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Modelling flood events in Venice Lagoon with a cumulant CO lattice Boltzmann shallow water model

Jessica Padrone[1], Silvia Di Francesco[1], and Sara Venturi[2]
[1]Università degli Studi Niccolò Cusano, Ingegneria civile, Roma, Italy (jessica.padrone@unicusano.it), (silvia.difrancesco@unicusano.it)
[2]Università di Perugia, Ingegneria civile e ambientale, Perugia, Italy (sara.venturi@unifi.it)

In this work a multi-relaxation time (MRT) Lattice Boltzmann model based on the use of non-conventional collision operator is used to simulate the flood event in Venice Lagoon.

Numerical methods (finite difference, finite volume and finite element methods) that solve the macroscopic equations of fluid mechanics (Navier Stokes equations), are usually employed for these aims. Most of these methods put in evidence that the application of bed slope and friction forces can lead to inaccurate solutions due to numerical errors.

In addition, the extension of these schemes to complex geometries is not straightforward and some of these approaches are very computational expensive if applied to real flows. Since the problems are posed at a large scale, it should be the aim to develop a simple and accurate representation of the source term to simulate realistic shallow water flows.

The LBM approach is a versatile method and it has been extensively applied in different fields.

Non-conventional Lattice Boltzmann models based on central moments and cumulants collision operators allows to simulate large-scale hydraulic problems such as flooding events and the use of a GIS environment allows to set the information related to topography, initial conditions (water depth and velocity values distribution), boundary conditions (position and type of solid and inlet/outlet boundaries), external force (value and distribution of roughness coefficients, obstacles position) and to make this data available for the execution of the numerical model.

In order to validate the correctness of the proposed mathematical model for Venice Lagoon, the real flood event that took place on November 12, 2019 is simulated: several field data are available for this test case; the results, in terms of water level and velocity field are compared with recorded data, verifying the accordance. Moreover, technical solutions for hydraulic risk evaluation and mitigation, taking account of the expected sea level rise, due to climate change, are proposed.