NUMERICAL PROJECTS

HYPERBOLIC SYSTEMS AND FINITE VOLUME METHOD

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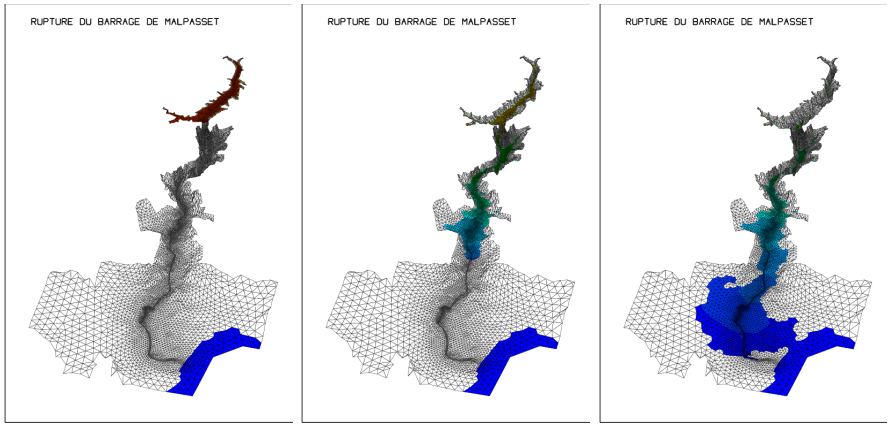
APPLICATIONS TO FREE SURFACE ENVIRONMENTAL FLOWS AND TRAFFIC MODELIZATION

Teacher : E. Audusse (BANG project - INRIA Paris-Rocquencourt and UPMC ; LAGA - University Paris Nord)

Duration : 20 hours.

Objective and contents: The main objective of this course is to present some basic features for the numerical simulation of hyperbolic equations by using the finite volume method. Hyperbolic systems naturally appear in the modelization of some important phenomena : transport phenomena, acoustic waves, gas dynamics (euler equations), free surface environmental flows and application to meteorology, oceanography or hydraulics (shallow water equations) but also traffic flows. The course will be divided in two parts. The first one will be devoted to the presentation of the problem : short introduction to the theoretical properties of the solutions (existence, uniqueness, regularity, entropy criterion...) and construction and analysis of numerical solvers to approximate the solutions (consistency, stability, convergence...). During the second part of the course, a more ambitious project will be proposed to the students (in group of two or three people) : simulation of traffic flow models, simulation of erosion processes in rivers, simulation of pollutant processes in environmental flows, simulation of shallow water flows in two dimensions with dam break experiences... All the computations will be performed by using MATLAB software.



(a) Initial solution (b) $t = 1000$s (c) $t = 2500$s

Figure 1: Dam break simulation

References :

Web sites (including several simulations) :

BANG Project at INRIA-Paris :
https://www.rocq.inria.fr/bang/SWE/index.html

EDANYA Research Group in Malaga :
http://edanya.uma.es/en/numericalintromenu

Books :

Edwige Godlewski, Pierre-Arnaud Raviart, Numerical approximation of hyperbolic systems of conservation laws, Springer, 1996

Randall J. LeVeque, Finite Volume Methods for Hyperbolic Problems, Cambridge University Press, 2002.

Articles :

E. Audusse, M.-O. Bristeau, A well-balanced positivity preserving second order scheme for shallow water flows on unstructured meshes, J. Comp. Phys., 206, pp. 311-333, 2005.

A. Aw and M. Rascle. Resurrection of "second order" models of traffic flow ? SIAM J. Appl. Math., 60(3):916-938, 2000.

T. Morales de Luna, M. J. Castro Diaz and C. Pares, A Duality Method for Sediment Transport Based on a Modified Meyer-Peter & Müller Model, Journal of Scientific Computing, Vol. 48. 2011, pp. 258-273