Flexible representation of obstacles in Lagrangian description for the drift of large floating debris in rivers during floods

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Context

Flood events in steepriver

⟹ drift of floating debris
(*tree trunks, rubbles, vehicles...*)

! hydraulic consequences
(*scours, cloggings...*)

! disregarded in risk mapping

! structural effects on bridges

⟹ need for better predictions

Collision model and obstacles represention

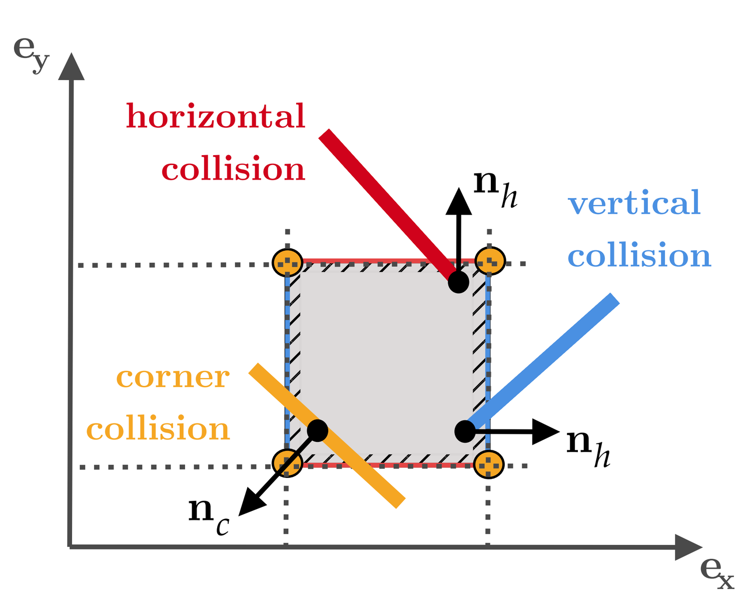
Dynamic model Introduction of impulse based on Newton's law of restitution (no friction)

→ **instantaneous** correction on the object dynamics

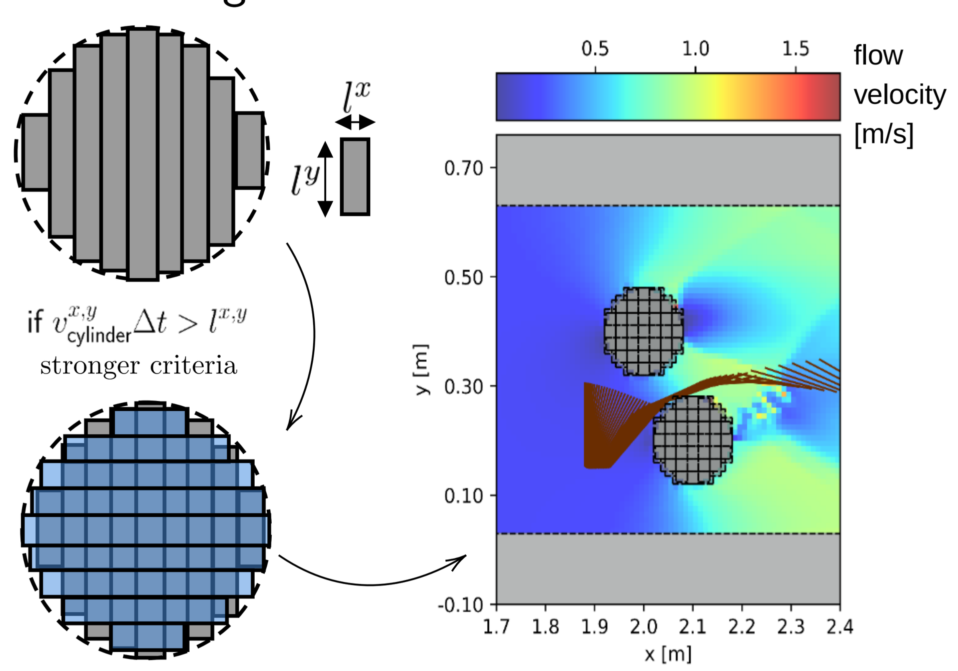
✓ No artificial geometric correction

✓ Requires only the impact point normal, cylinder velocity and position

Obstacles model Simple rectangular model for a systematic study of 3 types of collision:



Generalization Discretization of any shapes into rectangles :



Conclusion

The numerical model reproduces the

✓ **dynamics of floating debris**

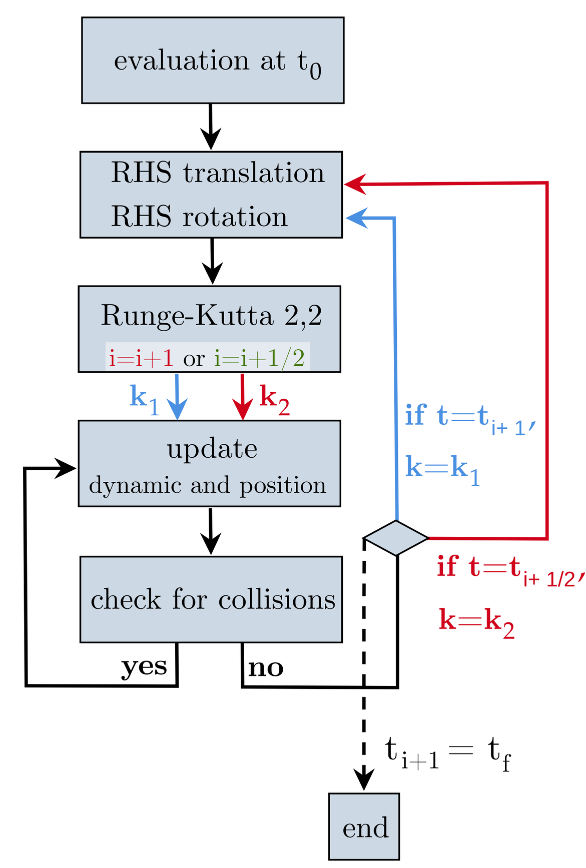
✓ **collisions phenomena**

⟹ model for studying clogging phenomena

Model

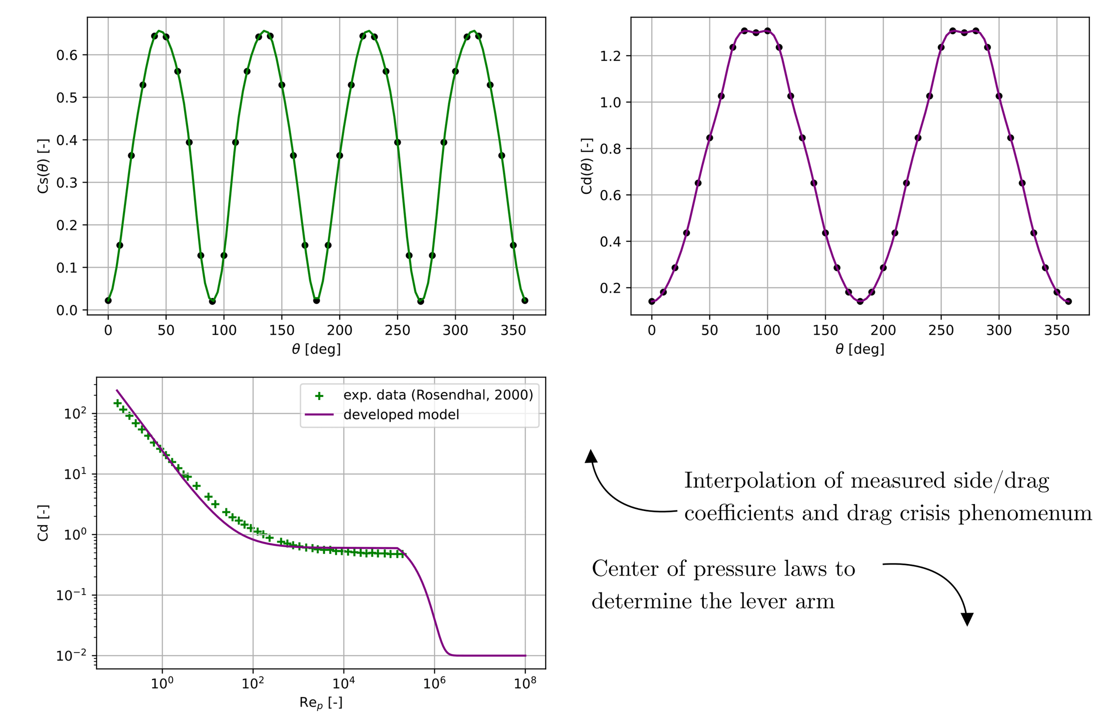
Model

- 2D Lagrangian approach for one floating debris
  → *cylinder, rigid, homogeneous*
- 2D Eulerian approach for the flow (*steady*), finite volume



