

WinTherface – Mass Exchange Driven by Wind and Temperature in Lake-wetland Interfaces

Summary

WinTherface addresses the study of exchange flows in lake-wetlands interfaces, and its impacts on the water quality, through a multidisciplinary approach integrating field, laboratory and numerical work. The employed methodologies aim at obtaining results at three levels hydrodynamic processes, instruments and societal applications. Detailed laboratory tests will allow phenomenological advances in understanding the wind effect on surface exchange flows and on the interaction of buoyancy, drag and wind forces. The findings of field and laboratory work will support the development of a physically based and efficient simulation tool to model the hydrodynamics and water quality of lakes and estuarine regions. This operational result will support the establishment of new design criteria to enhance lake water quality through sustainable solutions, configuring, at societal level, a key advance on the assessment of the aquatic environments quality, a mandatory directive for EU Member States.

The project involves the cooperation of two research centres: CESAM, leading the field work and CERIS, responsible for laboratory and numerical work. The feasibility of the project is ensured by a multidisciplinary team, which synergically includes members experienced in ecology and water quality; in field work; in hydrodynamic processes; in laboratory work employing laser based instrumentation and in numerical modelling with high-performance computing.

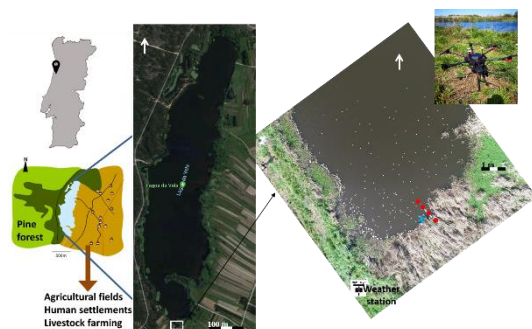


Figure 1. Schematic representation of the field site, Vela Lake.

The field work was carried out at Lake Vela (Figueira da Foz), a eutrophic freshwater shallow lake (1.5 m deep), with 70 ha of surface area, included in the Ecological European Net-Rede Natura 2000 (PTCON0055). A weather station and four water temperature probes installed in a littoral-pelagic transects are continuously collecting data allowing the characterization of seasonal and diurnal variations. Superficial flow

velocity was computed by Particle Tracking Velocimetry (PTV) and Particle Image Velocimetry (PIV) techniques employing images acquired by a drone equipped with a CMOS sensor camera. Two 48-h campaigns were carried out to collected zooplankton samples at the sub-surface in the lake-wetland interface and the pelagic zone for further research on horizontal migration patterns.

The laboratory tests were carried out employing the lock-exchange technique and image analysis technique. The dense fluid was obtained by a mixture of fresh water, salt and rhodamine while the ambient fluid was obtained by a solution of clear denatured ethanol and freshwater.

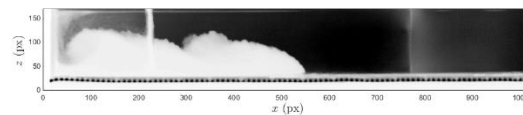


Figure 2. Laboratory test of a density current over an unobstructed bed.

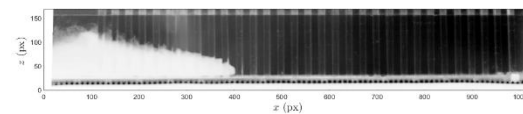


Figure 3. Laboratory test of a density current interacting with an array of emergent cylinders, simulating rigid vegetation.

Numerical modelling consisted in 3D large eddy simulation (LES) performed in OpenFOAM using VoF (volume-of-fluid) method to simulate the fluid phase.

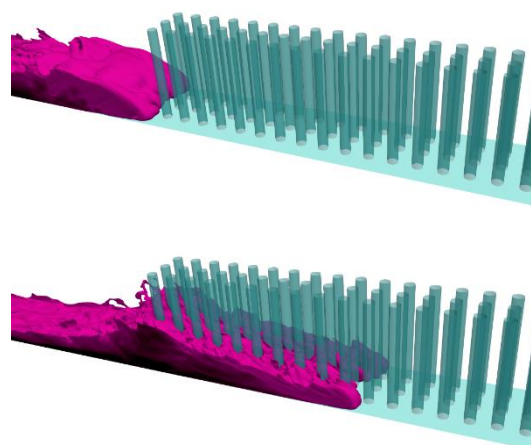


Figure 4. Two time instants of a LES-modelled density current interacting with an array of rigid cylinders.

Project Reference

PTDC/CTA-OHR/30561/2017

Leading Institution

IST-ID – Associação do Instituto Superior Técnico para a Investigação e Desenvolvimento (Portugal)

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Funding

FCT – Fundação para a Ciência e a Tecnologia

Period

2018-2022

Total

230 978.14€

CERIS

184 317.93€

Project Website

wintherfacefct.wordpress.com