Multiscale modelling and simulation of urban floods

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Flooding is one of the most dangerous and frequent natural hazards, accounting for significant human and economic losses every year. Because of climate change effects, more frequent and intense extreme precipitation is expected to further increase the severity of this hazard. To mitigate the impact of floods on human lives and property, both preventive and emergency measures are required. Emergency measures are operations carried out just before, during, or after a flooding event. In those cases, real-time knowledge of the extent of the flood and the areas in danger is needed to execute counter-measures. Instead, preventive measures are operations aiming at reducing the possibility of a certain area being flooded. Shallow water models provide flow data from which hazard indicators may be derived with a satisfactory trade-off between model complexity and accuracy. Accurate simulations of urban floods are usually prohibitively expensive due to the small mesh sizes necessary for the spatial discretization of the urban geometry and the associated small time steps constrained by stability conditions.

For this reason, substantial research effort has been devoted to developing multiscale modelling approaches. Multiscale modelling involves two steps : (i) upscaling, whereby the flow problem of interest is solved over a coarse, or Low Resolution (LR) space-time grid, and (ii) downscaling, whereby the results of the LR model are used as a basis to reconstruct High Resolution (HR) variables and risk indicators. The interest of the approach lies in its computational efficiency : LR models are several orders of magnitudes as fast as HR models, and the downscaling process is usually computationally affordable.

In this session, the speakers will give an overview on these two modelling strategies : firstly on porous-like shallow water equations and some applications on realistic urban floods and then on downscaling strategies where the relationship between the Low Resolution and High Resolution fields is inferred via neural networks.

The speakers are :

- Antoine Rousseau (INRIA, LEMON team) : Upscaled shallow water models with porosity and associated numerical methods
- Sebastian Nash (Pontificia Universidad Catolica) : Porosity models for urban floods simulation in Santiago
- Mustapha Allabou (IMT, Université de Toulouse) : Reduction of the Shallow Water System by an Error Aware POD-Neural Network Method : Application to Floodplain Dynamics
- Katia Ait-Ameur (INRIA, LEMON team) : Downscaling shallow water simulations using artificial neural networks

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