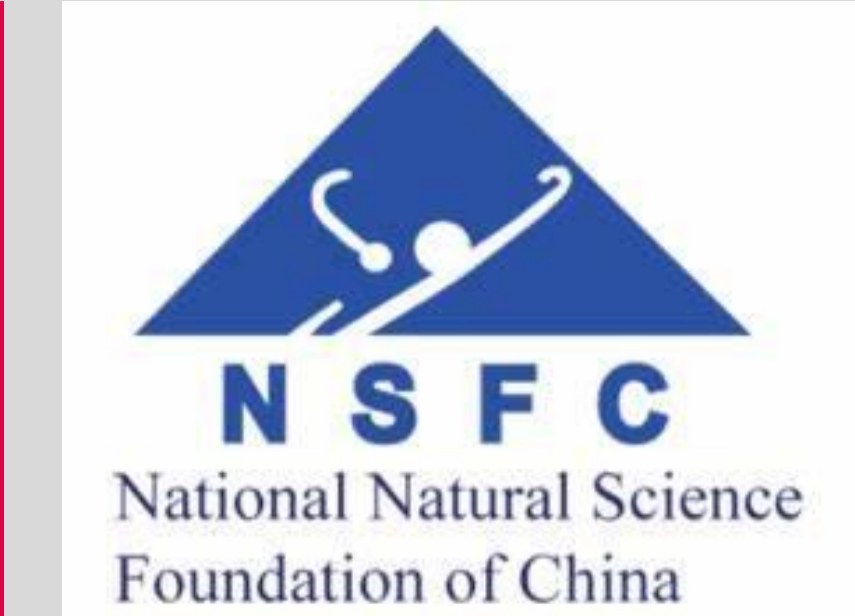


# Submarine Landslide Dynamics and Threat Assessment for Subsea Infrastructure

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BGA Annual Conference 2024



Acknowledgement

Prof. Thorsten Stoesser

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## 1 INTRODUCTION

Submarine landslides present notable characteristics, including their extensive scale, multistage progression, swift velocities, and formidable destructive potential. The dynamic process of landslide movement involves intricate phase transitions, rendering simulation and disaster analysis exceedingly challenging.

