



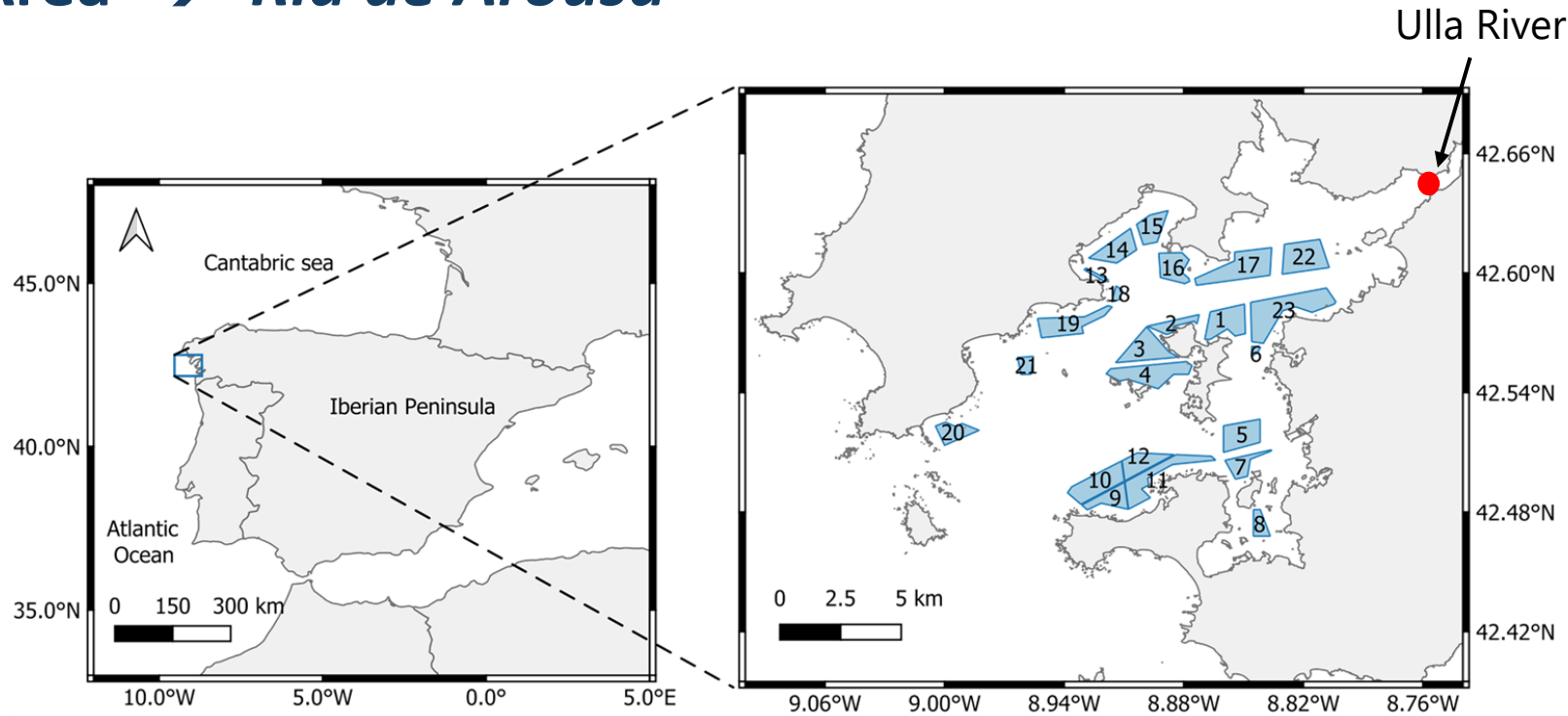
Modeling the Transport of Biodeposits in the Ría de Arousa (NW Spain)

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> Study Area → *Ría de Arousa*



