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2D hydraulic modeling strategies of the Vicht and Inde river for flood protection measures, related to the July 2021 flood (KAHR project)

8th International Meuse Symposium

Dr.-Ing. Julian Hofmann
Felix Steudtner, M.Sc. RWTH
Institute for Hydraulic Engineering and Water Resources Management,
RWTH Aachen University

BMBF-Project KAHR

- **Aim of the KAHR project:**
  "Gain of knowledge in flood research by scientific processing of the flood event in July 2021 with interdisciplinary and transregional networking."

- **Concrete aims of the IWW**

Climate Adaptation Flooding Resilience

KLIMA ANPASSUNG HOCHWASSER RESILIENZ

AP 1: Evaluation of flood protection measures

Tasks:

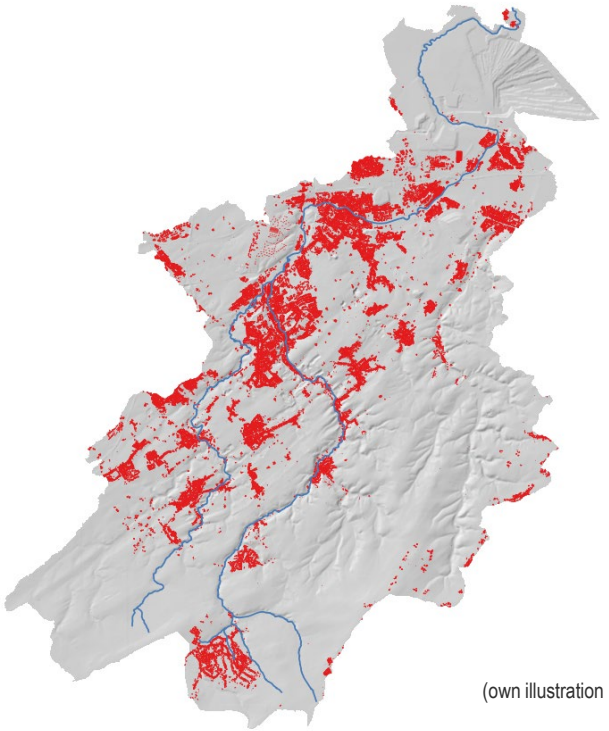
- Setup of hydro-numerical models for Inde River and Vicht River (NRW) — AP 1.1
- Verification of the nature similarity of the models — AP 1.2
- Modeling of the runoff event
  - Simulation of the July flood 2021 — AP 1.2
  - Evaluation of the effectiveness of flood protection measures in focus regions
  - Review of identified flood protection measures — AP 1.3

2D hydraulic modeling

- **Use of HYDRO_AS-2D (Hydrotec)**
  - Flussschlauchgenerator
    - Generating the river mesh from cross-section data
  - LASER_AS-2D
    - Mesh creation of the surrounding area
  - HYDRO_AS-2D
    - 2D simulation of flowing waters with the finite volume method

(Hydrotec 2022)

- **Input Data:**
  - Digital elevation model
  - Cross sections from terrestrial survey with river bed
  - Waters stationing map E3 NRW
  - ALKIS Data (Official Real Estate Cadastre Information System)
    - Element edges such as building outlines and street lines
    - Land use (k_{St} value)
  - Runoff Data (hydrological data)

