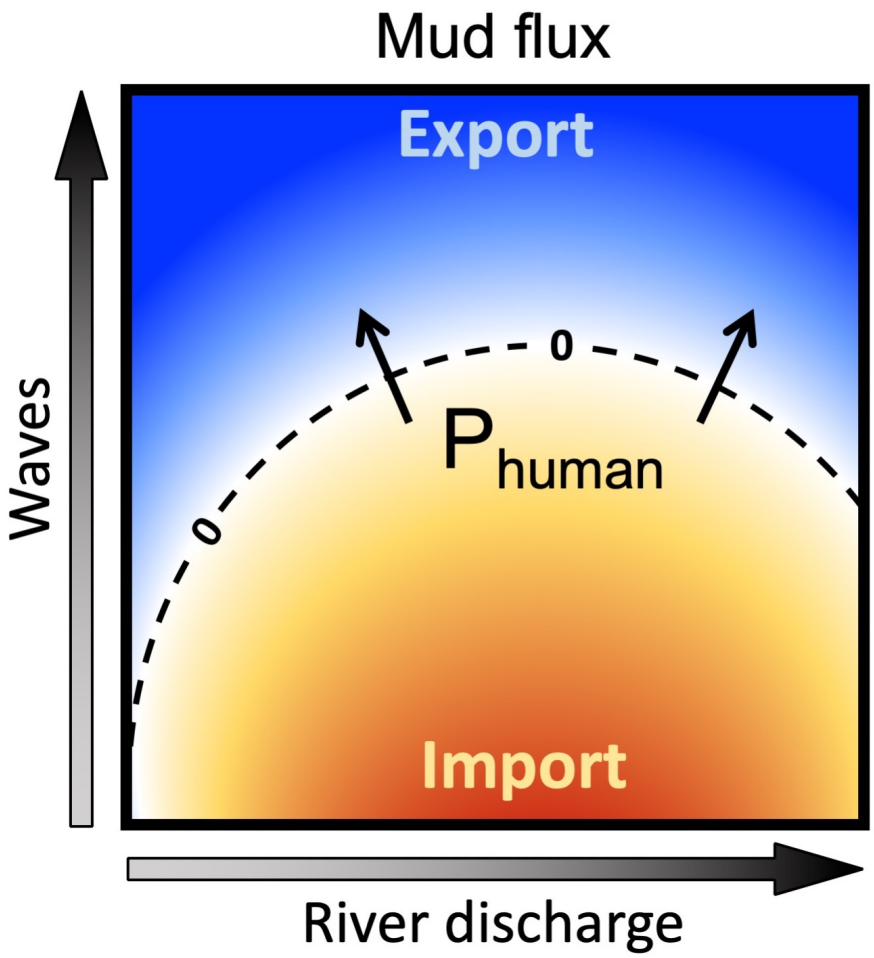
Abstract

Sediment fluxes at the estuary-sea interface modulate estuary morphologies and impact particle matter exchanges between marine and continental sources along the land-sea continuum. However, meteorological forcing (e.g., extreme events) and human activities (e.g., estuary deepening) drive pressures on estuary physical functioning, hence threatening estuarine habitats and their ecosystem services. There is an increasing societal need to better predict the potential trajectories of estuarine sediment fluxes resulting from natural and anthropogenic pressures. Nevertheless, it is difficult to derive generalizations from site-specific studies; thus, multi-site approaches appear necessary to move toward a global conceptualization of estuarine sediment transfers. This study explores 10-year numerical hindcasts of three contrasted macrotidal estuaries (Gironde, Loire, and Seine estuaries; France) to disentangle the relative contributions of hydrometeorological and morphological forcing on net sediment fluxes between estuaries and coastal seas. Our results highlight that intense wave events induce fine sediment ([?]100 μm) export to the sea but coarser sediment ([?]210 μm) import within the estuary. Remarkably, moderate to large river flows support mud import within the estuary. In addition, the Seine Estuary morphological changes due to human activities (i.e., estuary deepening and narrowing) increase fine sediment import within the estuary, shifting the estuary from an exporting to importing system. We propose a conceptualization of mud flux response to river flow and wave forcing, as well as anthropogenic pressures. It provides valuable insights into particle transfers along the land-sea continuum, contributing to a better understanding of estuarine ecosystem trajectories under global changes.



