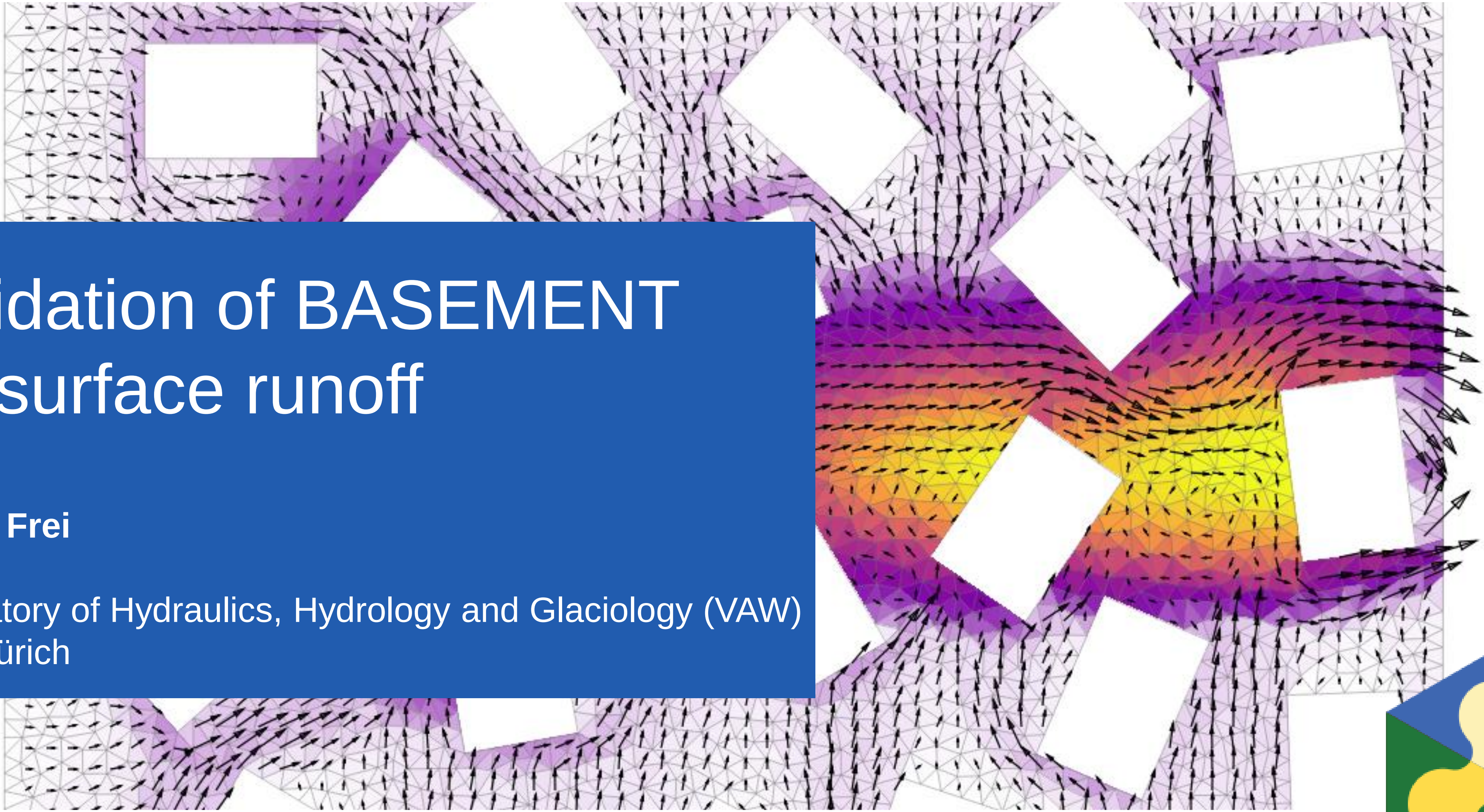