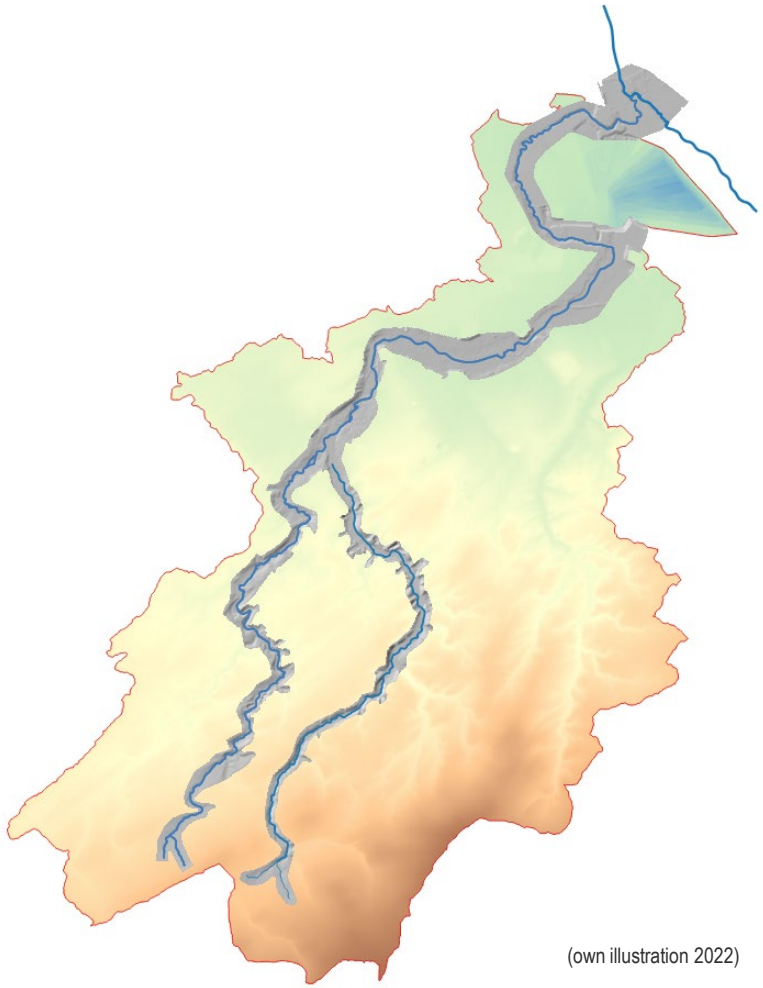


(own illustration 2022)

2D hydraulic modeling of the Inde and Vicht

- **Work status:**
  - Setup of two models each
    - Comparison before the 2021 flood event and afterwards
  - Models of the Inde River and Vicht River are in progress
    - Main focus first on the “new” Vicht River model