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AGU FALL MEETING

Ifremer – DYNECO/DHYSED + EPOC

SCIENCE is SOCIETY

AGU FALL MEETING

CONTEXT

Sediment fluxes along the land-sea continuum

- Changes of estuary morphology and associated habitats
- Transfers of nutrients and pollutants

OBJECTIVES

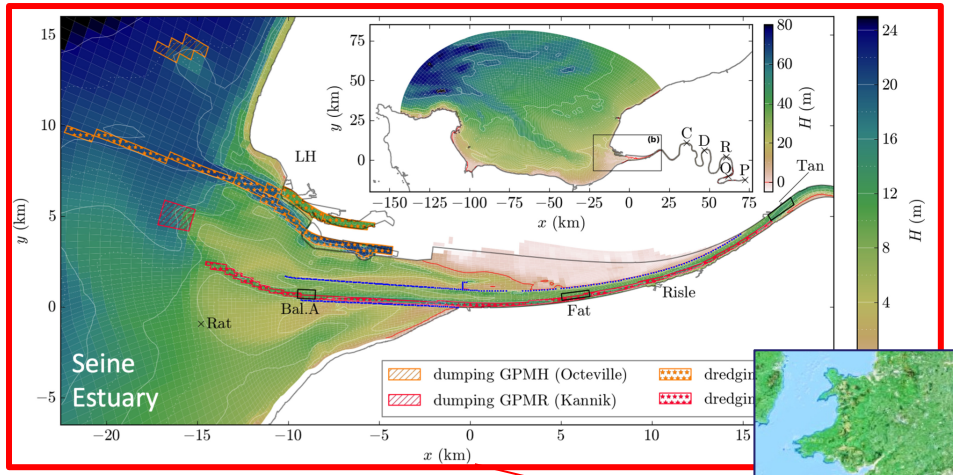
Unravelling the responses of estuarine sediment fluxes (mud + sand)

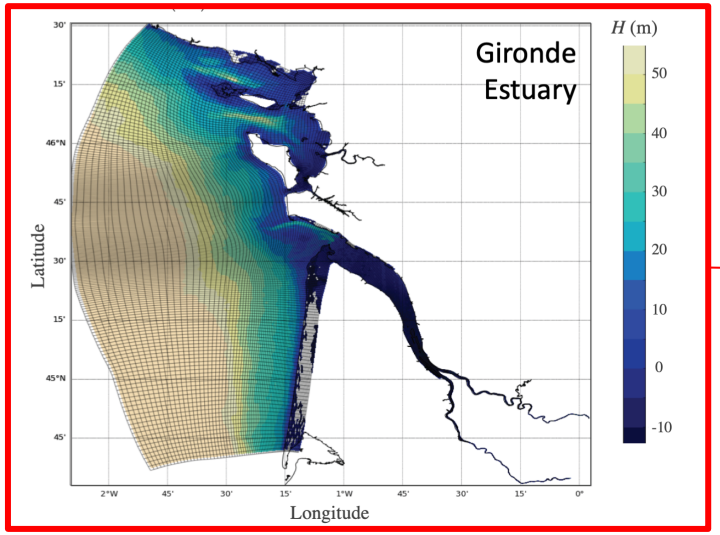
- To meteorological conditions (river discharge + waves)
- To anthropogenic pressures (deepening + narrowing)
- For different estuaries (beyond site-specific analyses)

