

Nador (Maroc), 01-10 Juin 2020

Equations aux dérivées partielles non-linéaires, théorie spectrale et applications

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Title : Modeling and numerical simulations for hydraulics and sediment transport

Abstract : The objectives of this course are mainly related to the introduction of models and numerical methods for hydraulics and sediment transport. This class of phenomena occur in many applications coupling hydrodynamics and morphodynamics and its modelling and simulation are of interest for under- and post-graduate students from applied mathematics and engineering. Understanding models and methods for solving hydraulics and sediment transport is also very useful for other expertises including geology and earth sciences. The structure of the course is divided into two main sections:

1. Numerical modelling of hydraulics and sediment transport: This section covers the governing partial differential equations widely used for modelling hydraulics and sediment transport and it covers the following topics:

- Navier-Stokes equations for hydrodynamics ;
- Derivation of shallow water equations for hydraulics ;
- Exner equations for morphodynamics ;
- Modelling erosion and deposition terms in sediment transport ;
- Mathematical study of the governing equations for coupled hydrodynamics and morpho-dynamics.

2. Numerical simulation of hydraulics and sediment transport: This section covers the numerical methods investigated in the literature for solving the governing equations introduced in the first section. The section is mainly focused on finite volume methods for hydraulics and sediment transport and it covers the following topics:

- Determination of the eigen-structure of equations for hydraulics and sediment transport ;
- Introduction of numerical methods for hyperbolic systems of conservation laws ;
- Formulation of finite volume for one-dimensional problems ;
- Well-balanced discretization of source terms in hyperbolic systems of conservation laws ;
- Implementation of finite volume for two-dimensional problems of hydraulics and sediment transport.

Matlab codes for solving hydraulics and sediment transport in one and two space dimensions will be provided to participants and tutorials on how to run them are also covered in this course.