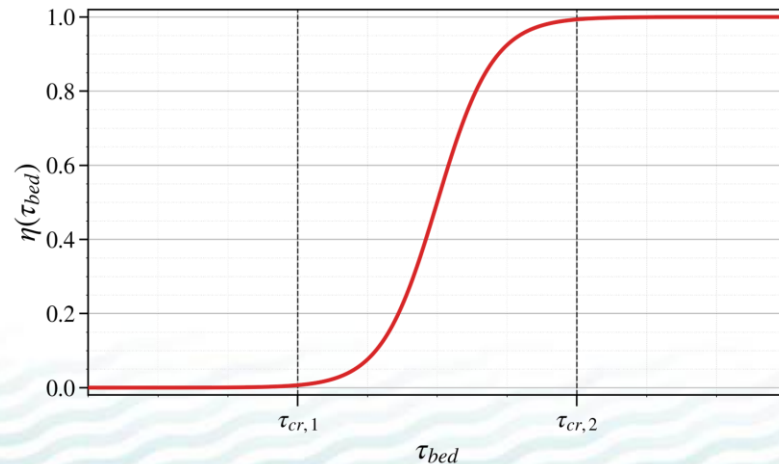
- Highly productive aquaculture system → Massive organic input to the seabed (**biodeposits**).
- Dense, non-buoyant particles ($r = 1,00 \text{ mm}$, $\rho = 1050 \text{ kg/m}^3$) → 3D MOHID-Lagrangian model.
- Continuous simulation → Dec 2019 – Dec 2023
- Up to 600,000.

> New Process Parameterizations in MOHID-Lagrangian

RESUSPENSION

- Occurs in Bedload layer (4 cm)
- τ_{bed} : increases with roughness (ε_0).
- τ_{cr} : decreases with radius (r_i).

$$\left\{ \begin{array}{ll} |\tau_{bed}| \leq |\tau_{cr,1}| & \rightarrow \text{No resuspension} \\ |\tau_{cr,1}| \leq |\tau_{bed}| \leq |\tau_{cr,2}| & \rightarrow \text{Bedload transport} \\ |\tau_{bed}| \geq |\tau_{cr,2}| & \rightarrow \text{Full Resuspension} \end{array} \right.$$



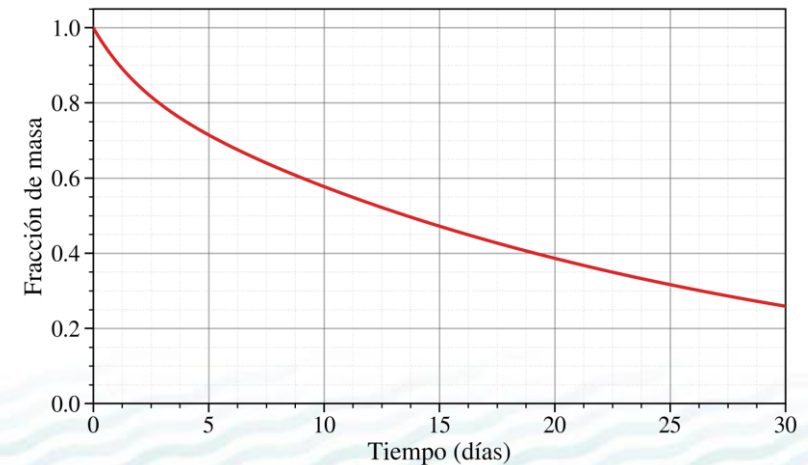
DEGRADATION

$$\mathcal{D}(t) = \alpha e^{-\mu_1 t} + (1 - \alpha) e^{-\mu_2 t}$$

Minimum radius : $7 \cdot 10^{-4} \text{ mm}$

Constants:

- $k_1 = 0.514 \text{ day}^{-1}$
- $k_2 = 0.04 \text{ day}^{-1}$
- $\alpha = 0.14$



> Experimental Setup

S1: Base case

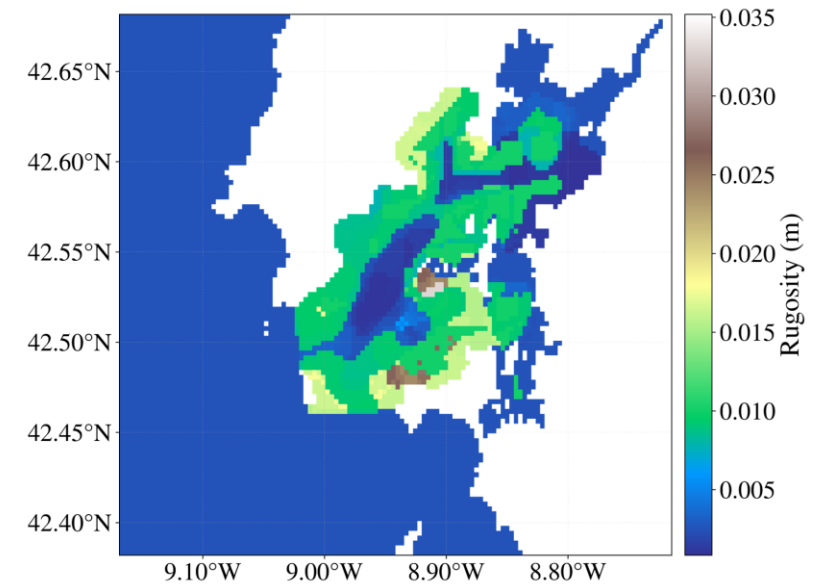
- No degradation
- Constant roughness :
 $\varepsilon = 0.0025 \text{ m}$