  - Calculation runs

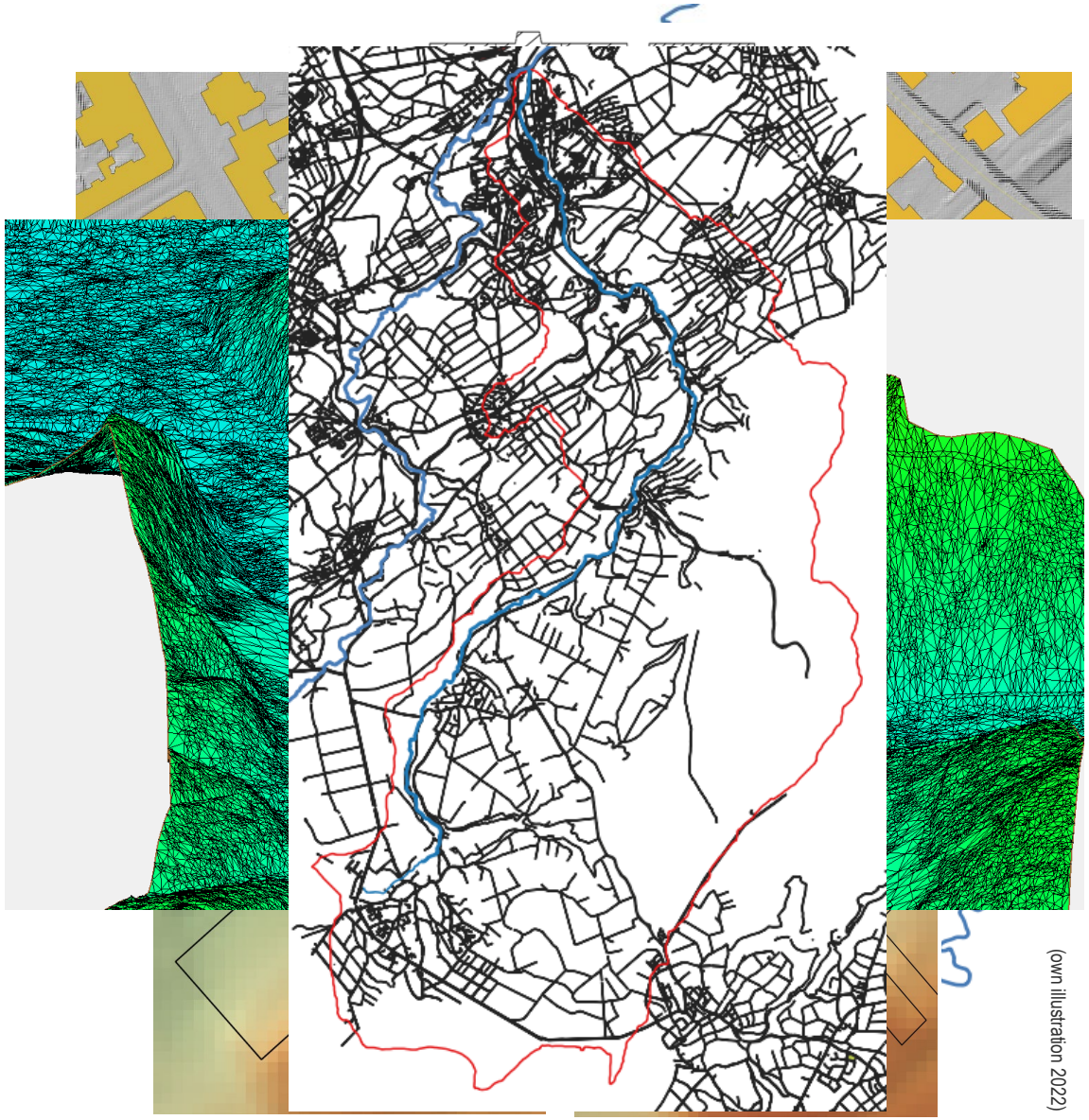
Input Data	Vicht River		Inde River	
	old	**new**	**old**	**new**
DEM	2016	2022	2016	-
Cross sections	1986 – 2012	2022	2017	-
ALKIS Data	01.04.2022	01.04.2022	01.04.2022	01.04.2022
Waters stationing map	30.11.2019	30.11.2019	30.11.2019	30.11.2019