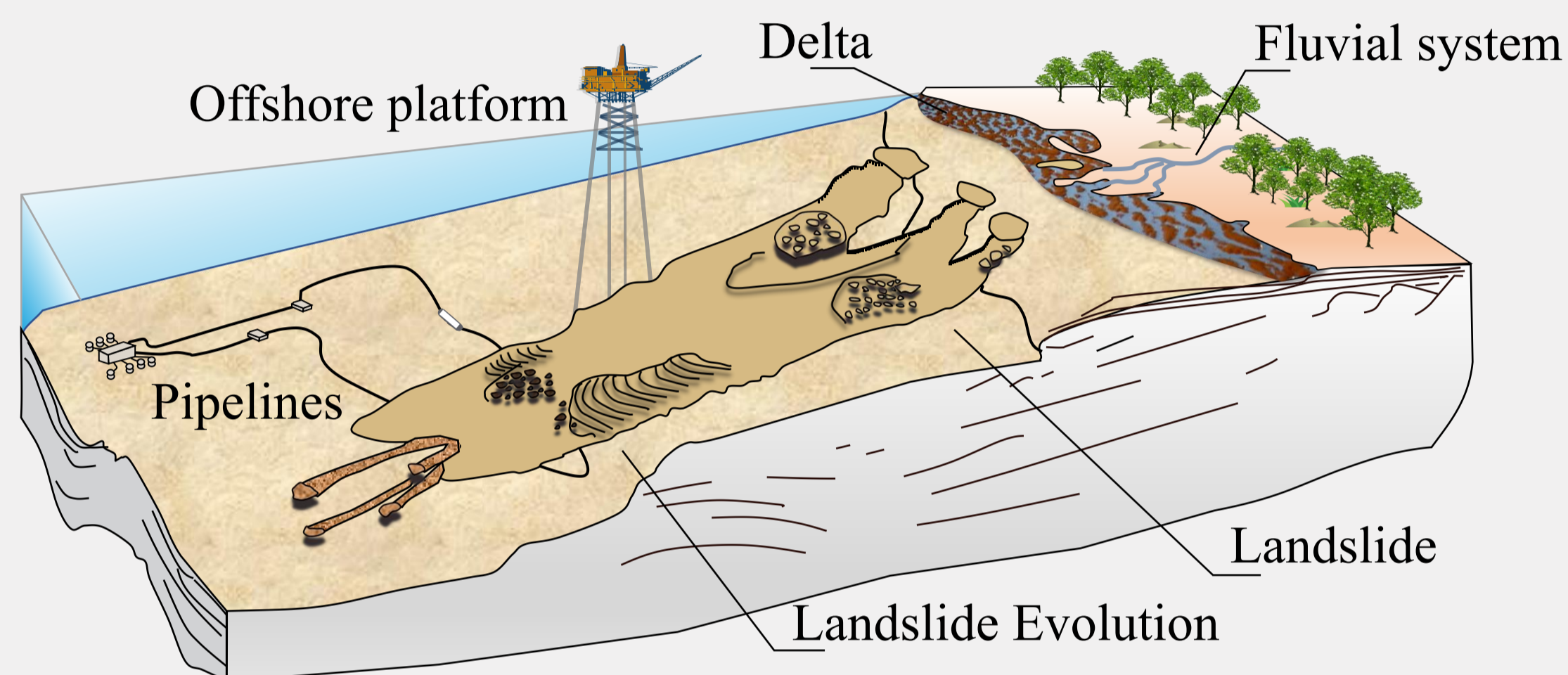


Figure 1. Submarine Landslide Evolution and Disaster Impacts.

## 2 METHODOLOGY

**Geotechnical Tests:** Submarine landslides undergo deformation across varying scales during their movement. To accommodate this, a diverse range of shear rates is necessary for sample testing. Therefore, vane shear and penetration tests with a variety of probes are utilized.

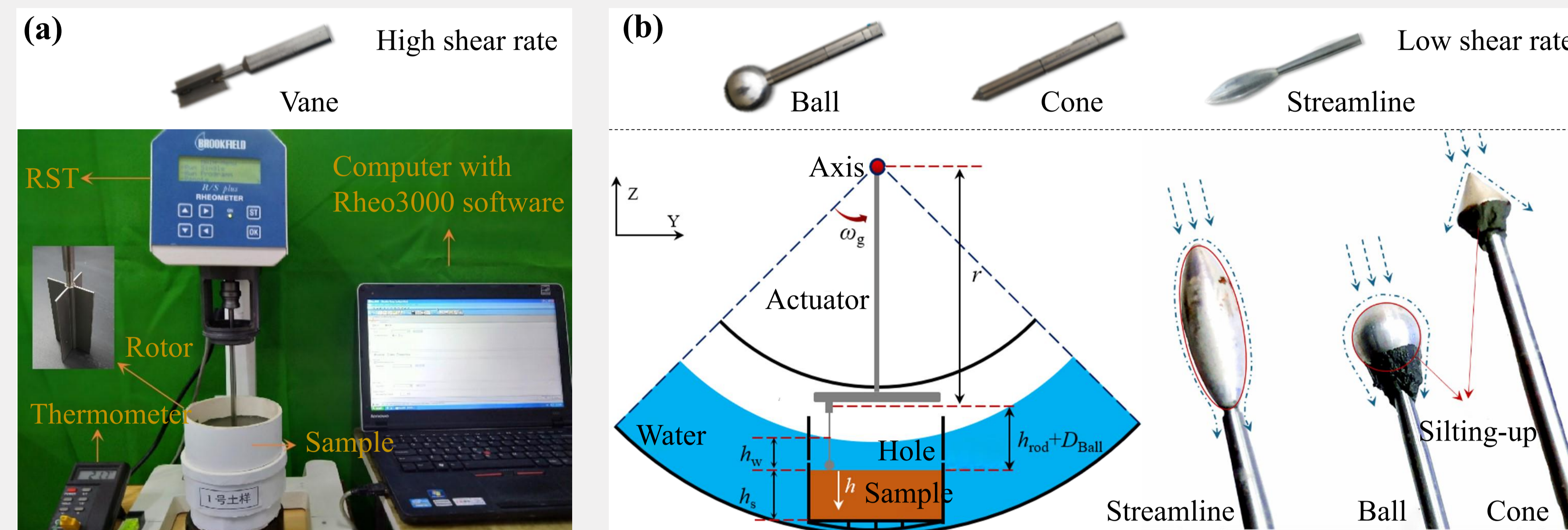


Figure 2. Sediment Sample Testing: (a) Rheological Test; (b) Centrifuge Experiment on Penetration Test.

