MSc. Thesis Proposal

Title: Flow simulation in Tagus estuary for current turbine application

Supervisors
Ramiro Neves (Prof.), Professor at MARETEC at IST
Guilherme Vaz (Dr., inv. Prof.), R&D manager at blueOASIS
Tiago Gomes (Eng.), Researcher at blueOASIS

Introduction

Motivation

The use of the natural power of running water of rivers and streams is dating back to the first water mills in ancient Greek and Roman times. Nowadays, in the energy transition from fossil fuel to renewable energy sources, river and marine hydrokinetic turbines for electricity generation can still be considered an emerging but growing technology. To predict current turbine performance and evaluate the economic feasibility of a project at a specific site, a detailed current resource assessment is crucial. For those tasks, numerical simulation tools are indispensable and, compared to model or on-site experiments/measurements, cheap methods used in concept and design stage. In this thesis, the flow in the Tagus estuary shall be investigated and assessed regarding the application of hydrokinetic turbines for powering Lisbon area. Estuarine flow is a complex process, with freshwater flow from the river encountering salt water from the sea, while being subjected to tides and constrained by local bathymetry.

Existing work

A software able to model such phenomena is MOHID (http://www.mohid.com/) developed at IST since 1985. MOHID is a three-dimensional numerical water modelling system based on the finite-volume approach, programmed in FORTRAN95 using an object-oriented philosophy. It allows integrated modelling of different physical and biogeochemical processes across multiple scales and systems. Coupling with external numerical tools is possible to enhance the software's functionalities.

To estimate the power production, multi-fidelity approaches for a turbine operation under the previously computed current/tidal resources are possible. From simple actuator disk models, to BEM/panel methods, up to viscous-flow RANS or even SRS approaches can be employed. With multi-phase viscous-flow code ReFRESCO, developed by MARIN (www.marin.nl) together with blueOASIS (www.blueoasis.pt), the detailed operation of such turbine, including interaction with free-surface, bottom, objects and other turbines can be accurately simulated. Therefore, the coupling between MOHID and ReFRESCO, both MPI-accelerated FORTRAN95 codes, never performed before, will enlarge the capabilities of both tools and permit a highly accurate representation of full-scale operating hydrokinetic turbines.

Objectives

The following studies are planned to be performed:

- Get familiar with using MOHID.
- Setting up the test cases, considering the bathymetry of Tagus estuary, river flow, tides etc.
- Assess current turbine performance in Tagus estuary environment, using the simplified model existing in MOHID.
- Get familiar with using CFD code ReFRESCO and its actuator disk functionality.

- Couple ReFRESCO with MOHID (file and/or memory-based).
- Compare performance of MOHID, ReFRESCO and MOHID+ReFRESCO coupling for a benchmark turbine (Southampton, Tocardo, etc.) at river Tagus.
- Reporting and presentation. Upon good performance of the candidate the work may be presented in a conference and/or in a journal.

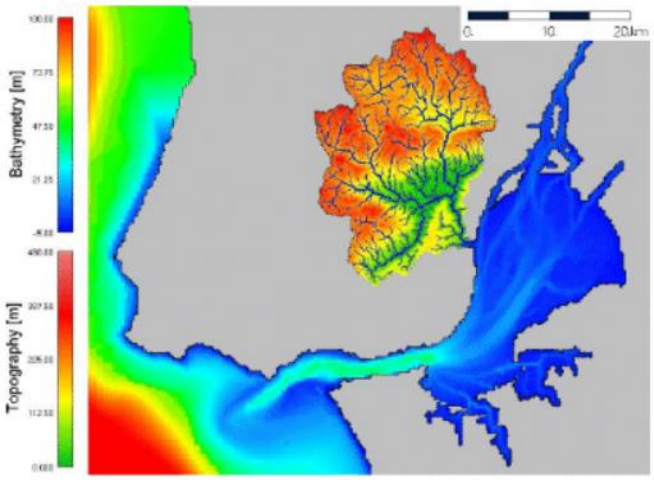

Figure 1: Bathymetry of Tagus estuary

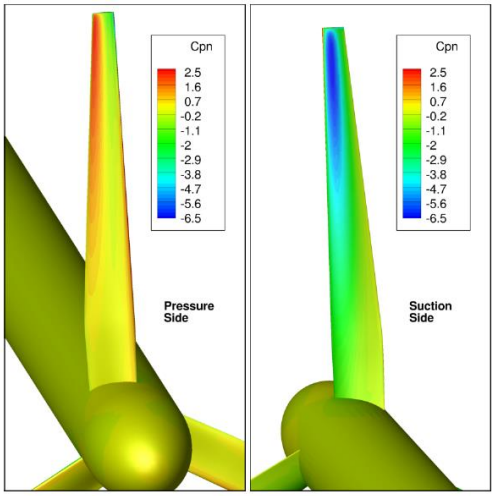

Figure 2: ReFRESCO turbine blade pressure distribution.

Requisites

Applicants must have:

- General knowledge of CFD
- Coding experience with FORTRAN, Python or similar.

Good to have:

- Linux experience
- LateX experience
- Git experience

Added value to have:

- Knowledge on MOHID.

Location

blueOASIS (www.blueoasis.pt) Edificio D.Pedro, Quinta da Fonte, R. Malhões, 2770-071 Lisboa The student is invited to join the team in the office when the supervisor is present (at least three days per week).

Companies Involved

blueOASIS is a young team with more than 45 years of combined knowledge and experience on Aerospace, Mechanical, Naval and Maritime engineering. The multicultural and multidisciplinary team is committed to make our oceans safer and greener, using state of the art numerical and data science tools. BlueOASIS focuses on renewable energies, ocean cleaning, decarbonization, sustainable offshore structures and green ships optimization.

Bibliography

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