Large eddy simulations of turbulent flow through idealized vegetation with suspended sediment load

T. Paone,* R.M.L. Ferreira*, A.H. Cardoso* and V. Armenio†

*Civil Engineering Research and Innovation for Sustainability (CERIS)
Instituto Superior Técnico, Universidade Técnica de Lisboa,
Av. Rovisco Pais, 1, 1049-001
Lisbon, Portugal
e-mail: teresa.paone@tecnico.ulisboa.pt, ruimferreira@ist.utl.pt, antonio.cardoso@ist.utl.pt

† Department of Engineering and Architecture
University of Trieste
V. Valerio, 10, 34217
Trieste, Italy
Email: vincenzo.armenio@dia.units.it

ABSTRACT

The flow past emergent cylinders mounted on a wall is a fluid mechanics problem of considerable practical and fundamental interest. In environmental fluid mechanics, it is a proxy for emergent vegetation in open channel flow. The presence of vegetation shapes the mean flow field and turbulence and strongly influences the morphological and ecological dynamics of river and coastal areas. Due to the increased form drag associated to the cylindrical obstacles, turbulence, and thus the ability of re-suspension, are reduced within the vegetation, if compared with a boundary layer flow with the same discharge. Recently, large eddy simulations (LES) are used to solve this type of flow since its complex three-dimensional unsteady behavior presents troubles for statistical turbulent model [1]. None of them contain a suspended sediment tool.

In the present study, the LES-COAST code including a suspended sediment model [2] is adopted to study flow-vegetation-sediment interactions. It is an Euler-Euler single-phase approach involving LES with sub-grid-scale model to solve the 3D Navier-Stokes equations coupled with an advection-diffusion equation to solve the suspended sediment concentration. The objectives are i) to observe how the presence of suspended sediment load influences the flow field within an array of cylinders by comparing the results with and without sediment in the water column and ii) to understand how this configuration affects the sediment transport process by comparing the results for the vegetation with existent numerical data performed for an isolated cylinder.

REFERENCES

[1] Stoesser, T., S. Kim, & P. Diplas (2010). Turbulent flow through idealized emergent vegetation. J. Hydraul. Eng. 136, 1003–1017.

[2] Dallali, M. & V. Armenio (2014). "Large eddy simulation of two-way coupling sediment transport." *River Flow - the 7th International Conference on Fluvial Hydraulics - at EPFL*, Lausanne, Switzerland.