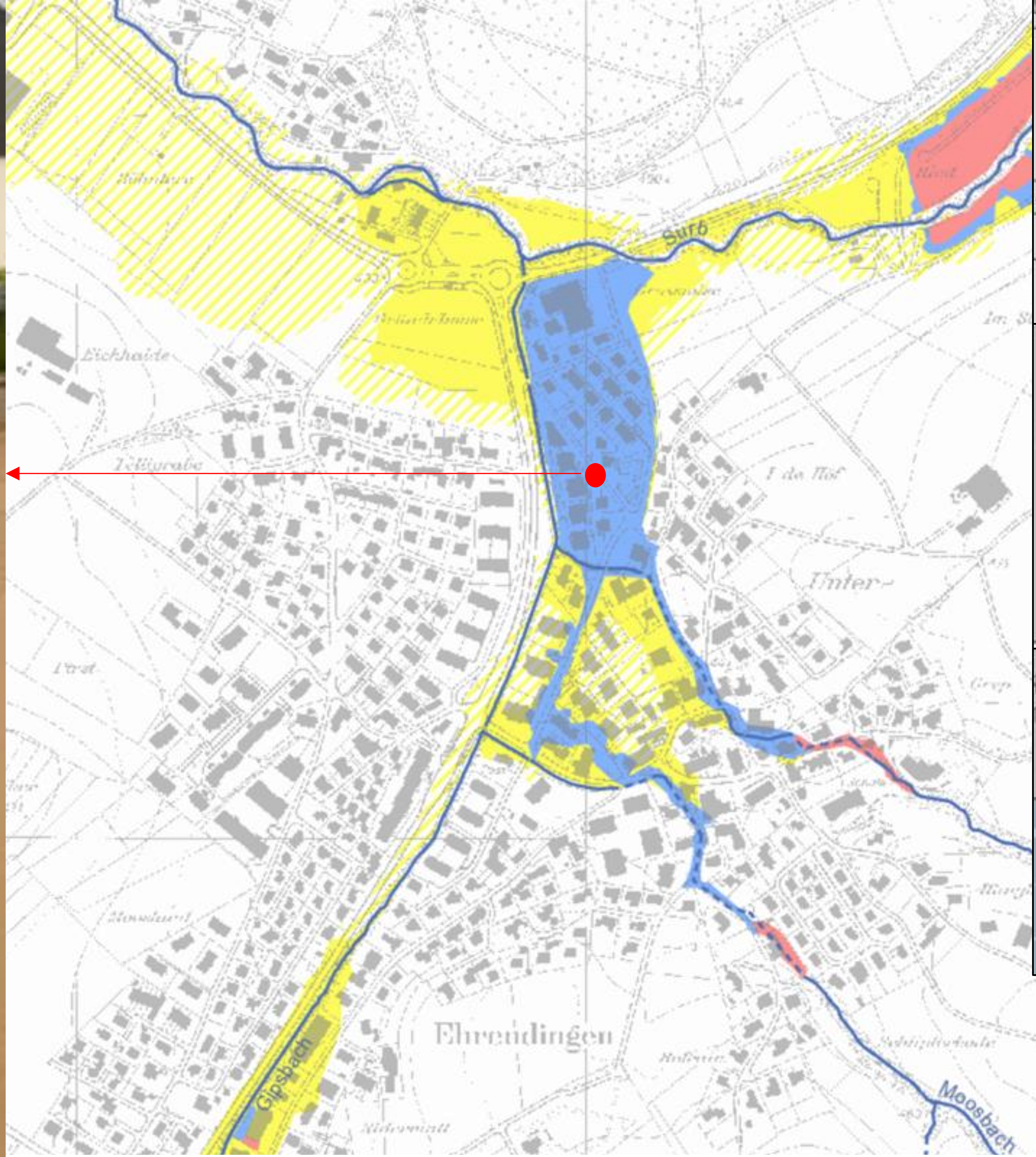
ETH zürich

