INTER·DISCIPLINARY & IN·LAB GRADUATE PROGRAM

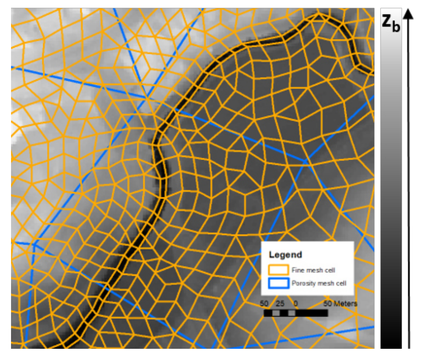
UNIVERSITÉ DE MONTPELLIER

Large–scale hydrodynamic modelling of the Upper Mekong Delta.

Objective:

The objective is to set up a two-dimensional "Shallow Water" (SW2D) hydrodynamic model of the upper Mekong Delta in Cambodia, including the city of Phnom-Penh.

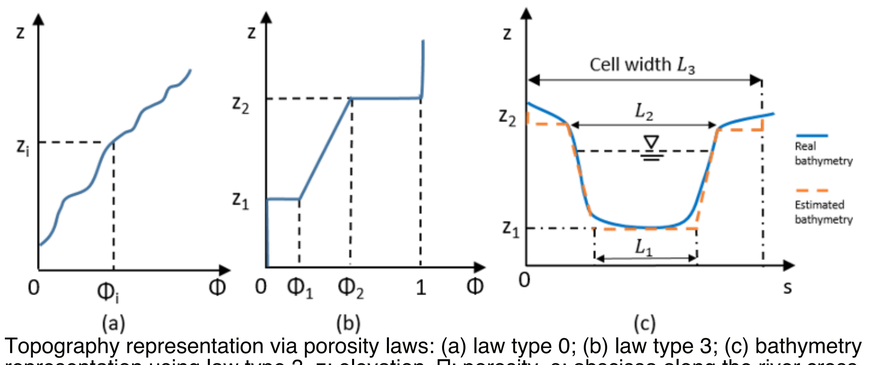
Given the size of the study area, a "porosity" model will be used. Indeed, large-scale and long-term modelling is computationally demanding, especially in urban areas where individual buildings and/or blocks of buildings must be explicitly represented in the model geometry (i.e. the mesh). While increasing the mesh size speeds up the simulation, it leads to local errors, as the fine topographic information is averaged.



Comparison of a standard 2d mesh and a porosity mesh.

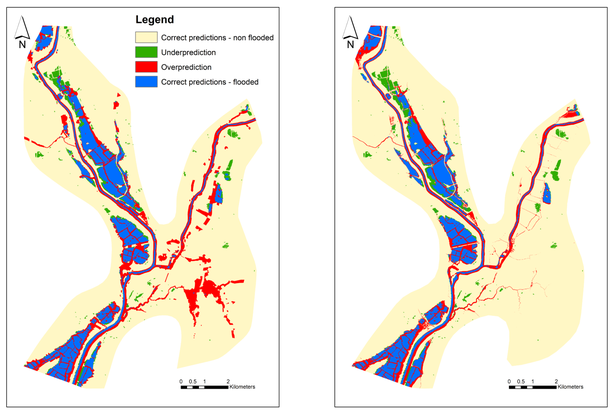
SW2D-DDP model

In order to provide a relevant trade-off between simulation time and accuracy, the SW2D-DDP model (Guinot et al. 2018), based on an irregular triangular mesh, incorporates porosity concepts in combination with the traditional SW equations. Porosity is defined as a function of water depth, which allows for a more detailed representation of floodplain topography and riverbed geometry, despite comparatively large cells.
In the plain, the porosity laws are exclusively determined from the Digital Terrain Model. To represent the geometry of the river bed, not visible on the DTM, a simplified law (e.g. trapezoidal) can be used.