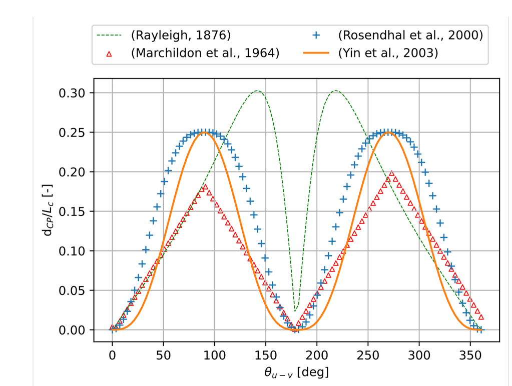
Forces

- Added mass force
- Hydrodynamic forces (drag and side forces)

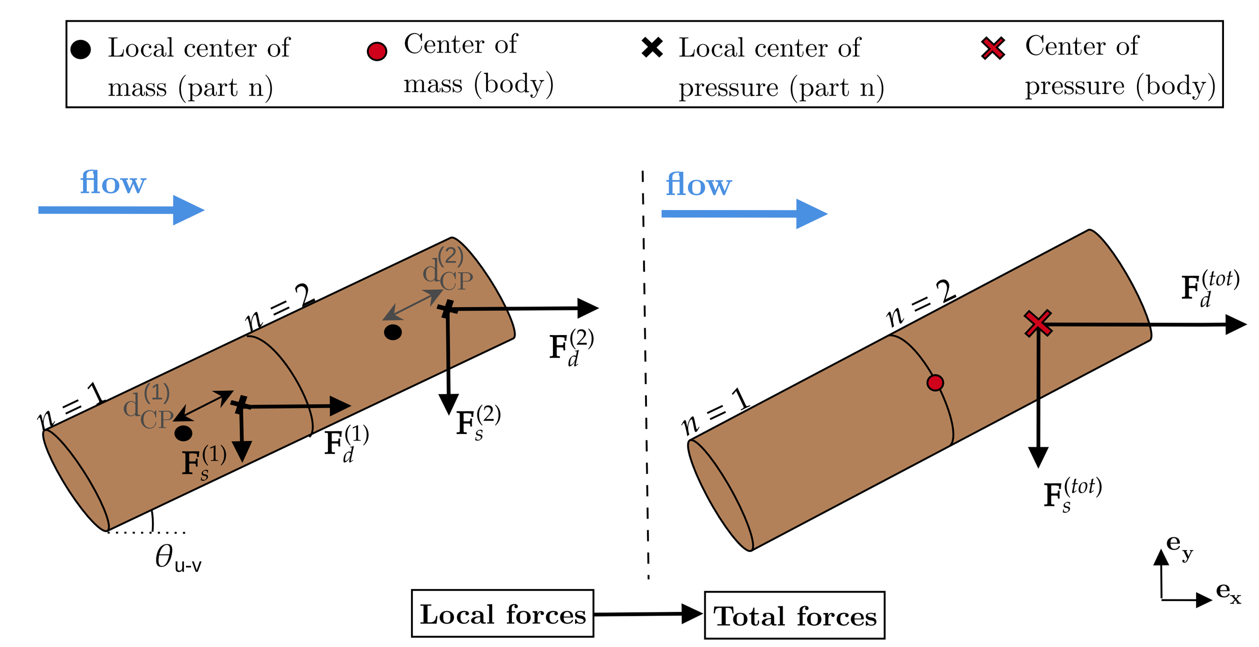


Torques

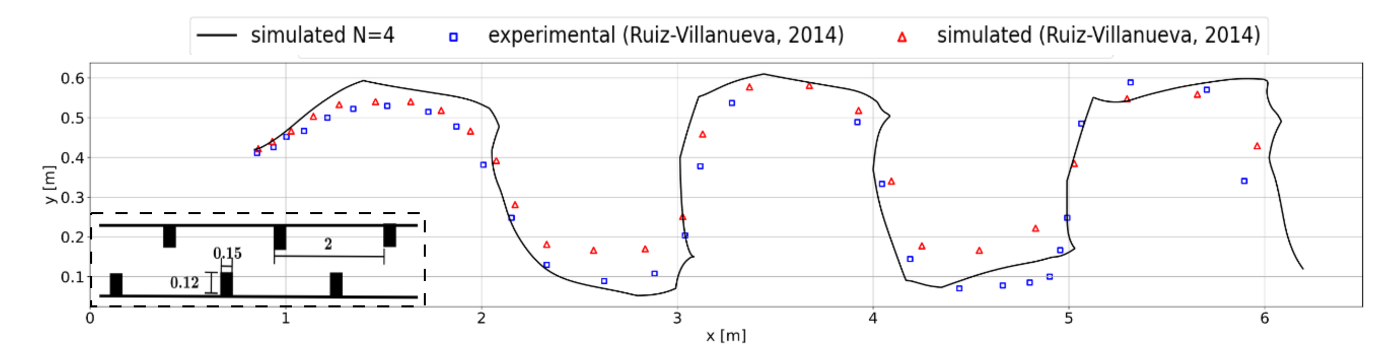
- Offset torque
