# Rescuer Worshop 2: A 2D shallow water code- SLOWS

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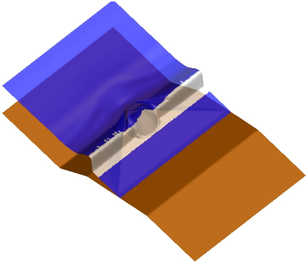
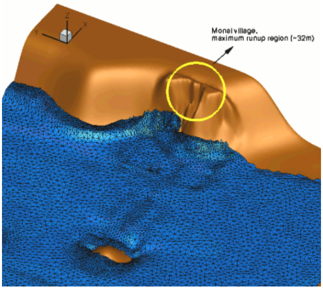
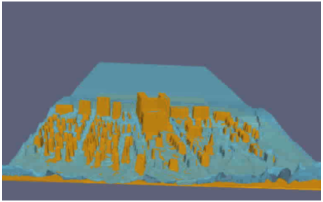
# What is SLOWS?

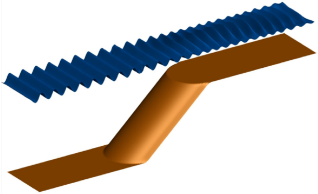
- SLOWS (Shallow Water Open-Source Solver) is a 2D numerical model for solving the shallow water equations. Academic solver
- Developed in the team Cardamom.
- Web page `https://team.inria.fr/cardamom/slows-shallow-water-flows/`
- It is designed for urban and natural flood modeling, incorporating terrain variations, boundary conditions, and numerical stabilization techniques.
- Uses Residual Distribution and Finite volume methods (FVM) for accurate representation of hydrodynamics.
- Supports high-order numerical schemes for improved accuracy.

# Some examples





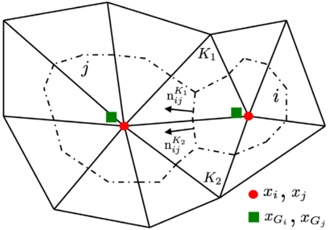





# Key Features of SLOWS

- Solves the 2D shallow water equations and/or the dispersive enhanced Green-Naghdi model.
- Schemes: RD or **node based** finite volume approach for the hyperbolic part.
- Schemes: Continuous FE for the dispersive part.
- Includes *wetting and drying* mechanisms to simulate realistic flood scenarios.
- Allows different *boundary conditions*, such as open boundaries, walls, and inflows.
- Supports high-resolution unstructured grids.

# Focus on: A Node centered scheme

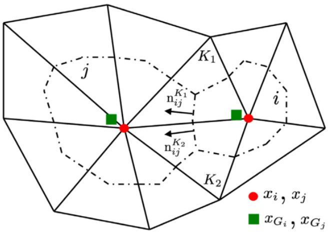



$$\bar{\mathbf{U}} + \nabla \cdot \mathbf{F}\mathbf{U} = \mathbf{S}_b + \bar{\Phi}_i$$

$\mathbf{U} = [h, \mathbf{q}]$, $\mathbf{F}$ the flux of the SWE and $\mathbf{S}_b$ topography terms. $\bar{\mathbf{\Phi}}_\mathbf{i} = \int_{C_i} \mathbf{\Phi}$

- Computation of the fluxes → Approximate Riemann Solver of Roe.
  - Well balanced formulation of the integrals of the fluxes and the bathymetry source
  - Robust modification of the reconstruction and the numerical flux for wet/dry fronts

# Focus on: A Node centered scheme

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- Higher order spatial accuracy: Second and Third order MUSCL scheme on the physical variables and topography
- Green-Gauss reconstruction for the gradients.
- RK2 and RK3 in time

# Focus on: Topography Treatment and Wet/Dry Fronts

- An upwind discretization approach is used on the bed topography terms following Hubbard and Garcia-Navarro (2000)
- Satisfy the C-property
- Dry cell identification using a threshold following (Ricchiuto and Bolerman 2009)
- Conservation of the flow at rest with dry regions (redefine emerging topography at the cells)
- Flow in motion over adverse slopes (Castro et al. 2005)

# Installing and Running SLOWS

- Ensure dependencies (C++ compiler, required libraries) are installed.
- Download and install GMSH for mesh generation: `https://gmsh.info/`.
- Download the source code from the official repository.
- Compilation steps:
  1. Navigate to the SLOWS directory.
  2. Run `make` to compile the executable.
  3. Verify the installation by running a test case.

# Directories

- SRC - sources
- textinput - inputfiles
- output - were results are stored
- gridfiles- secondary codes to convert mesh files to grd
- input -mesh files

# Running a Test Case in SLOWS

- Modify the configuration file to set up initial conditions, boundary conditions, and numerical parameters.
- Use a predefined test case to check if the code runs correctly.
- Command to execute:
  - `./slows`
- Visualizing results using external tools (Tecplot, ParaView).

# Monai valley benchmark

The origin of the 1993 the Hokkaido-Nansei-Oki tsunami is an earthquake with epicentre offshore the island of Okkaido in Japan. The Tsunami wave has rapidly propagated and hit the Japanese coast. The highest damage has hit the island of Okushiri where water has covered heights up to 30 meters literally washing away the Monai village.

In 2004, as part of a workshop organized by the US National Science Foundation, an experiment has been set up, reproducing the impact of the Tsunami wave on the shore of the Okushiri island, in the Monai village area. The objective of the experiment was to provide a set of well organized data, reproducing the 1993 Tsunami event, to validate numerical codes for Tsunami simulation.

Description of the problem and Experimental data

`https://isec.nacse.org/workshop/2004_cornell/bmark2.html`

- Corresponding Folder for SLOWS: textinput/Okushiri
- Assignment: Run the Code and plot the experimental vs numerical results ($T_f = 25$sec)

# The Seaside Oregon

Description of the problem and Experimental data

`http://coastal.usc.edu/currents_workshop/problems/prob4.html`

- Prepare a new mesh using Gmsh. Use inflow BC at left
- Run the code
- Plot the results. Experimental vs numerical

# Troubleshooting and Common Issues

- Compilation errors: Check missing dependencies and library paths.
- Runtime errors: Ensure proper boundary conditions and input parameters.
- Visualization issues: Convert data into compatible formats for post-processing.