S2: Degradation effect

- Realistic degradation:
 $\alpha = 0.14,$
 $\mu1 = 0.514 \text{ day}^{-1},$
 $\mu2 = 0.04 \text{ day}^{-1}.$
- Constant roughness :
 $\varepsilon = 0.0025 \text{ m}$

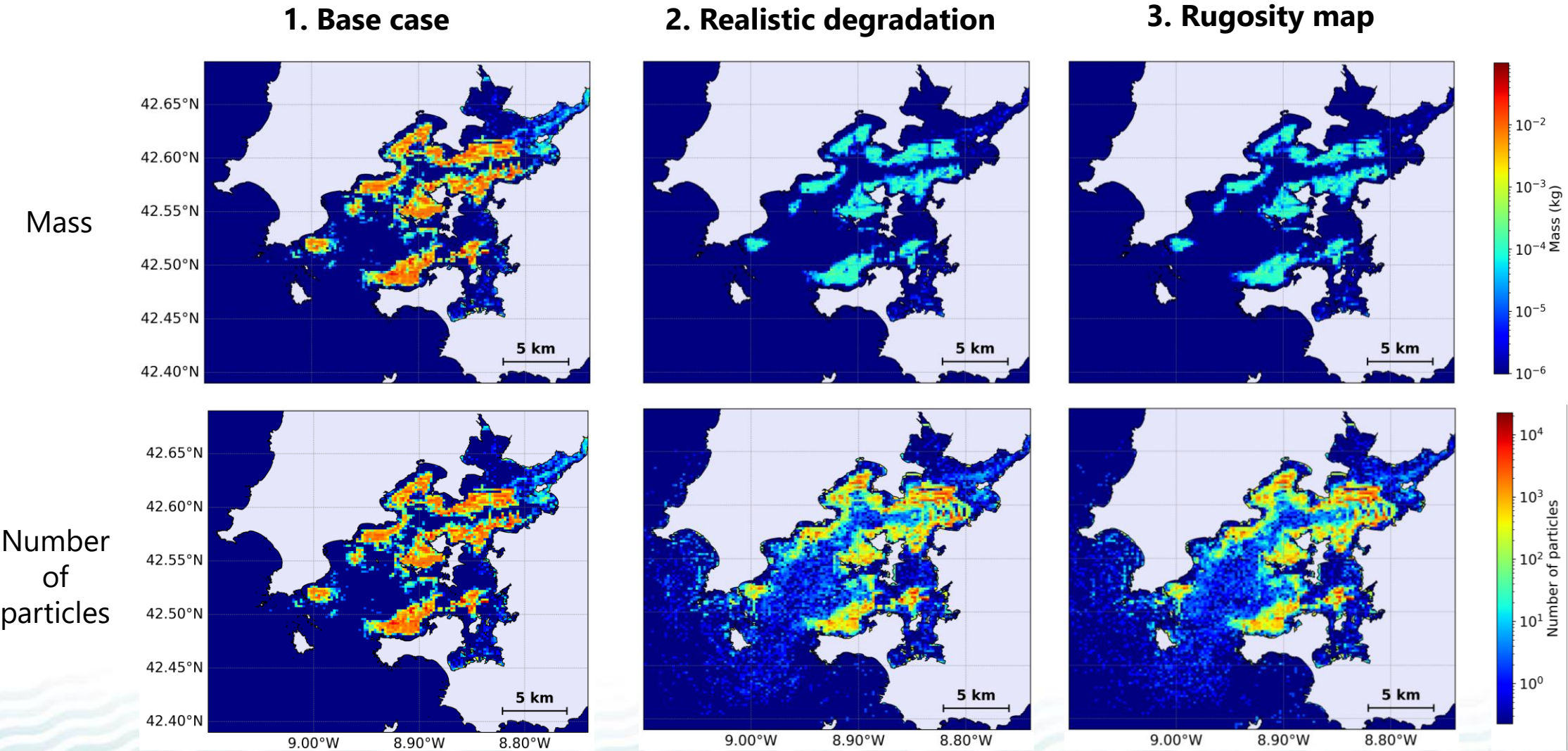
S3: Realistic Rugosity Map

- Realistic degradation.
- Roughness map:

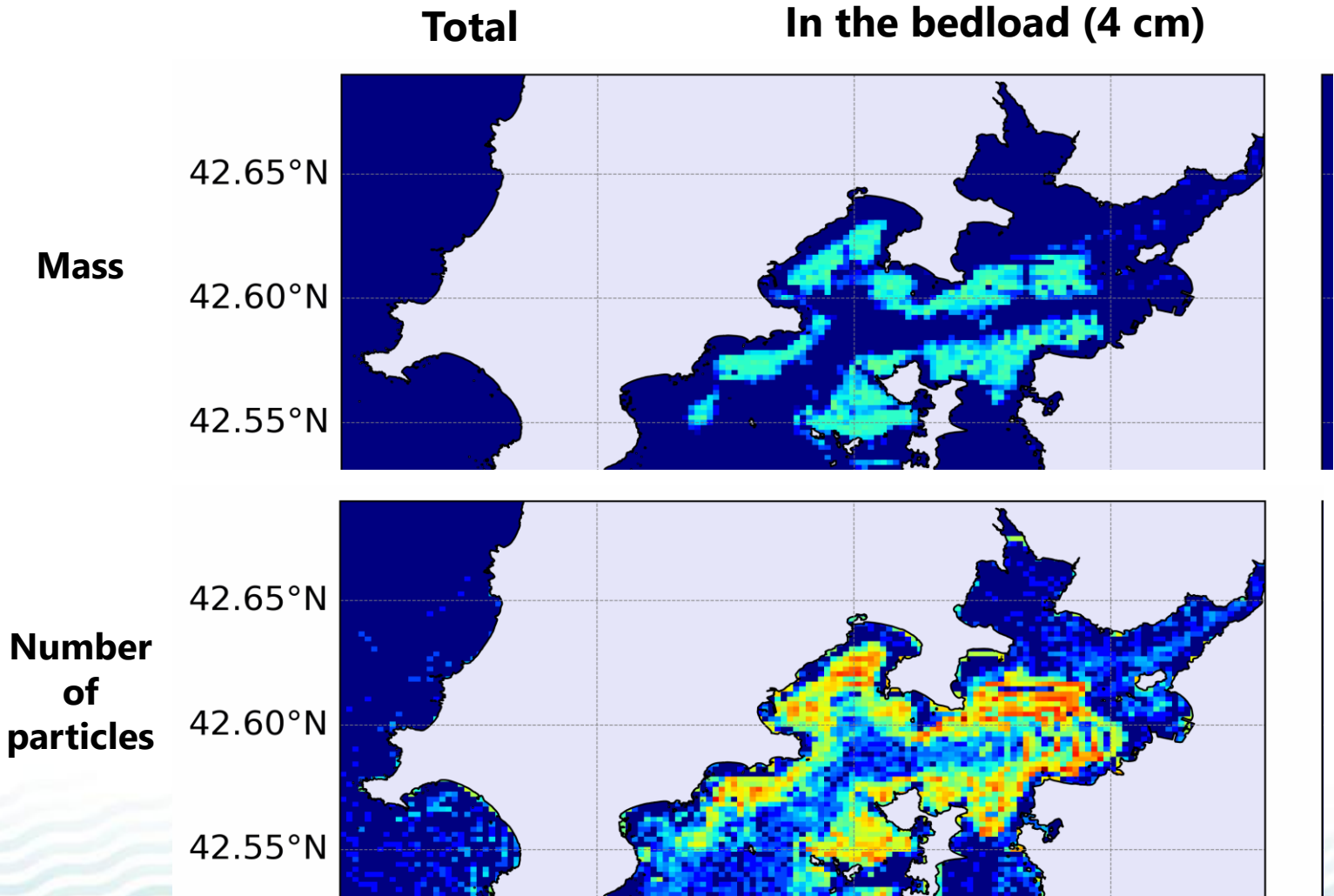


Mass vs Number of particles analysis

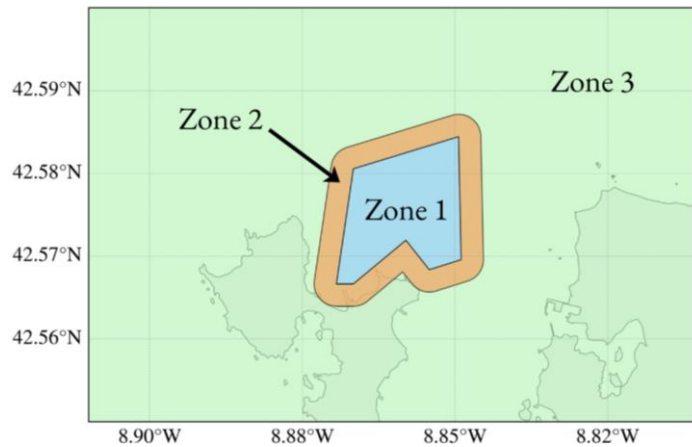
> Final Spatial Footprint: Particle Number vs. Organic Mass



