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MODELING OF WETTING-DRYING TRANSITIONS IN FREE SURFACE FLOWS AND OVER COMPLEX TOPOGRRAPHIES

***A. Soulaïmani[1], J-M. Zokagoa[1], T. Quach[2] and G.W. Tchamen[2]**

[1] Ecole de technologie supérieure,
Mechanical Engineering
1100 Notre-Dame O., Montréal (QC)
H3C1K3, Canada
Azzeddine.soulaimani@etsmtl.ca

[2] Hydro-Québec
Unité Barrages et Hydraulique
75 Blvd René-Levesque Ouest,
3ème étage,
Montréal (QC) H2Z 1A4, Canada
Quach_Thanh.Tung@hydro.qc.ca

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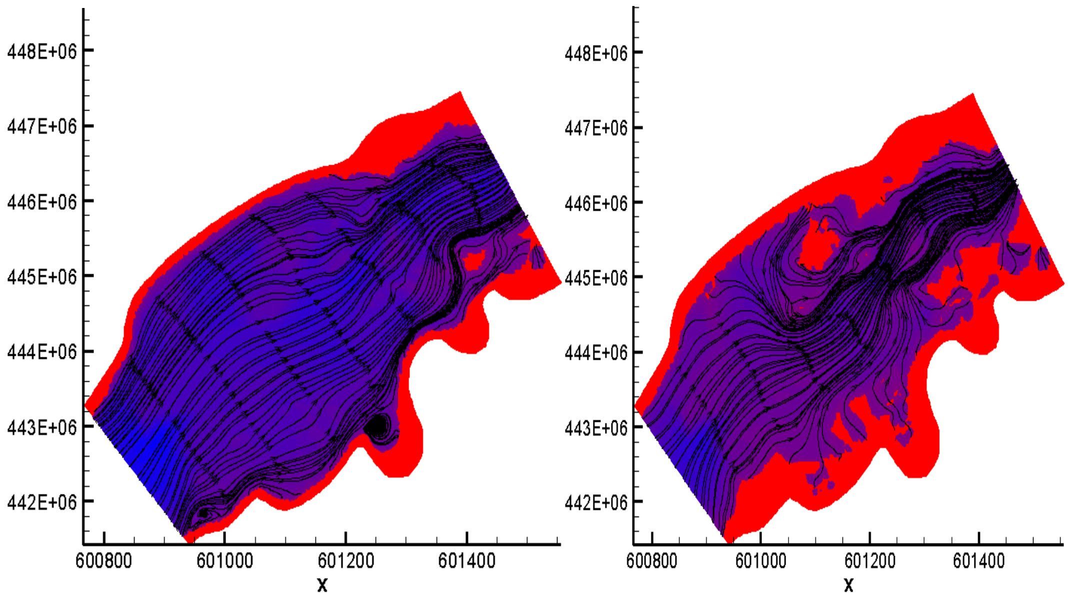
ABSTRACT

The development of numerical techniques in computational fluid dynamics for free surface flows has been of a great interest during the last decades ([1-6]). The general purpose involves an accurate prediction of dam breaks, flumes and fluvial floods, estuarine and costal circulations and other catastrophic flooding phenomenon. Most of these flooding events include wetting and drying surfaces. The challenge is greater when the domain is of a complex topography. Indeed, for the two-dimensional shallow water equations which are generally used to model shallow-water flows in nature, most of existing numerical models have failed to predict accurately wet/drying fronts' movements. The main efforts have been put on building accurate and stable numerical solvers for shock capturing and unfortunately less were devoted on resolving the wetting/drying fronts, which are of more practical importance. The most satisfactory results are those relative to flow in channels. The treatment of the source terms in case of extreme slopes and abrupt changes in the irregular geometries leads generally to important numerical errors and stability difficulties, and these become more critical when dealing with propagation over complex dry beds. An appropriate numerical discretization of the source terms is one key of the accuracy and stability of the numerical schemes.

This paper presents a numerical model based on a simple finite volume solver and a special treatment of the wetting and drying areas. Indeed, using a linearization of the term relative to the gravity forces and a Lax-Friedrich scheme, the resulting shallow-water solver is shown to be stable and robust for any bathymetry. The second relevant issue concerns a special conservative treatment for wet-dry beds. The numerical model has been validated trough the benchmark case of the second test of CADAM [7], which shows accurate prediction of water level evolution over a bump. Furthermore, a real case study has been assessed by simulating flooding and drying flows over the breakwater of a portion of the river "rivière des prairies" in Quebec (Canada), which

has a complex bathymetry. The simulation involves a fluctuating inflow flux and using a non-reflecting condition for the outflow boundary. The figures below show the wetting and drying areas, respectively due to the increasing and decreasing inflow fluxes. The results prove the capability of the scheme in handling complex flow domains and assess the robustness of the code.



Streamlines during the flooding and drying events in the breakwater on "river des prairies"

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