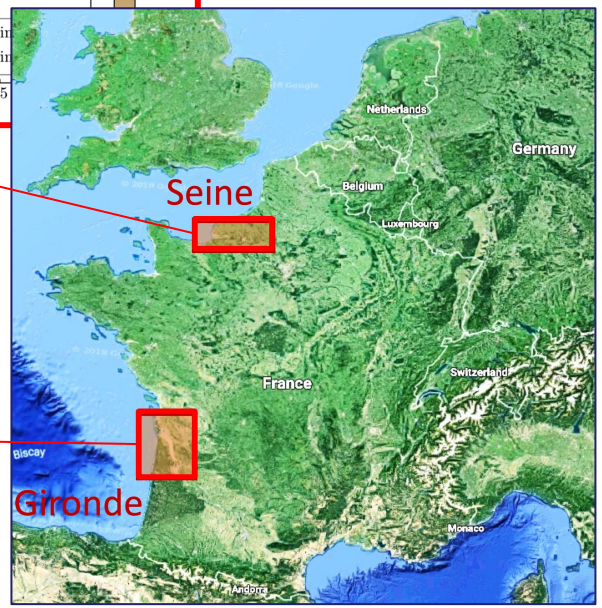
SCIENCE *is* SOCIETY

AGU FALL MEETING

NUMERICAL MODELING OF MACROTIDAL ESTUARIES







Wave Watch III®
(waves)

+

MARS3D-curvilinear
(hydrodynamics)

+

MUSTANG
(sediment)
eros./depos., consolidation, flocculation,
multi-layer, multi-class (mud+sand+gravel)

mustang by Ifremer

SEDIMENT FLUX CONCEPT

- Wave events

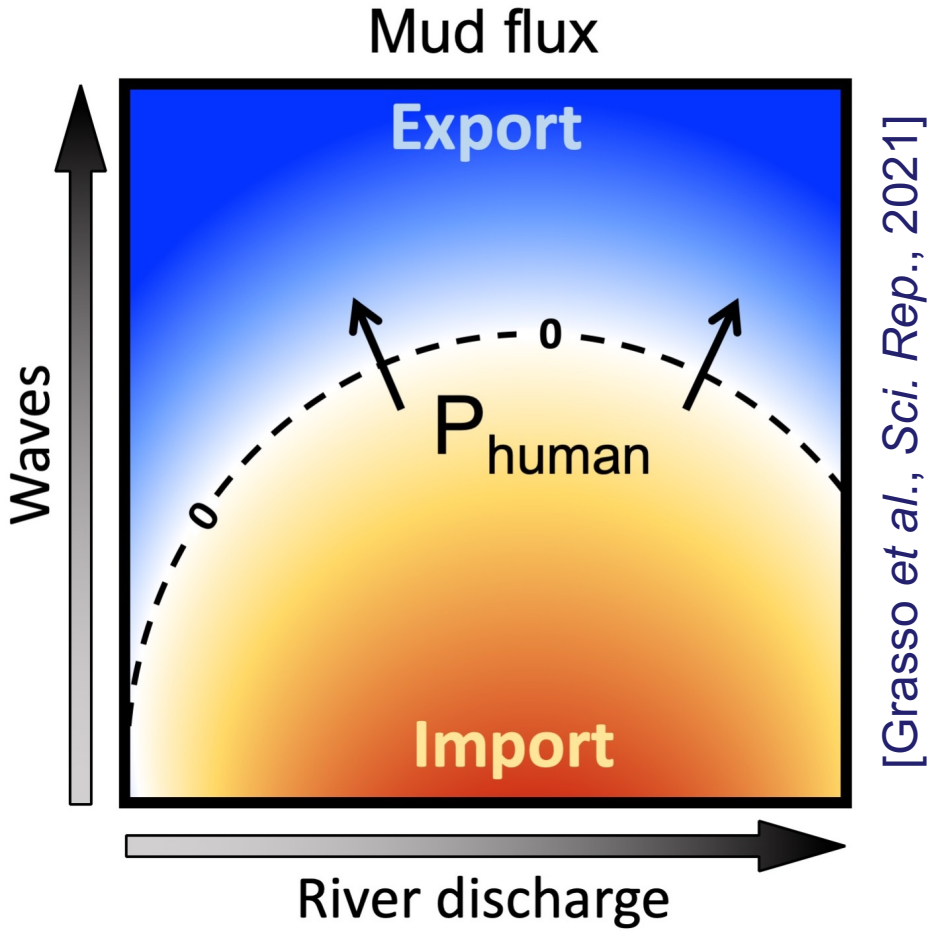
  → Mud export to the sea

- Moderate to large river flows

  → Mud import within the estuary

- Estuary deepening and narrowing

  → Mud import within the estuary



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