>Transport Mechanism: Near-Bed Dominance



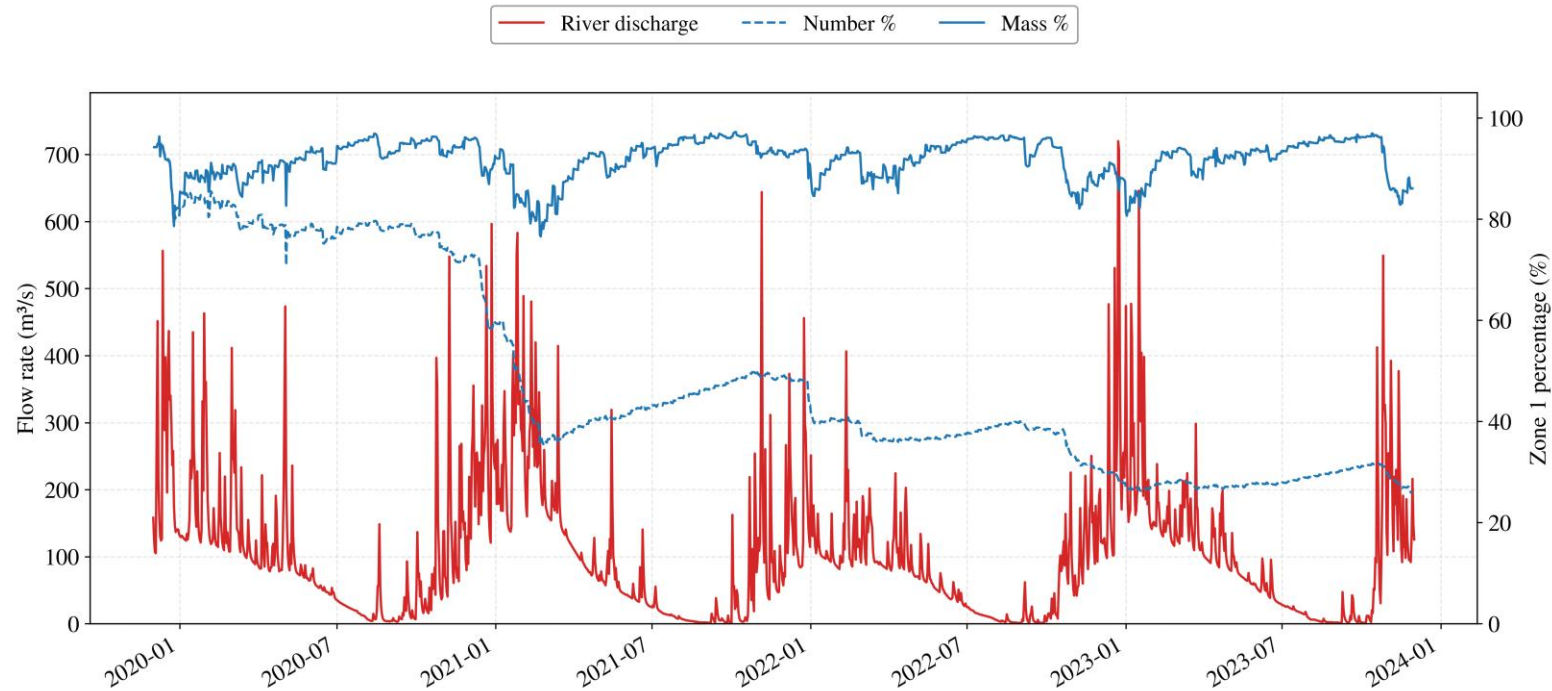
> Local Dynamics: Source-Centered Temporal Analysis