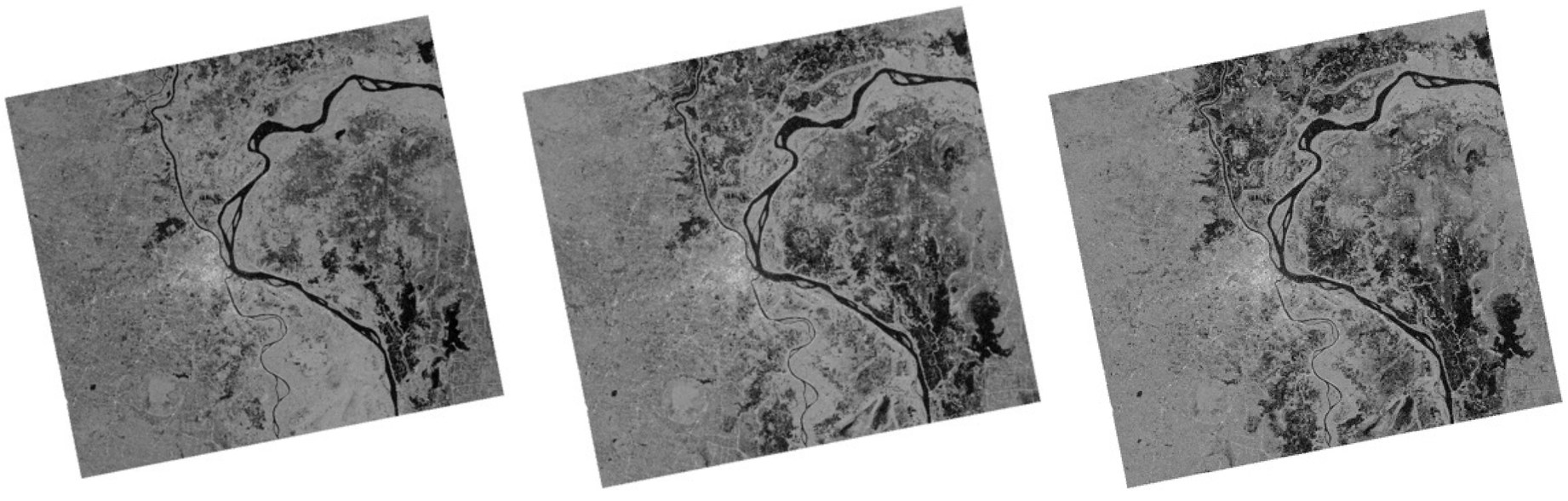
Topography representation via porosity laws: (a) law type 0; (b) law type 3; (c) bathymetry representation using law type 3. z: elevation, Φ: porosity, s: abscissa along the river cross-section. source: Ayoub et al., 2022

SW2D-DDP was previously validated against a fine 2D model, on the Severn River (Ayoub et al., 2022)



Assimilation of remote sensing data

The objective of this research will then be to evaluate the results of the model with information (flooded areas...) extracted from satellite images, and then to set up a data assimilation method in order to estimate the parameters of this law by jointly assimilating long time series of flood extent maps derived from satellite images and available in-situ measurements. In the Sentinel images below, one can notice the presence of the city along the Mekong in the centre-west of the figure (very light pixels). We can also note the evolution of the flooded area at these three dates (very dark pixels).



Subsets of Sentinel-1 images of floods acquired in Cambodia over the upper Mekong Delta: from left to right on 12 September 2021, 6 October 2021, and 30 October 2021.

References:

Vita Ayoub, Carole Delenne, Marco Chini, Pascal Finaud-Guyot, David Mason, Patrick Matgen, Ramona Maria-Pelich, Renaud Hostache. A porosity-based flood inundation modelling approach for enabling faster large scale simulations, Advances in Water Resources, Volume 162, 2022.

Vincent Guinot, Carole Delenne, Antoine Rousseau, Olivier Boutron. Flux closures and source term models for shallow water models with depth-dependent integral porosity. Advances in Water Resources. 122, 1–26, 2018.

Team:

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