(own illustration 2022)

2D hydraulic modeling of the Vicht River

- **Work status**
  - River axis taken from the waters stationing map
  - DEM1 2022 pre-processed
  - Building outlines pre-processed
  - first iteration steps with LASER_AS-2D
    - thinning of the nodes by approximately 95%
  - Element edges taken from ALKIS data
    - streets and railroad lines



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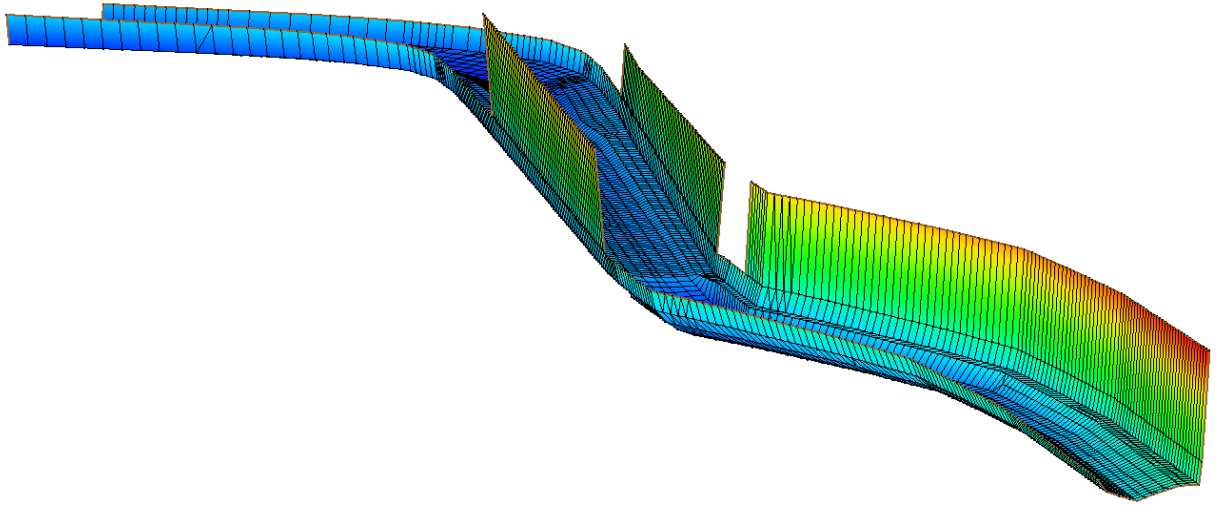
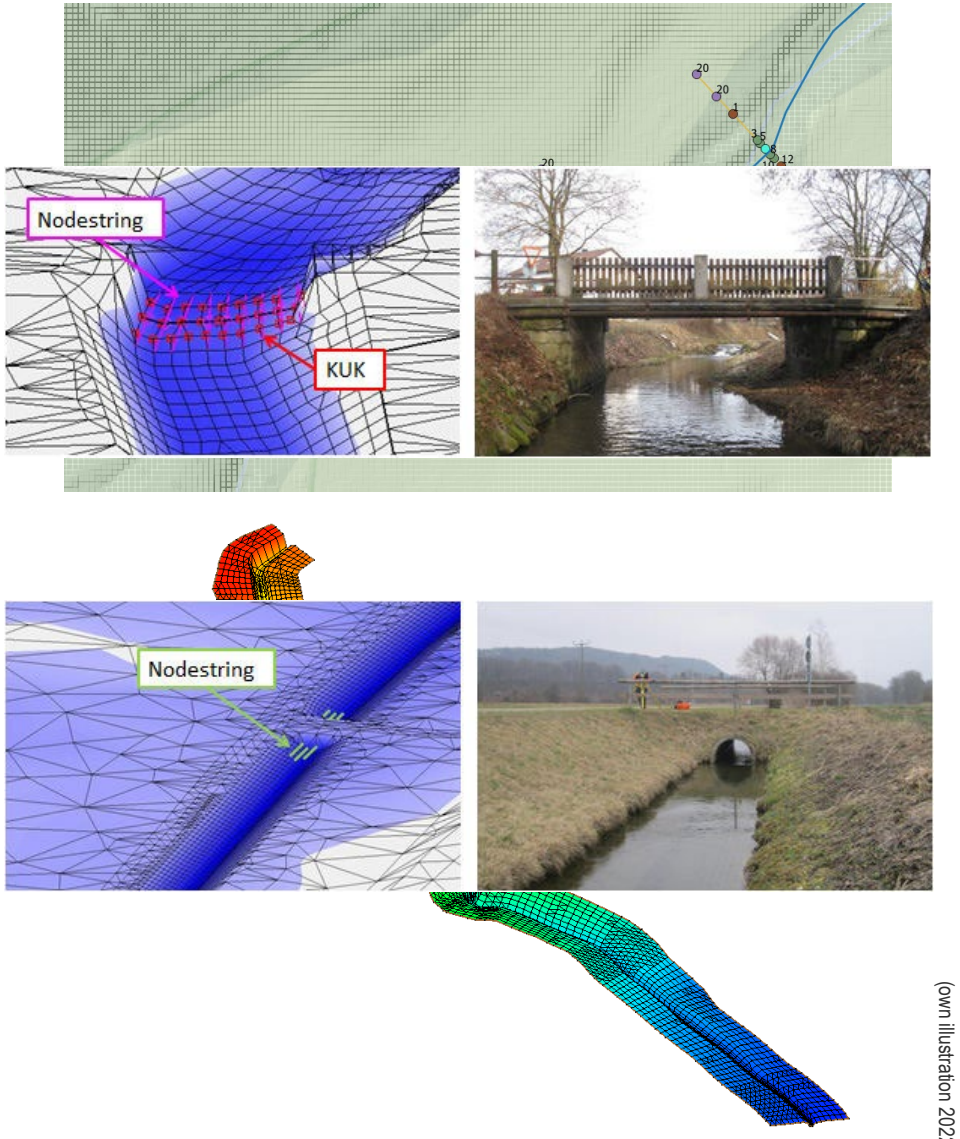
2D hydraulic modeling of the Vicht River