**Numerical Models:** Using Euler-Euler and Euler-Lagrange models respectively to describe different stages of landslides. The immersed boundary method facilitates the structure-fluid coupling.

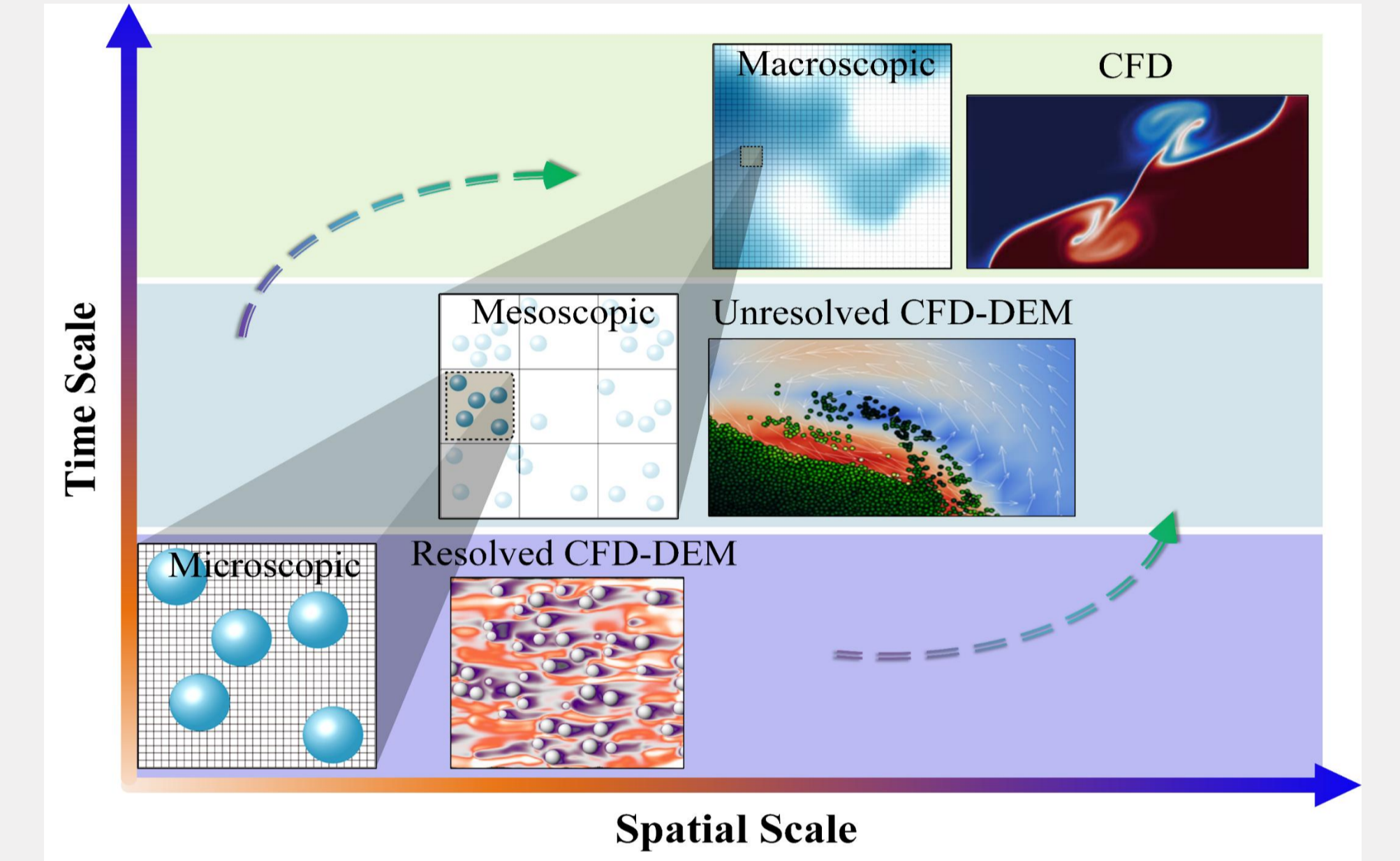


Figure 3. Multiscale Numerical Simulation.