1. Continuous local mass accumulation.
2. Mass stabilization.
3. No significant difference with realistic rugosity.

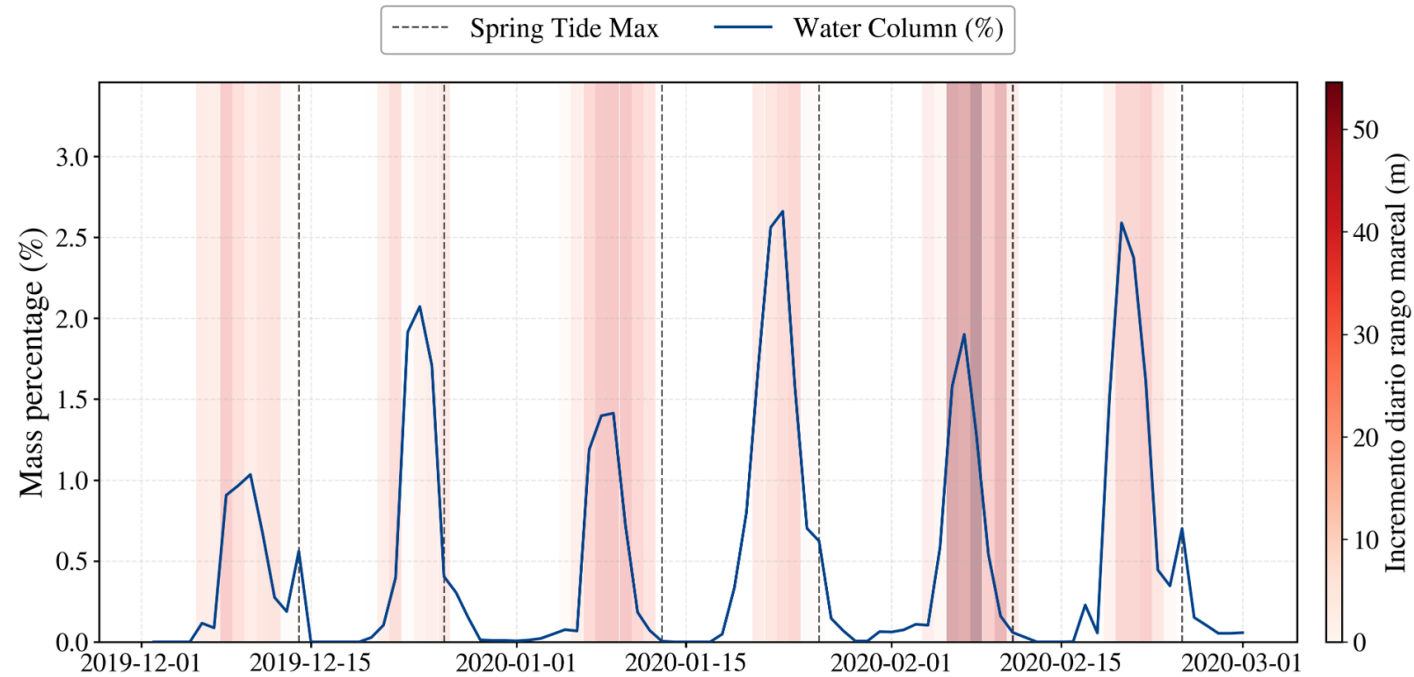


> Environmental forcing: River discharge



- Representative case (Polygon 14).
- Surface river input → Drives compensating **bottom currents** (continuity).
- **No direct peak-to-peak match** → Fluvial forcing acts as system preconditioning.

>Environmental Forcing: Tidal Modulation



- Synchronized global response correlate to **neap-spring tide cycle**.
- **Neap-to-spring dominance** → Maximum resuspension occurs during the transition.
- **Stratification vs. Turbulence** → Stronger stratified bottom flow compensates for unresolved spring-tide turbulence.

> Take-home messages

- **Degradation is the master variable:** establishes a dynamic steady state and prevents infinite organic mass buildup.
- **Severe spatial decoupling:** widespread particle dispersal contrasts with highly localized mass, meaning standard particle-tracking overestimates the real impact area.
- **Transport is driven by episodic forcing:** threshold-controlled seasonal river pulses and tidal transitions modulate benthic mobility.
- **Process-oriented 3D framework:** reliable tool to differentiate retention vs. export zones for sustainable aquaculture planning.



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