- **Work status**





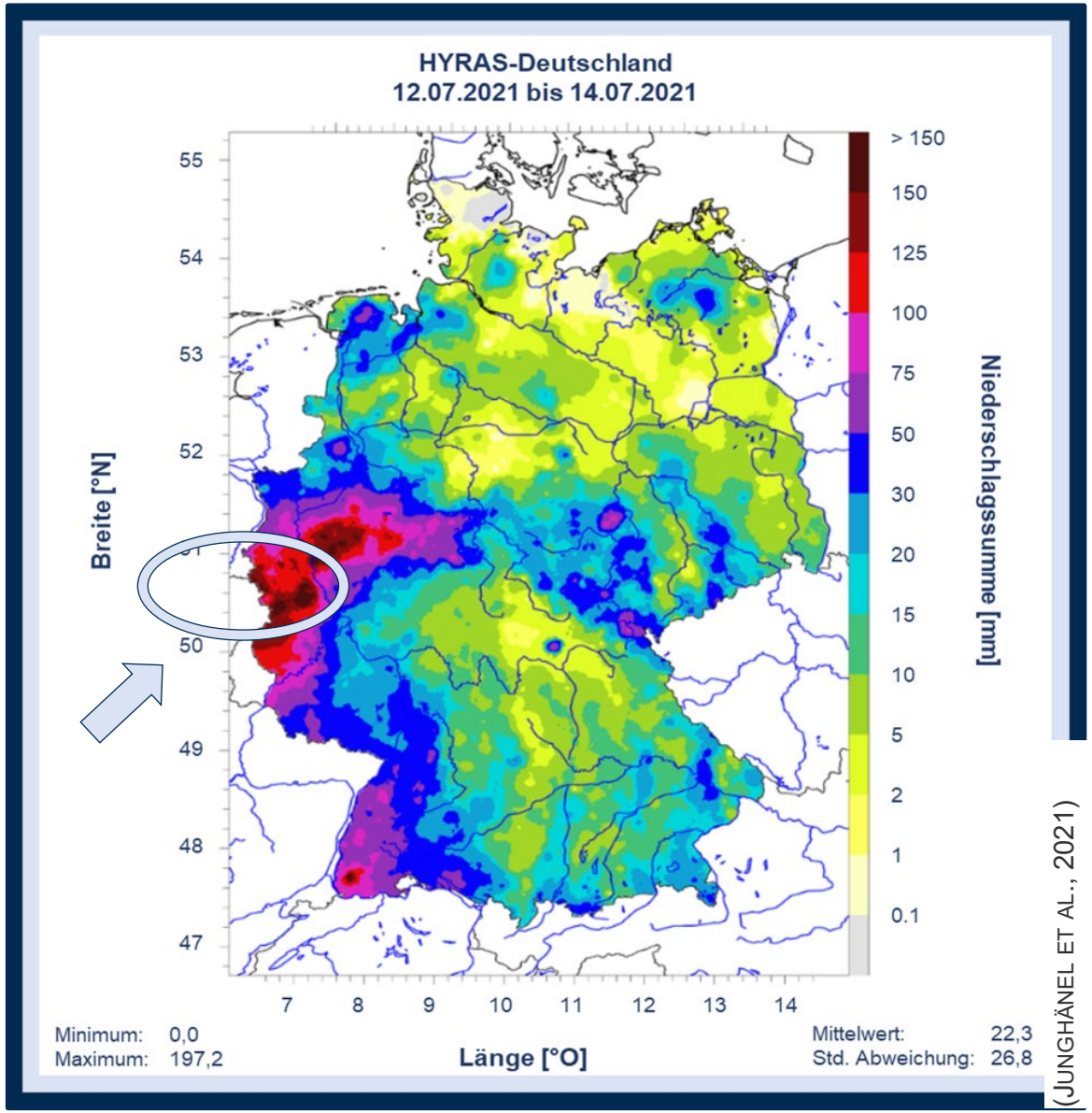
(own illustration 2022)

- Design of the river mesh
  - 23 river kilometers
  - 67 bridges and a few culverts
  - river walls and other buildings

Hindcast of Flash Flooding at Vicht Catchment

- **Slowly-moving low-pressure system „Bernd"**
  - ➢ recurrent and persistent heavy rain overlarge areas
- **Experiment: flash flood modeling combining fluvial and pluvial processes**
- **Modeling challenges:**
  - ➢ Flooding interactions of surface and streams
  - ➢ Influence of soil moisture conditions
  - ➢ Influence of bridges

Preliminary results of experiments



(JUNGHÄNEL ET AL., 2021)

