Validation of the HWP14 Scheme for the Shallow Water Equations on Real-World Cases in Stockerau, Austria

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Abstract
We present several validation cases for the numerical scheme HWP14 that simulates 2D surface flow by solving the shallow water equations. The scheme was implemented within the Visdom software framework. We compare our simulation results against the data provided by the Riomom consulting agency. The dam break data, corresponding to the city of Stockerau, Austria, was initially obtained by using the Hydro_AS-2D simulator for the 100-year flood. The considered dams are located on small river streams connected to the large wetlands of the Danube river. In this poster, we briefly describe some of the techniques used in our simulation and demonstrate validations for three dam break locations.

Buildings and Wall Boundary Conditions
One standard technique for modeling buildings involves modifications to the bathymetry: In order to avoid this, we introduce the technique of wall boundaries. a) A building modeled by a modified bathymetry occupies additional cells on all sides. b) Wall boundaries allow us to reflect water waves at cell interfaces without occupying additional cells. Furthermore, it is possible to absorb, if necessary, the energy of a wave by reducing its velocity. Thus, the boundary layer effects are captured more accurately.

In all cells fully occupied by buildings, the wall boundary condition is applied. In these cells, we ensure zero gradient in the water level at all cell interfaces, and change the sign of the velocity component perpendicular to the given cell interface. c) In cells that are only partially occupied by buildings, we increase the roughness according to the coverage ratio, thus reducing the flow velocity. This improves the building treatment even for larger cell sizes.

Comparison of the Wave Arrival Times
We compare the wave arrival times and flood maps computed with Visdom against the corresponding Hydro_AS-2D data. The following figures show the water extent after 2 (red), 4 (green) and 8 (blue) hours simulated using the HWP14 scheme with Visdom. The simulation results from Hydro_AS-2D are visualized using isolines with matching colors. In all three scenarios, both simulations produce similar results. Slight differences can only be observed in areas most distant from the breach locations.

Comparison of the Water Depths
Comparison of the water depths simulated by Visdom and Hydro_AS-2D. The following figures show the discrepancies in the simulated water depths after 8 hours. Figures a) and b) show regions (marked with yellow circles) that are completely dry in Visdom but wet in Hydro_AS-2D. Here, the source of the discrepancy can be both the bathymetry discretization and the boundary treatment. The biggest discrepancies can be observed in regions that are connected through culverts. In Visdom, culverts are not yet supported, thus the water cannot pass there. Figure c) shows a region (marked with a yellow circle) which is only wet in Visdom. This is caused by the combination of the high CFL = 0.95 causing local waves and the low bathymetry resolution.

Sources of discrepancies:
1. The simulators are based on different discretization techniques, Hydro_AS-2D uses an unstructured triangular mesh, while Visdom is based on a uniform grid.
2. Grid resolution. We used cells of size $2 \times 2$ meters. Smaller structures are not captured accurately.
3. Inlet boundary condition treatment. Described above.
4. Not supported culverts. Some regions cannot be flooded indirectly.
5. High CFL numbers reduce the accuracy. The Hydro_AS-2D simulations were performed using CFL = 0.95, thus we had to use the same number.