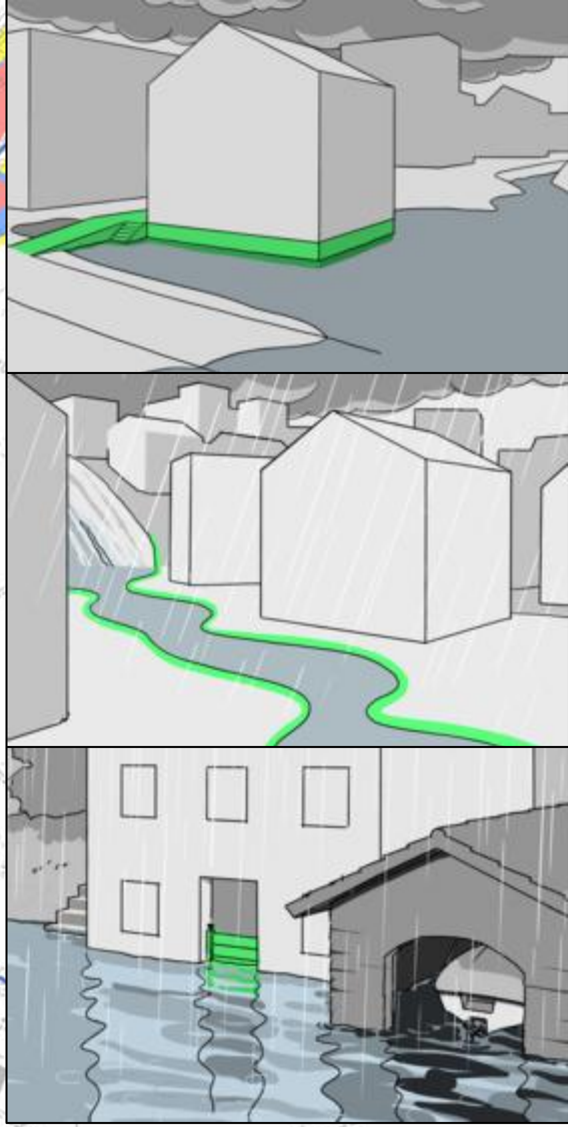


Validation of BASEMENT for surface runoff

Seline Frei

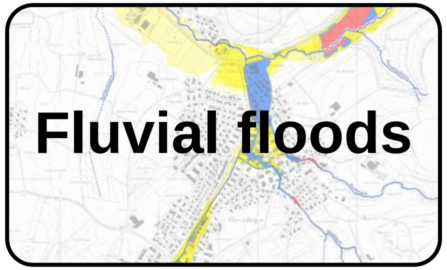
Laboratory of Hydraulics, Hydrology and Glaciology (VAW)
ETH Zürich





https://www.schutz-vor-naturgefahren.ch/

Hazard map Switzerland: fluvial floods



Fluvial floods → Hydrodynamic 2D models (BASEMENT) → Calibration & Validation → Standard use in enineering companies

and pluvial floods?

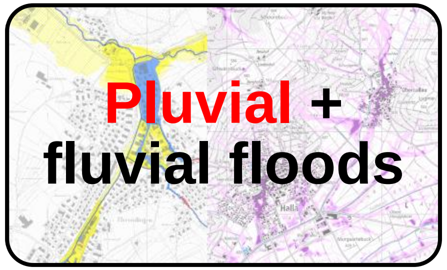
Surface runoff


June 2024 (Canton Schaffhausen)

Heavy precipitation events are likely to become significantly more frequent and intense[..]. Rare extreme events such as 100-year precipitation events will be markedly more intense.

(National Centre for Climate Services NCCS)

Surface runoff map Switzerland: pluvial floods



→ Hydrodynamic 2D models (BASEMENT) → **Calibration & Validation** → Standard use in enineering companies

and pluvial floods?

(i) GIS-based methods for determining surface flow path

(ii) Cellular automata for determining floodplains

(iii) 1D hydrodynamic sewer models

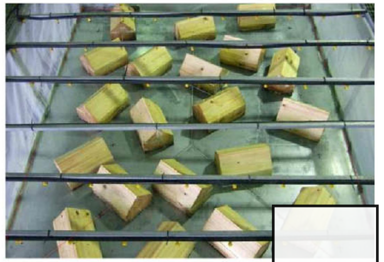
(iv) 2D hydrodynamic surface runoff models

(v) coupled 1D-2D flooding models

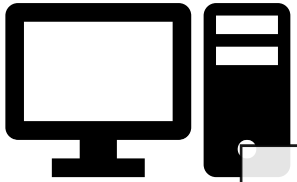
(Maier et al. 2008)