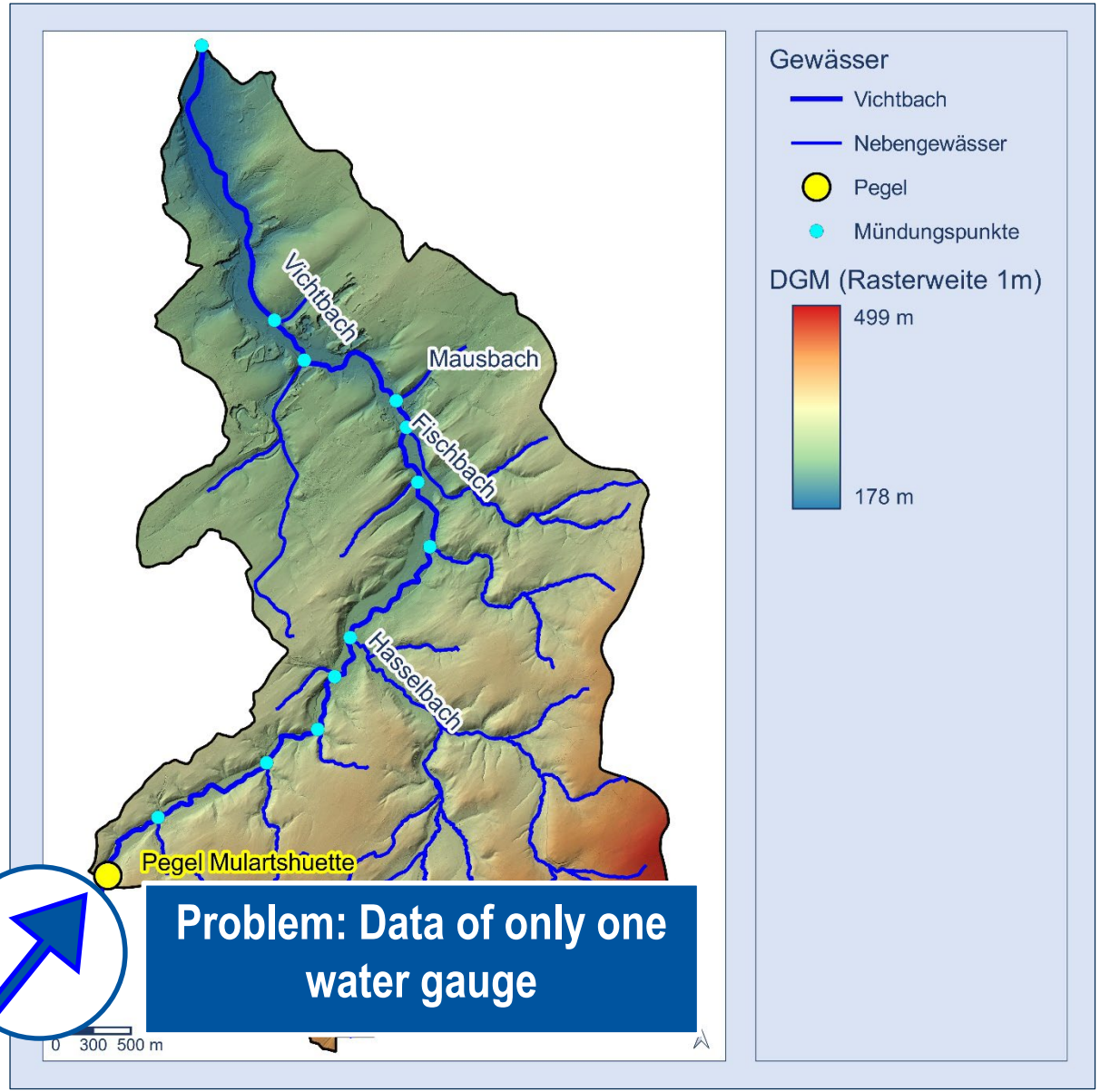
Experiments of Modeling Flash Flooding

2D fluvial

- Initial Water level
- Discharchge main river