- Resistance torque



Subdivision procedure Tackling the flow



Validation Center of mass trajectory



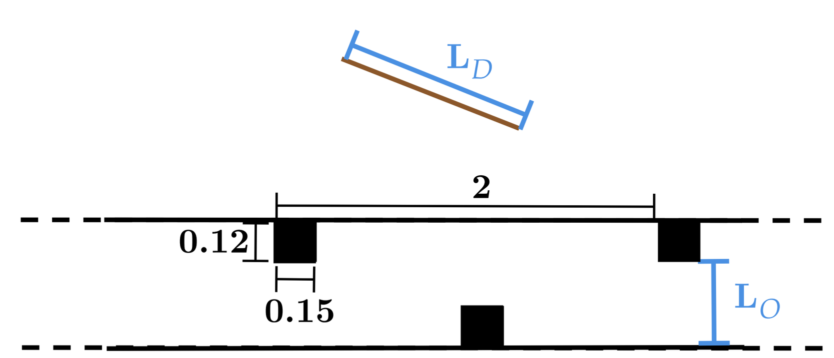
Results

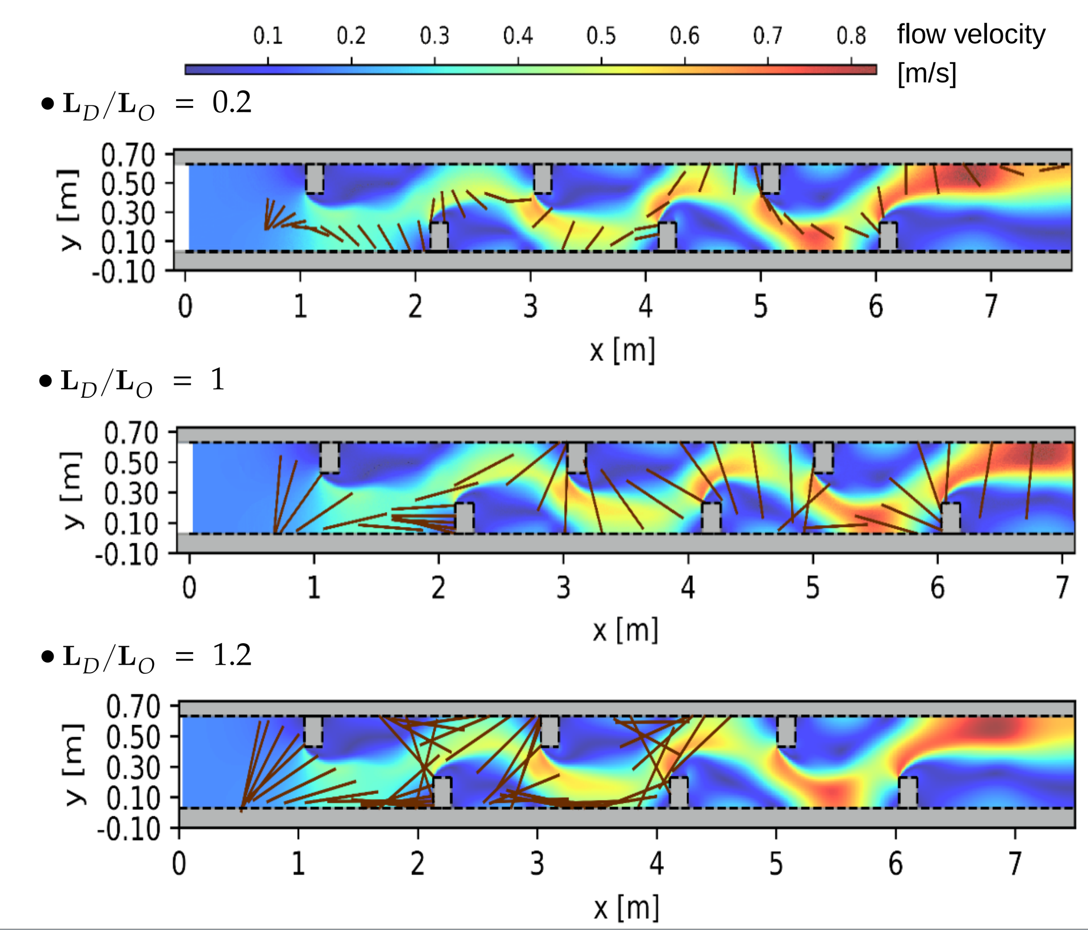
Debris size and its interaction with obstacles

