Deutsches Geodätisches Forschungsinstitut (DGFI-TUM)
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Uncovering the extent of tides in global river systems

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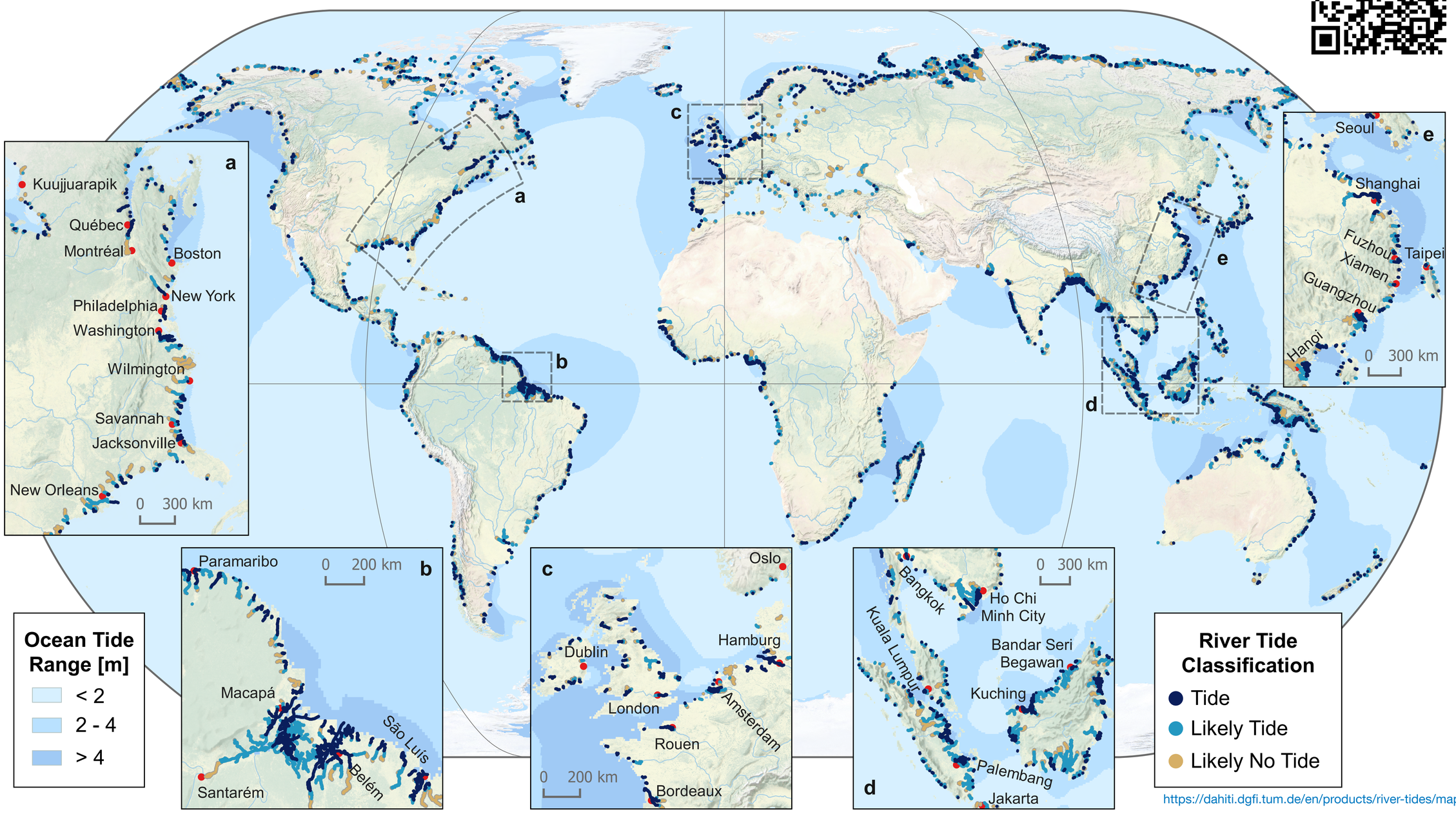
Interactive



https://dahiti.dgfi.tum.de/en/products/river-tides/map

Fig. 1 Global river tide classification atlas *(Hart-Davis et al., 2026)*, with zooms into regions of interest. Background map shows tidal range from EOT20 *(Hart-Davis et al., 2021).*

Motivation

Coastal rivers are ecologically and economically vital transition zones between land and sea that are tidally influenced but fresh for much of their lengths. Tides in coastal rivers affect carbon and nitrogen cycling, esturine habitats, sediment storage, and salinity, but **the extent of tidal influence is generally unknown over most of the world's rivers**. Here, we use the recently launched Surface Water Ocean Topography (**SWOT**) satellite, which provides wide-swath elevation measurements at unprecedented scales, to produce a global atlas of tidal influence in rivers for the first time. Tidal constituents are estimated based on the vectorized SWOT RiverSP product (*SWOT, 2024*) and validated against in-situ river and tide gauges. **Over 175,000 river kilometers are influenced by tides globally**, and 290 million people live near and depend on these coastal transition zones. Manmade and natural obstacles, such as dams, limit tidal propagation in an estimated 18% of all tidal rivers. As sea levels rise, tidal rivers will undergo rapid hydrologic and morphologic changes that depend on local management, morphology, and climate. The ability to monitor tidal responses to rising seas and river management decisions using remote sensing represents a major advancement for the study of coastal rivers.