## 3 RESULTS

**Constitutive Models:** Through geotechnical unit and centrifugal tests, constitutive models suited for the shear behavior of submarine landslides from sedimentary to turbidity current stages has been developed. This model enables the description of various mechanical properties of both fluid and soil.

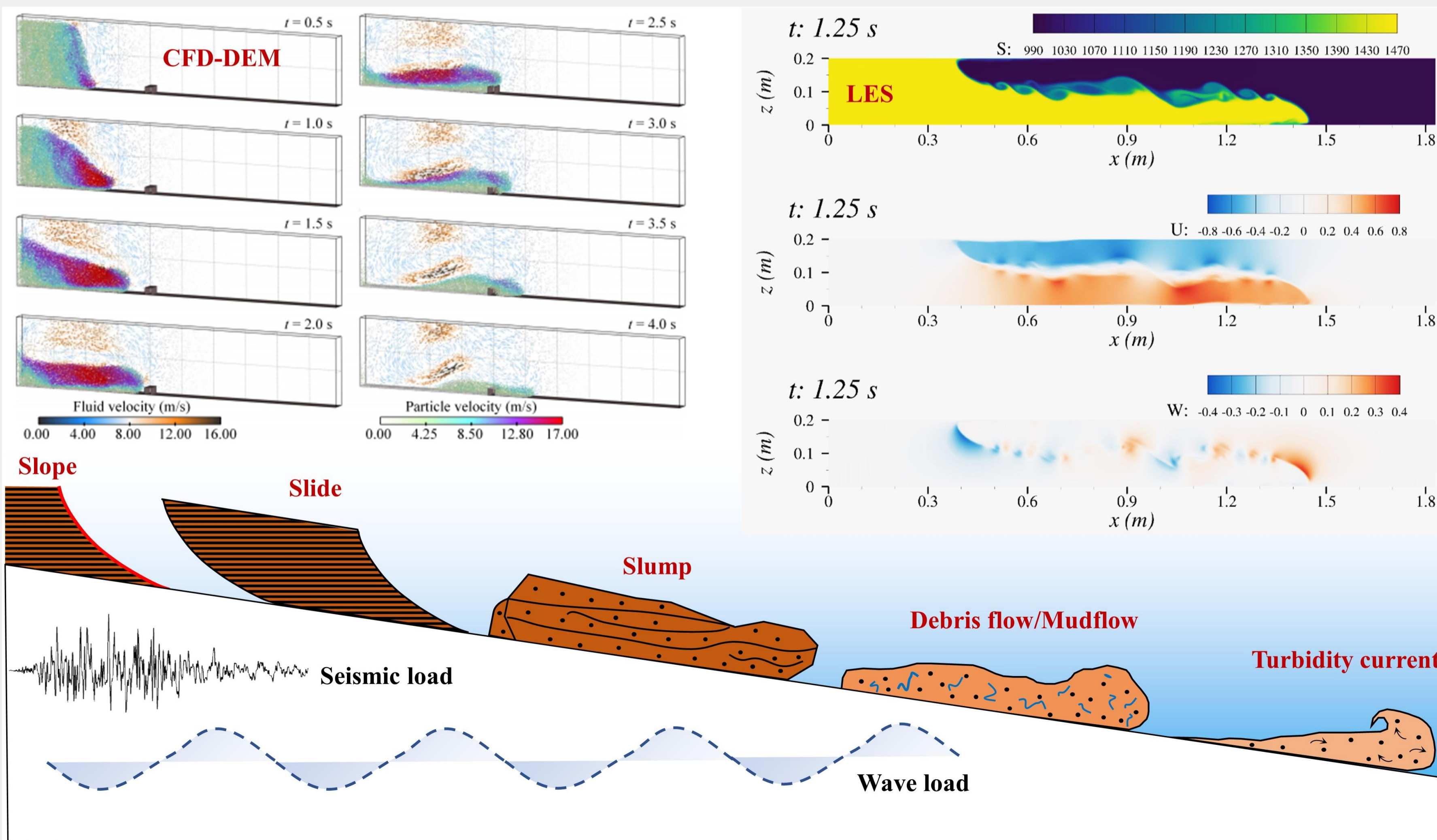


Figure 4. Simulation of Complete Life Cycle of Submarine Landslides.