- Varying parameter : debris length L_D
- Same simulation duration and debris type

⟹ Increase in the number of collisions

⟹ Direct consequences on the object dynamics with **temporary clogging**

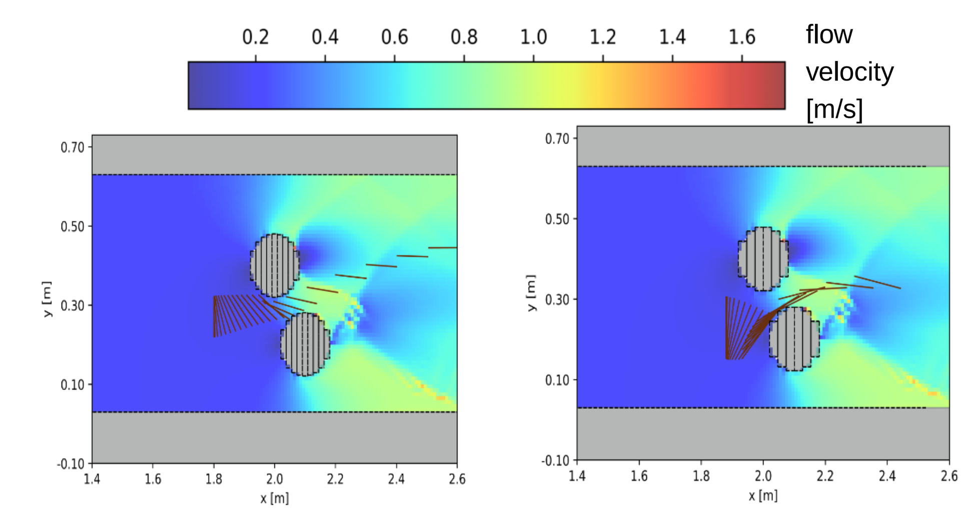




Initial condition sensitivity

- Varying parameter : initial position
- Same simulation duration and debris type

⟹ **Trajectory strongly affected**



Limitations and future work

- multiple floating debris ⟹ need for the study of additional collisions
- obstacle contouring validation ⟹ need for experimental data on detailed trajectories
- field application ⟹ need for the introduction of unsteady flows, friction force, etc.

References

- E. Persi, G. Petaccia, and S. Sibilla. "Large wood transport modelling by a coupled Eulerian- Lagrangian approach", *Nat. Hazards (Dordr.)*, Apr. 2017.
- V. Ruiz-Villanueva, E. Bladé, M. Sanchez-Juny, B. Marti-Cardona, A. Diez-Herrero, and J. M. Bodoque. "Two-dimensional numerical modeling of wood transport", *J. hydroinformatics*, 16 (5):1077-1096, Sept. 2014.
- C. Hecker. "Collision response Part 3", *Game Developer Magazine*, page 11–18, 1997.

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