Overview presentation

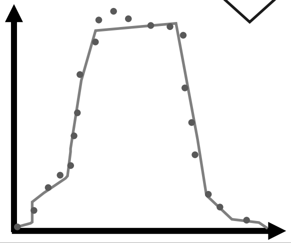
Physical model



Numerical model



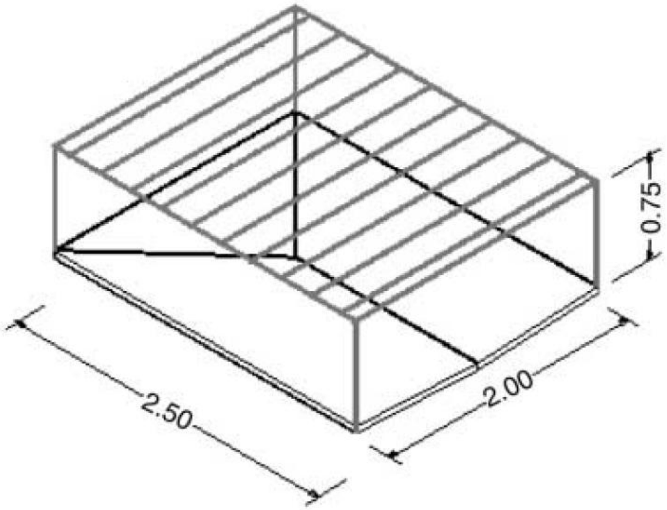
Comparison



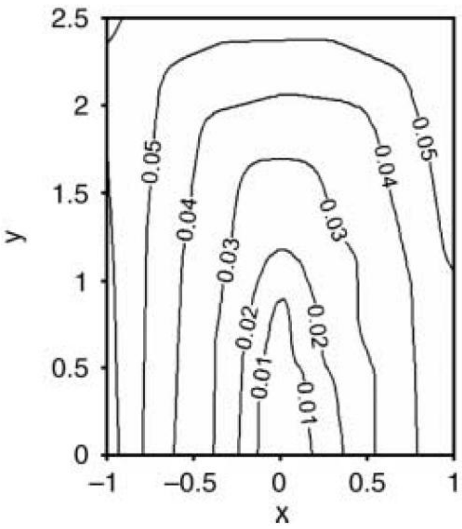
Physical model

Cea et al. 2010 at University A Coruña, Spain:

Experimental validation of two-dimensional depth-averaged models for forecasting rainfall–runoff from precipitation data in urban areas. *Journal of Hydrology*