**Submarine Landslide Dynamics:** As the landslide transitions from the slope to a turbidity current, the strength and density of the landslide gradually decrease, while the water content increases. The analysis framework shifts from soil mechanics to fluid mechanics.

**Threat Assessment:** Analyzing the intricate flow fields when a submarine landslide impacts engineering structures (such as pipelines and pile foundations) led to the establishment of empirical equations for impact forces on subsea infrastructures.

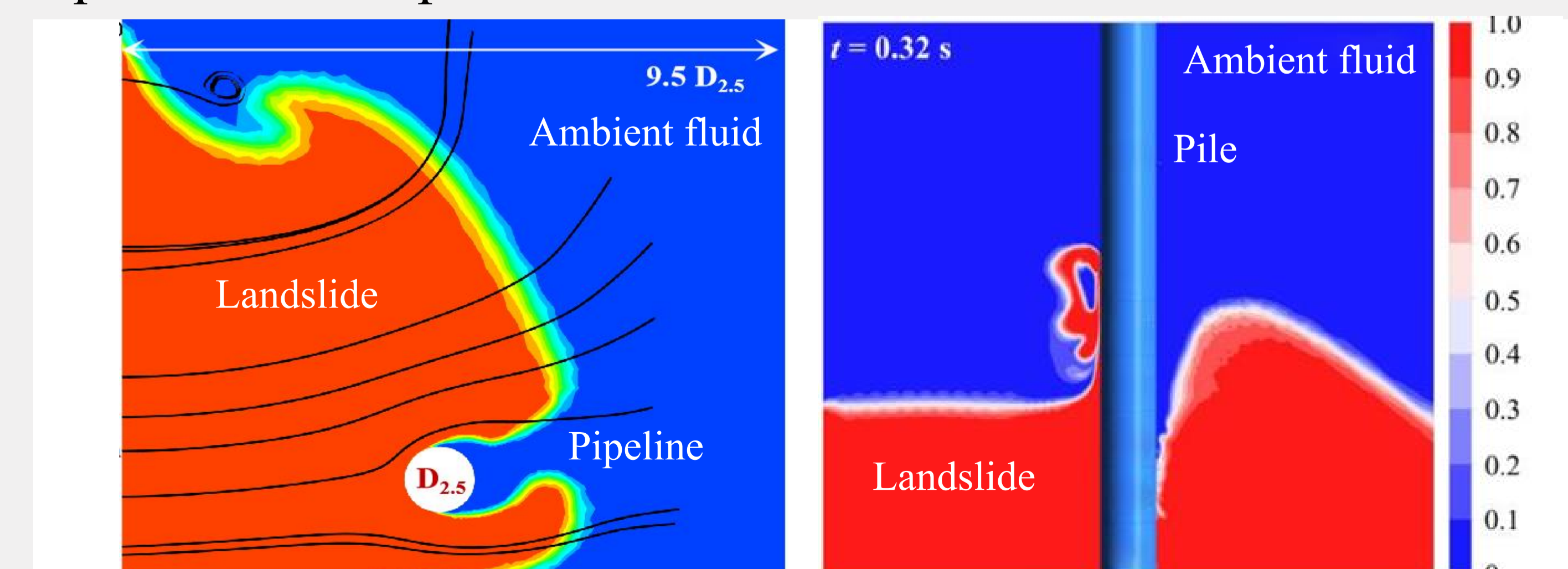


Figure 5. Simulation of Landslides Impacting Pipeline and Pile Foundations.

## 4 CONCLUSION

By sample tests, development of constitutive models, and numerical simulation, we have successfully reproduced the entire life cycle of submarine landslides and evaluated their disaster impacts. Each stage of the landslide presents a significant threat to the safety of structures. Consequently, in designing defense measures, it is imperative to avoid the path of the landslide to the greatest extent possible.

### References

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