La Rochelle Université
Institut Littoral Urbain Durable Intelligent

HR EXCELLENCE IN RESEARCH

Fully funded PhD thesis in coastal oceanography

Laboratory

UMR 7266 LIENSs (https://lienss.univ-larochelle.fr/)

Thesis title

Hydro-sedimentary dynamics of sandy beaches during storms

Thesis supervision

PhD director: Xavier Bertin, CNRS, Research Director, 60 %

Co-director: Anne-Claire Bennis, University of Caen Normandie, Full professor, 40%

Co-supervisor: Kevin Martins, CNRS, Research Officer

Description of the PhD project

Erosion of sandy coastlines is a global concern, generally attributed to a reduction in sediment supply from rivers and rising sea levels. However, the contribution of storm events to these long-term erosive trends remains poorly understood, even though high return periods events can cause profound and long-lasting morphological changes at regional scale. This knowledge gap can be explained by the difficulty in obtaining in situ observations during such events, which limits our understanding of the physical processes responsible for beach erosion during storms. Recently, Pezerat et al. (2023) collected observations of bottom pressure, vertical velocity profiles and sediment concentrations at a dissipative beach situated to the south-west of Oléron Island (Bay of Biscay) under storm conditions (significant wave height exceeding 6 m at breaking). The analysis of this exceptional dataset showed that an undertow exceeding 0.2 m/s developed as far as 4 km from the shore. This mean seaward-oriented current, combined with wave orbital velocities exceeding 3 m/s, dominated sediment transport and could result in very substantial sand transport seaward. The development of infragravity (IG) waves exceeding 1 m in height, with troughs coinciding with the strongest waves (bound wave pattern), also contributes to sediment transport seaward. Finally, a time lag between sediment resuspension and the peak in wave orbital velocities was also observed, which can contribute to net sediment transport seaward. This process, controlled by wave non-linearities and sediment grain size, mostly remains ignored in process-based morphodynamic models.

This project aims to better understand and model sediment dynamics in the presence of storm waves, in order to quantify the fate of sediment eroded from beaches during such events. It will provide a better understanding of the contribution of storm surges to the long-term evolution of sandy beaches, which remains an open scientific question at international level. More specifically, the processes observed by Pezerat et al. (2023) remain specific to given hydrodynamic conditions and beach morphology and need to be explored for different sediment grain sizes and beach slopes. This PhD project is based on future hydrodynamic campaigns to be carried out at the DYNALIT National Observation Service's study sites located in the Nouvelle-Aquitaine Region as part of the national PEPR IRICOT and regional PSGAR CORALI projects. The DYNALIT study sites in the Nouvelle-Aquitaine region exhibit great diversity in their morphology, ranging from steeply sloping beaches in the Basque Country to gently sloping ones in Charente-Maritime, for which monthly to half-yearly beach morphology data have been available since the late 1990s. During these forthcoming campaigns, turbidity sensors will be co-located with pressure transducers and current profilers deployed on the seabed. The dynamics of the beach upper part will by monitored using LiDAR scanners, deployed in the scope of the ANR IMPASTO project. Analysis of the field observations will be complemented by numerical simulations using the SCHISM modelling system (Zhang et al., 2016), par-

tially developed at LIENSs (e.g. Martins et al., 2022) and CROCO, partially developed at the M2C laboratory (e.g. Porcile et al., 2023). These two numerical modelling systems use a similar sediment transport module, derived from that of the USGS (Warner et al., 2008), which will be the subject of further development. In particular, parameterisations of intra-wave dynamics (effects of IG waves and short wave phase lag) will be developed for phase-averaged modelling, in order to study the contribution of storms to long-term beach erosion.

Cited references:

Martins K., Bertin X., Mengual B., Pezerat M., Lavaud L., Guérin T., Zhang Y.J., 2022. Wave-induced mean currents and setup over barred and steep sandy beaches. Ocean Modelling, 179, art. no. 102110

Pezerat M., Bertin X., Coulombier T., 2023. Cross-shore suspended sediment transport in a macro-tidal and low-sloping upper shoreface. Earth Surface Processes and Landforms, 48 (5), pp. 853 – 862

Porcile, G., Bennis, A.-C., Boutet, M., Le Bot, S., Dumas, F. and Jullien, S., 2024. Implementation of additional spectral wave field exchanges in a 3D wave-current coupled WAVEWATCH-III (version 6.07) - CROCO (version 1.2) configuration and assessment of their implications for macro-tidal coastal hydrodynamics. Geoscientific Model Development 17(7), pp. 2829–2853

Warner, J.C., Sherwood, C.R., Signell, R.P., Harris, C.K., Arango, H.G., 2008. Development of a three-dimensional, regional, coupled wave, current, and sediment-transport model. Computers and Geosciences 34, 1284–1306.

Zhang, Y.J., Ye, F., Stanev, E.V., Grashorn, S., 2016. Seamless cross-scale modelling with SCHISM. Ocean Modelling 102, 64–81.

Thesis management and practical arrangements

This PhD thesis will be based at the LIENSs laboratory at La Rochelle University (https://lienss.univ-larochelle.fr/) and scientific visits will be regularly organised at the M2C laboratory at University of Caen Normandie (https://m2c.cnrs.fr/). As explained above, this PhD thesis is a contribution to the PEPR IRICOT national project (https://www.pepr-risques.fr/fr/projets-cibles/iricot-vers-une-meilleure-comprehension-des-risques-littoraux-pour-preparer-societe) and close collaborations will take place with the PSGAR CORALI regional project. The numerical tools used in this PhD project are partially developed at LIENSs and M2C labs, which will make them easier to learn.

The operation budget of this thesis (participation in conferences, missions to French partners, including in the overseas territories) will be covered by the IRICOT project. The gross salary will be 2300 €/month (1840 €/month after taxes). Social security contributions include health insurance and pension contributions.

Finally, the computing resources required for this thesis project will be provided by the MCIA and CRIANN regional computing centres, the national GENCI resources, and a local cluster (320 cores).

Application procedure:

We are looking for a strongly motivated candidate with a Master degree or an engineering diploma in physical oceanography, environmental fluid mechanics or Civil Engineering. Previous experience in hydro-sedimentary numerical modelling with SCHISM or CROCO would be a major asset. Interested candidates should contact Xavier Bertin (xbertin@univ-lr.fr), Anne-Claire Bennis (anne-claire.bennis@unicaen.fr) and Kevin Martins (kevin.martins@univ-lr.fr), and send a detailed CV, a cover letter and transcripts of their Master's grades by 17 July 2026. Auditions will be held on the 20 July 2026, remotely or in person.