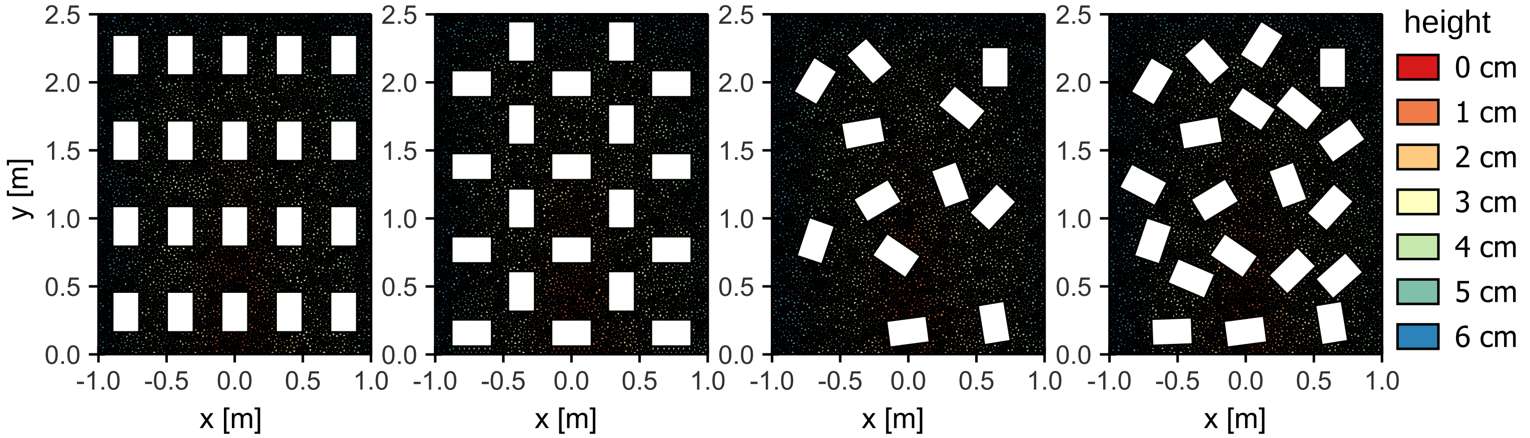


Cea *et al.* 2010



Physical model

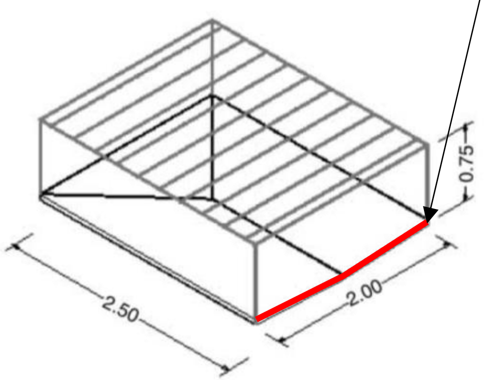
4 different house configurations

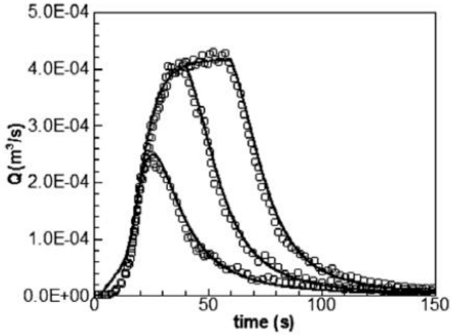


(a) Y20 (b) S20 (c) A12 (d) A20

3 different hyetographs: Block rain with 300 mm/h für 20s, 40s und 60s

Measurement from physical model: Hydrograph *Q(t)* at downstream boundary





Cea *et al.* 2010

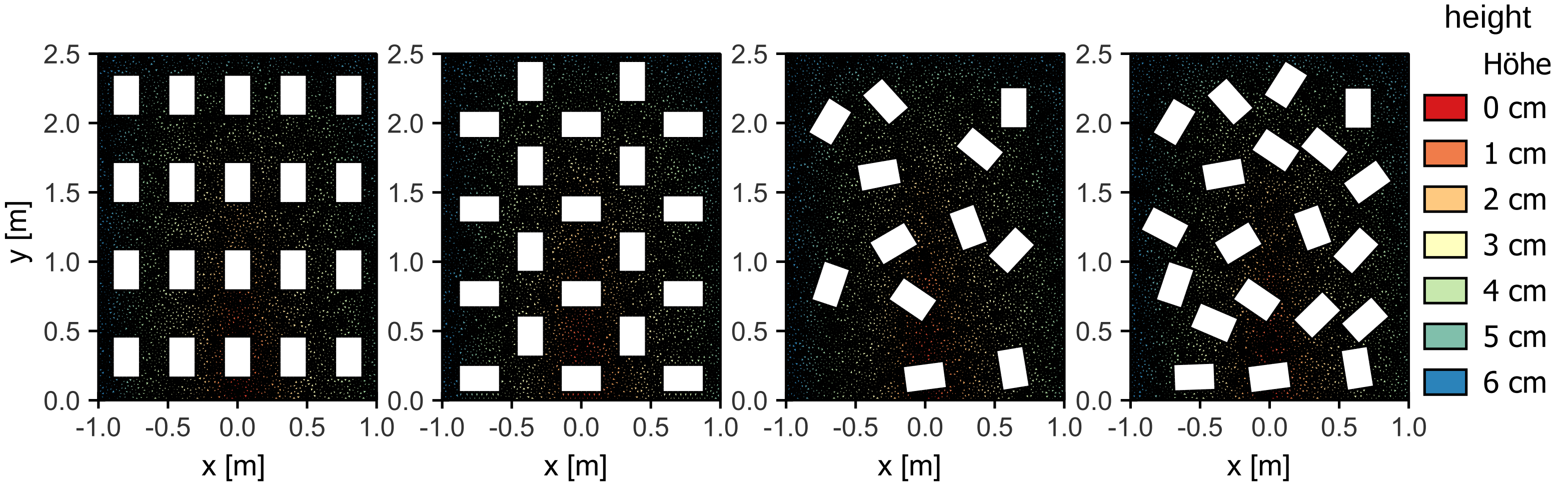
Numerical model: Mesh

Mesh

Plugin BASEmesh in QGIS

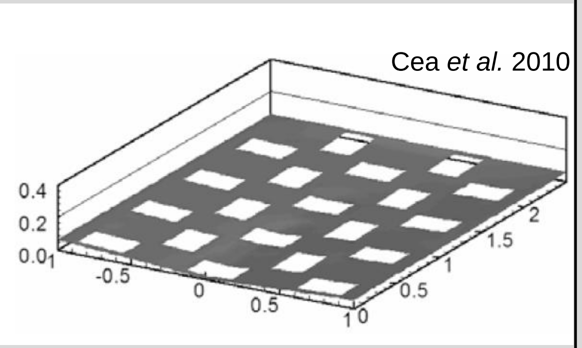
Size: 2 x 2.5m

$A_{max} = 11\ cm^2 \rightarrow$ ca. 6‘000 Zellen