2D fluvial and pluvial

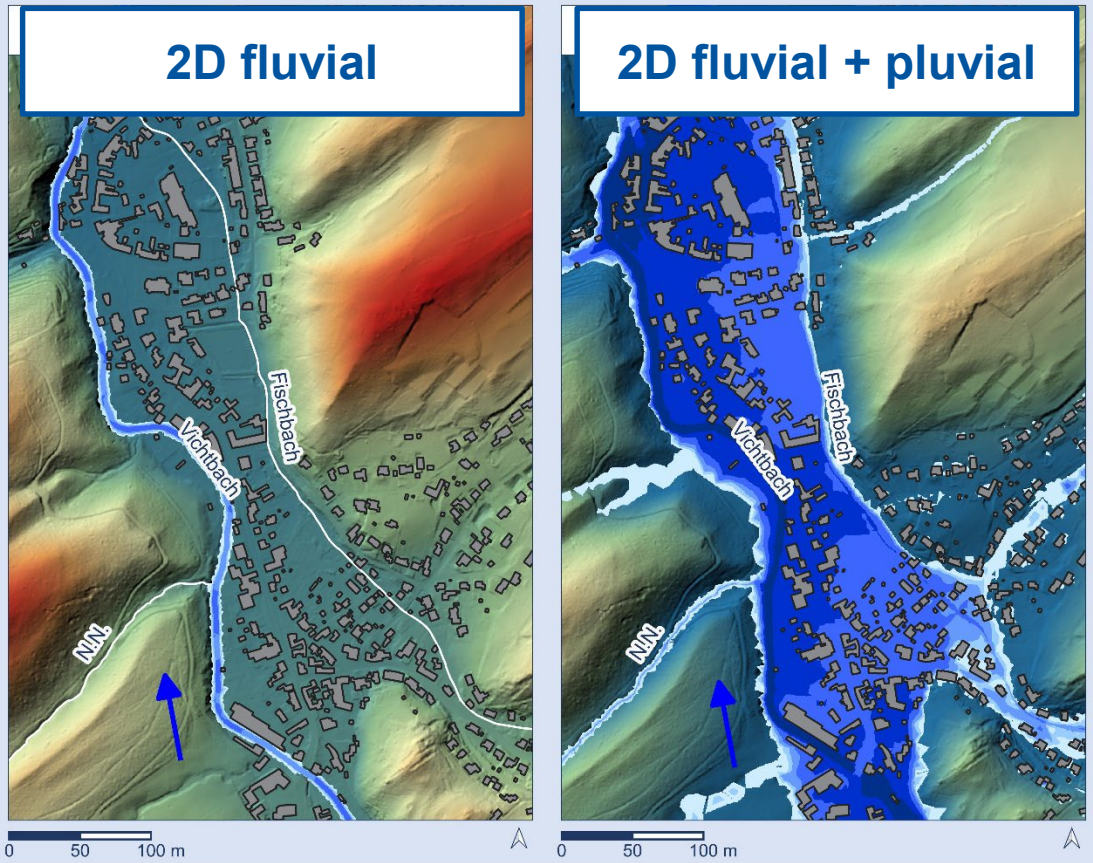
- Initial water level
- Discharge main river
- Rainfall to 2D-Model

