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CFD numerical tool to quantify energy dissipation produced by natural ecosystems under waves and current conditions

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Capacity for coastal ecosystems to damp flow energy has been widely recognized and the associated coastal protection service is more and more considered by coastal managers. However, more efforts should be done on well characterizing small scale processes under realistic conditions to develop new tools and formulations that will help to put in value this ecosystem service. This work aims to make a step forward in better understanding the physics involved in flow-vegetation interaction by using CFD modeling to find new formulations based on the most important parameters driving each problem. These parameterizations will serve to feed larger scale models that can be applied to solve the ecosystem scale. The CFD model OpenFOAM© is considered in this study. OpenFOAM© is a three-dimensional Navier-Stokes (NS) solver that allows reproducing free surface flows linking fluid pressure and fluid velocity. It allows evaluating free surface evolution, nonhydrostatic forces and gives a detail definition of the flow considering turbulent effects. Different types of ecosystems are reproduced in the model. Focusing this study on intertidal areas two ecosystems are simulated: saltmarshes, ecosystem that develops in template zones, and mangroves, covering intertidal areas in tropical zones. Two different approaches are followed. Saltmarshes are reproduced by introducing and extra term in the momentum equation that accounts for their characteristics and induce flow energy dissipation. Mangroves, instead, are simulated considering the individual trees that conform the forest. The first approach allows quantifying energy attenuation produced by the ecosystem based on its characteristics and incident flow conditions. In addition, the second approach allows studying more detailed processes such as flow velocities and turbulent processes inside the field, the forces exerted on the individual elements and the bottom shear stresses around them. Then, both approaches represent valuable tools to better characterize flow-vegetation interaction. Furthermore, the flexibility of the model on reproducing different ecosystem characteristics, as well as different hydrodynamic conditions, gives the possibility of simulating different scenarios that will allow get new formulations or extend existing ones.