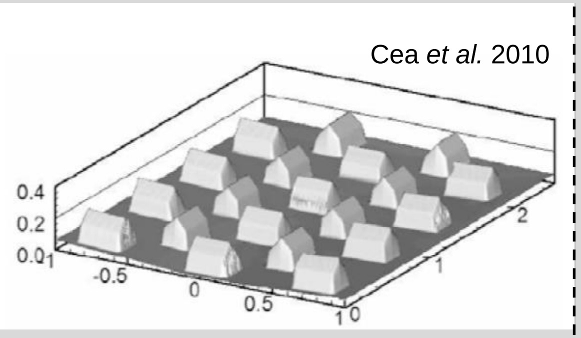


(a) Y20 (b) S20 (c) A12 (d) A20

Building hole



Building block



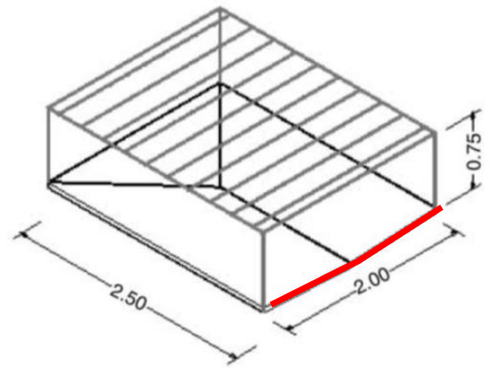
Numerical model

BASEMENT

BASIC SIMULATION ENVIRONMENT
FOR MODELLING OF ENVIRONMENTAL
FLOWS AND NATURAL HAZARDS

www.basement.ethz.ch

Setup



BASEMENT v4.0.2, BASEHPC

Roughness

k_{st} = 90 $m^{1/3}/s$ (aluminium)

Boundary conditions

Block rain (Source term for all cells)

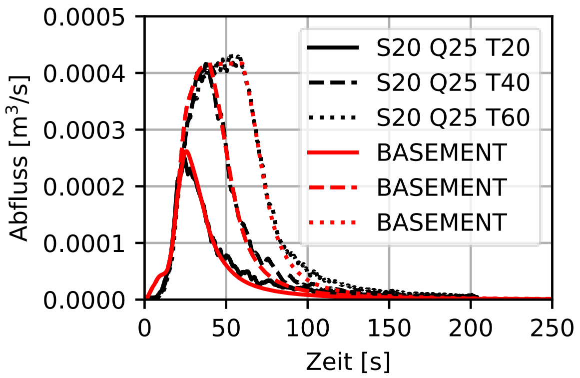
Uniform flow (J = 0.05)

Min water depth (wet ⬄ dry)

h_{min} = 0.01 mm

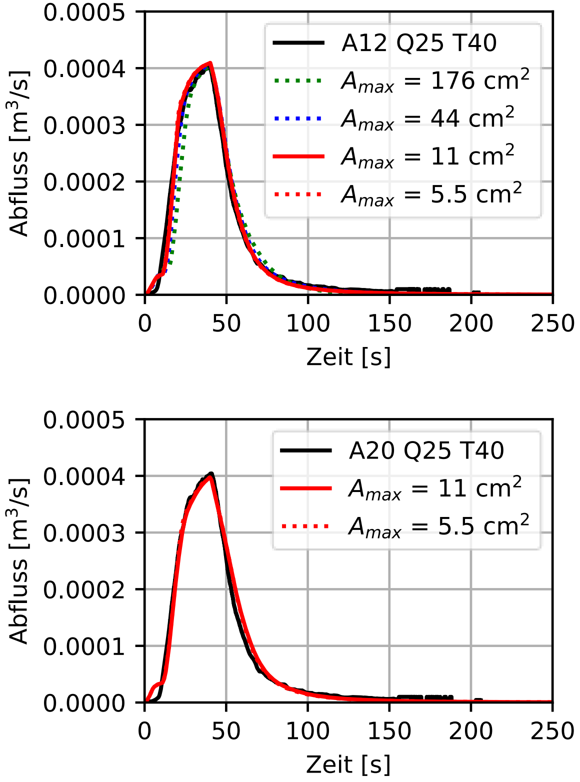
Comparison numerical model & physical model

