

Master Thesis

Development of an Overland Flow Model Emulator

January 22, 2018

Sebastiano Rusca

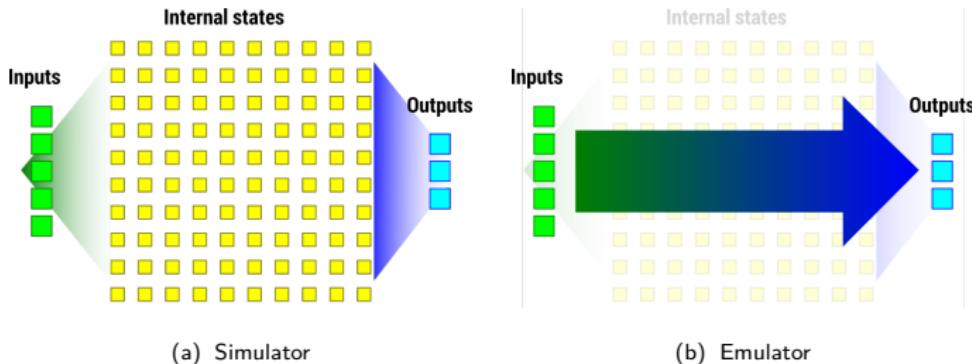
Eawag: Swiss Federal Institute of Aquatic Science and Technology

This work is licensed under a Creative Commons “Attribution-ShareAlike 4.0 International” license.



What is emulation?

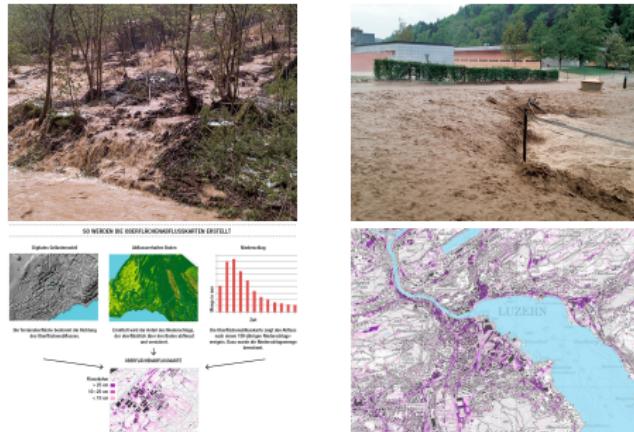
- **Emulator, aka surrogate model:** approximation model that mimic the behavior of a simulator model as closely as possible
 - computationally cheaper to evaluate
 - constructed with data driven, bottom-up approach
 - internal states of the simulator model are lost



source: "Model Order Reduction and Emulation." EmuMore's blog, January 20, 2018

Why overland flow?

- very topical issue, also in Switzerland (e.g. Zofingen 2017)
- BAFU and cantons already dealing with the problem
- **simulators do a good job... but are still too slow**



source: Denzler, Lukas. "Quantensprung für die Prävention von Wasserschäden." *umwelt Magazine*, 03/2017

Project idea & goals

Idea: Emulate overland flow for a real Swiss case study

- Obtain real topography and rain data (BAFU)
- Build specific emulators for the different study variables
- Assess their performance through comparison with historical datasets (e.g. water depths, flow velocities, pictures)

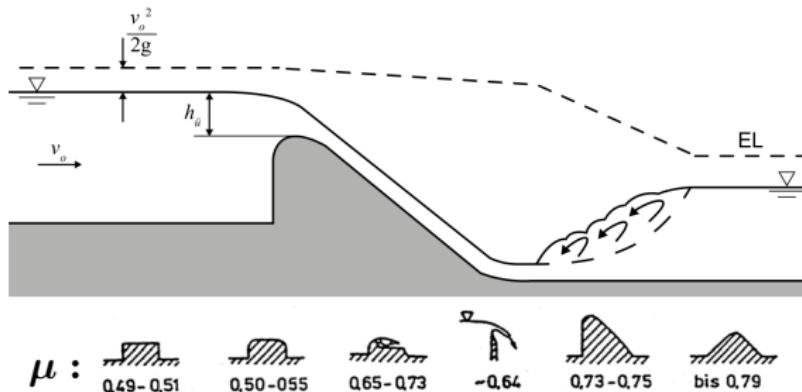
Goals

- Design, dimension and optimize flooding mitigation structures making use of emulators
- Test effectiveness of emulator-based warning systems
- Assess suitability of locations for measurement sensors under various conditions
- Carry out water level uncertainty quantification

The weir equation: problem set-up

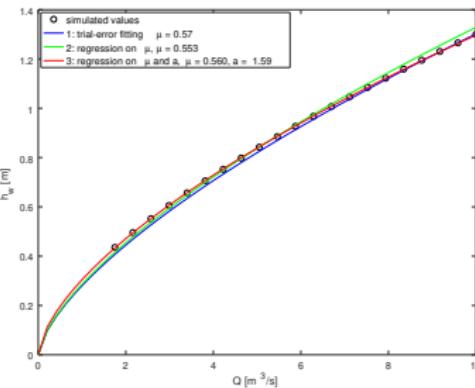
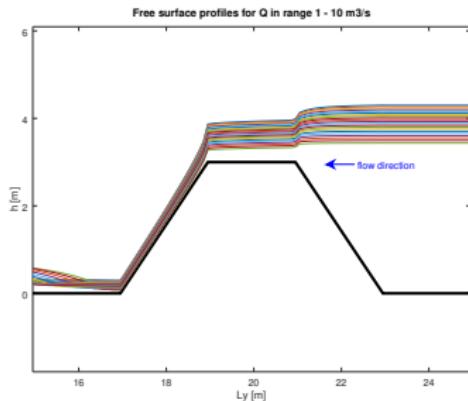
Weir equation

$$Q = \frac{2}{3} \mu B_w \sqrt{2g} h_{\ddot{u}}^a, \quad \text{usu. } a = 3/2$$



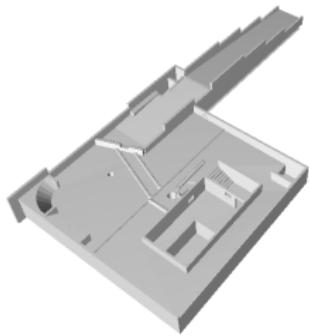
source: Boes, Robert. "Wasserbau - Vorlesungsmanuskript." ETH Zürich - VAW, 2016.

The weir equation: results



fitting method	μ	a	MSE
1: trial-error	0.570	1.50	2.69E-04
2: regression on μ	0.553	1.50	2.36E-04
3: regression on μ and a	0.560	1.59	2.25E-06

Next steps



(c) floodX case study



(d) Coimbra case study



(e) Swiss case study