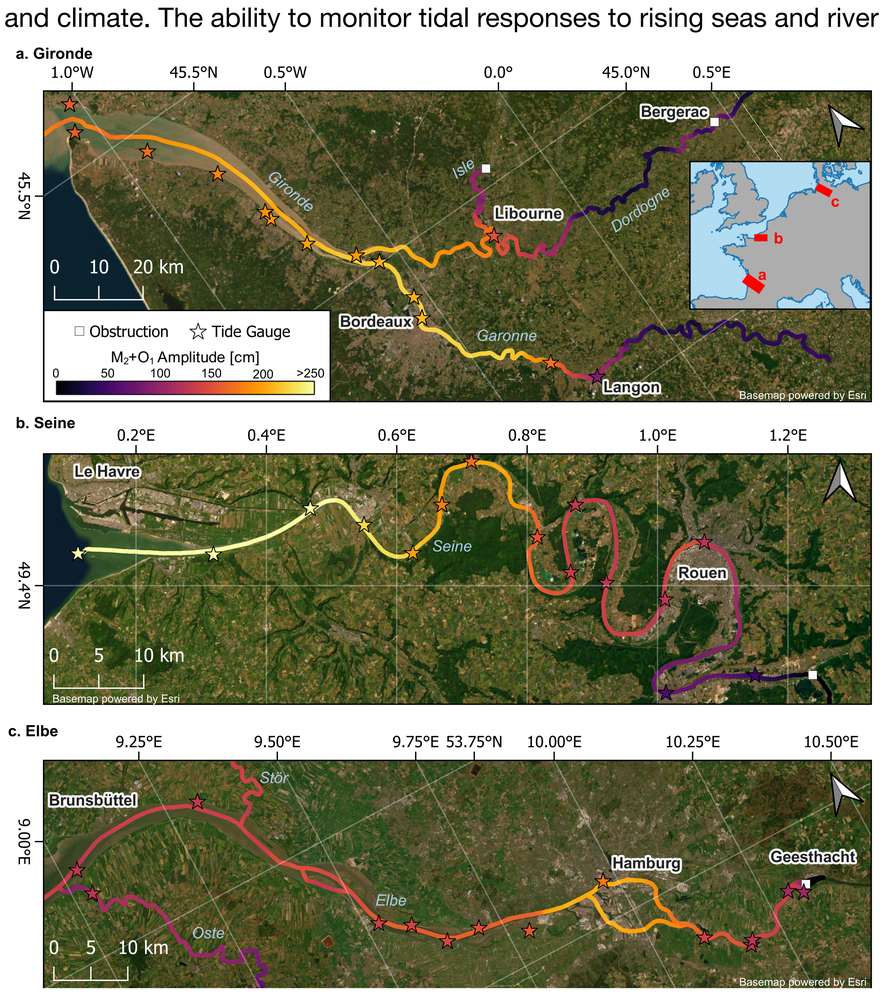


Fig. 2 M_2+O_1 amplitude derived from RiverSP, with stars being tide gauges.

Key Findings and Discussion

- Over two years of the SWOT RiverSP product is used to derive the M_2 and O_1 tidal constituents for every river observed by SWOT. Figure 2 shows the amplitude of the M_2 tide in three different river systems.
- Based on these findings, the first global atlas of tidal extent with rivers is produced and displayed in Fig. 1.
- The resultant data is also able to quantitatively show that the river slope plays an important role in the extent which tides can propagate within rivers.
- These findings, which will continue to evolve and improve with increased SWOT data, already demonstrate the strength of this dataset to study key physical processes across the land-ocean-aquatic continuum.
- This global dataset opens new possibilities to monitor and model changes in estuarine habitats, salt water intrusion, compound flooding events among a vast number of biogeochemical processes.
- The data is available via Zenodo (*Scherer & Hart-Davis, 2026*) and DAHITI.

References

SWOT (2024): **SWOT Level 2 River Single-Pass Vector Data Product, Version C.** PO.DAAC, CA, USA. https://doi.org/10.5067/SWOT-RIVERSP-2.0

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Hart-Davis M., Scherer D., Schwatke C., Sawyer A., Pavelsky T., Ray R., Matte P., Dettmering D., Seitz F.: **Observing the tidal pulse of rivers from wide-swath satellite altimetry**. Nature, 10.1038/s41586-026-10287-z, 2026

Scherer D., Hart-Davis M.: **SWOT River Tides (data)**. Zenodo, https://doi.org/10.5281/zenodo.15223860, 2026