Discharge hydrograph at downstream boundary

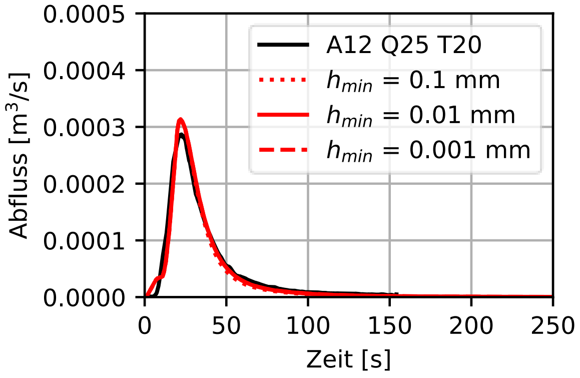


Comparison numerical model & physical model

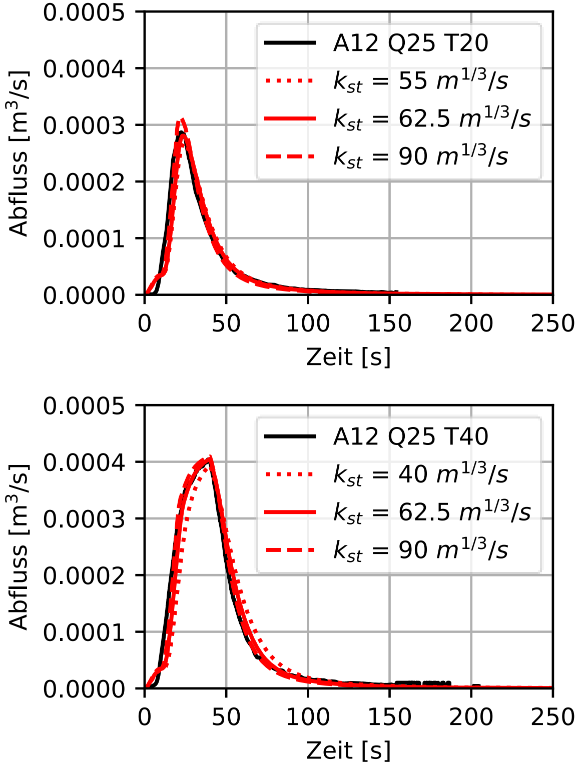
Mesh



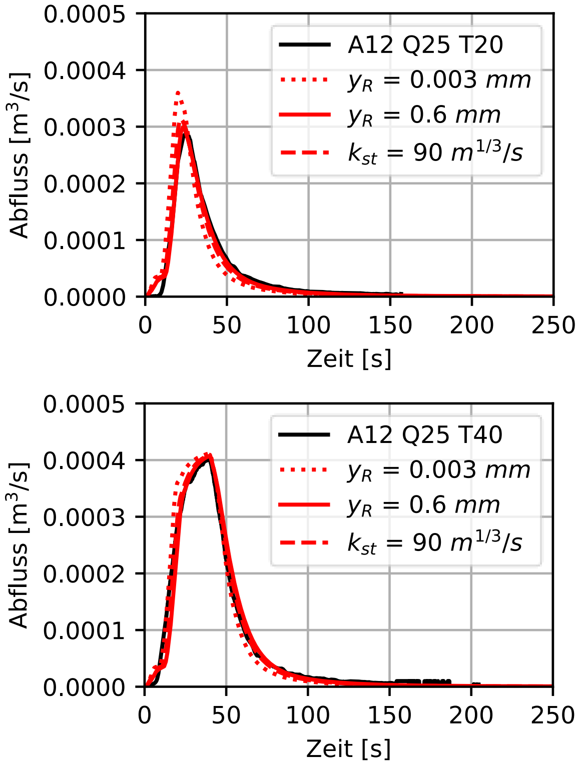
h_{min}



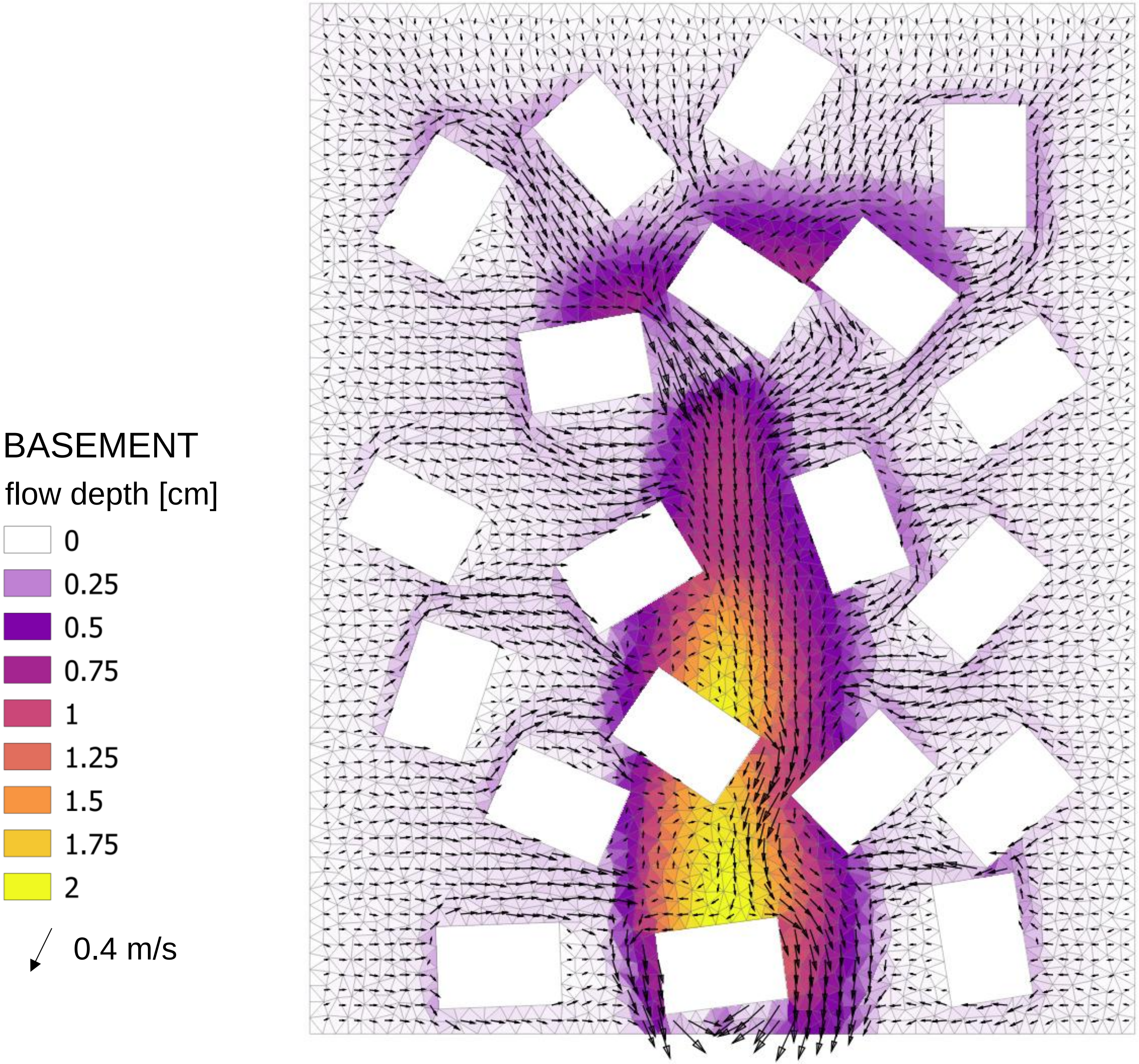
k_{st}

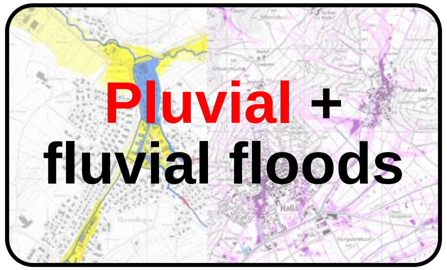


roughness Bezzola (2002)



Numerical model





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www.basement.ethz.ch

Vergleich numerische Modellierung & physikalische Modellversuche

Cea *et al.* 2010: k_{st} = 62.5 → tief für Aluminium (80 – 100), Staub und kleine Abflusstiefen

BASEMENT: k_{st} = 90 m$^{1/3}$/s

Umrechnung k_{st} = 90 m$^{1/3}$/s in absolute Rauigkeit:

$$k_{st} = \frac{21.1 \text{ bis } 26}{\sqrt[6]{k_s}} \rightarrow k_s = \left(\frac{21.1 \text{ bis } 26}{k_{st}}\right)^6 = 0.2 \text{ bis } 0.6\ mm$$

Tabellenwerte Aluminium:
k_s = 0 bis 0.003 mm (Bollrich, 2019)

Rauigkeitsansatz nach Bezzola, 2002

BASEMENT k_s = 0.003 mm, 0.06 mm → $y_R = k_s$