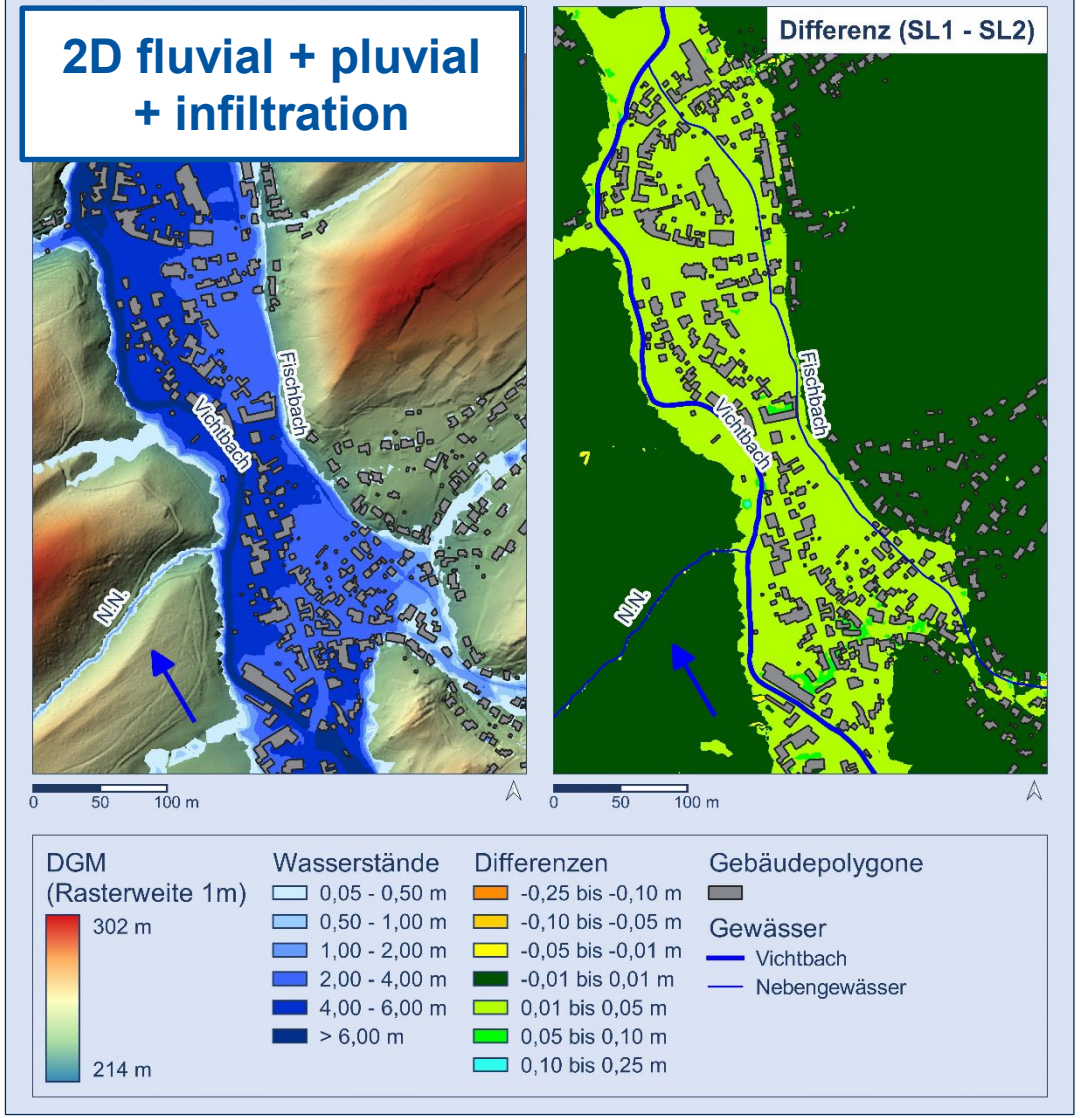


Problem: Data of only one water gauge

(Eigene Darstellung)

Preliminary Results: Different Simulation Runs



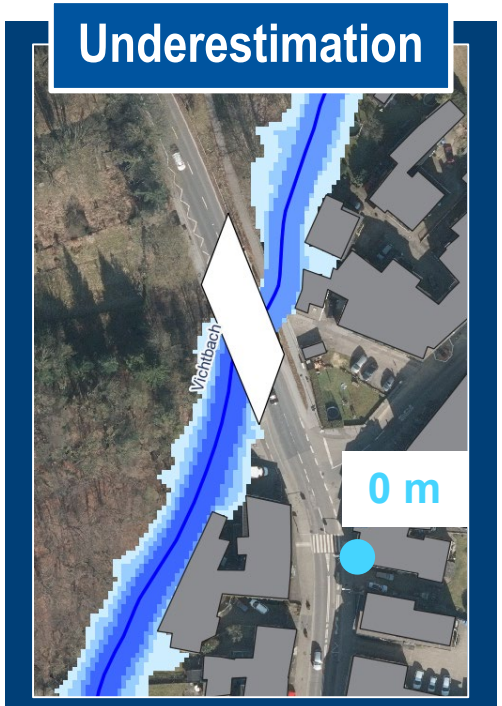


Preliminary Results: Validation at Single Point

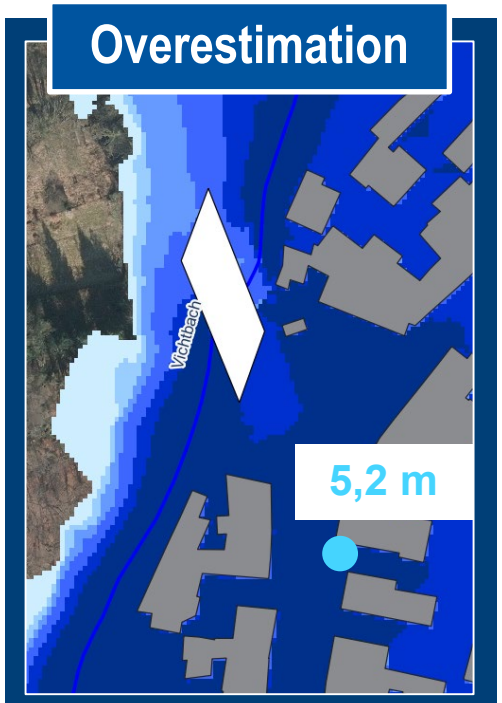
Estimated flood level
from flood marks

(HOFMANN, 2021)

Flood simulation results

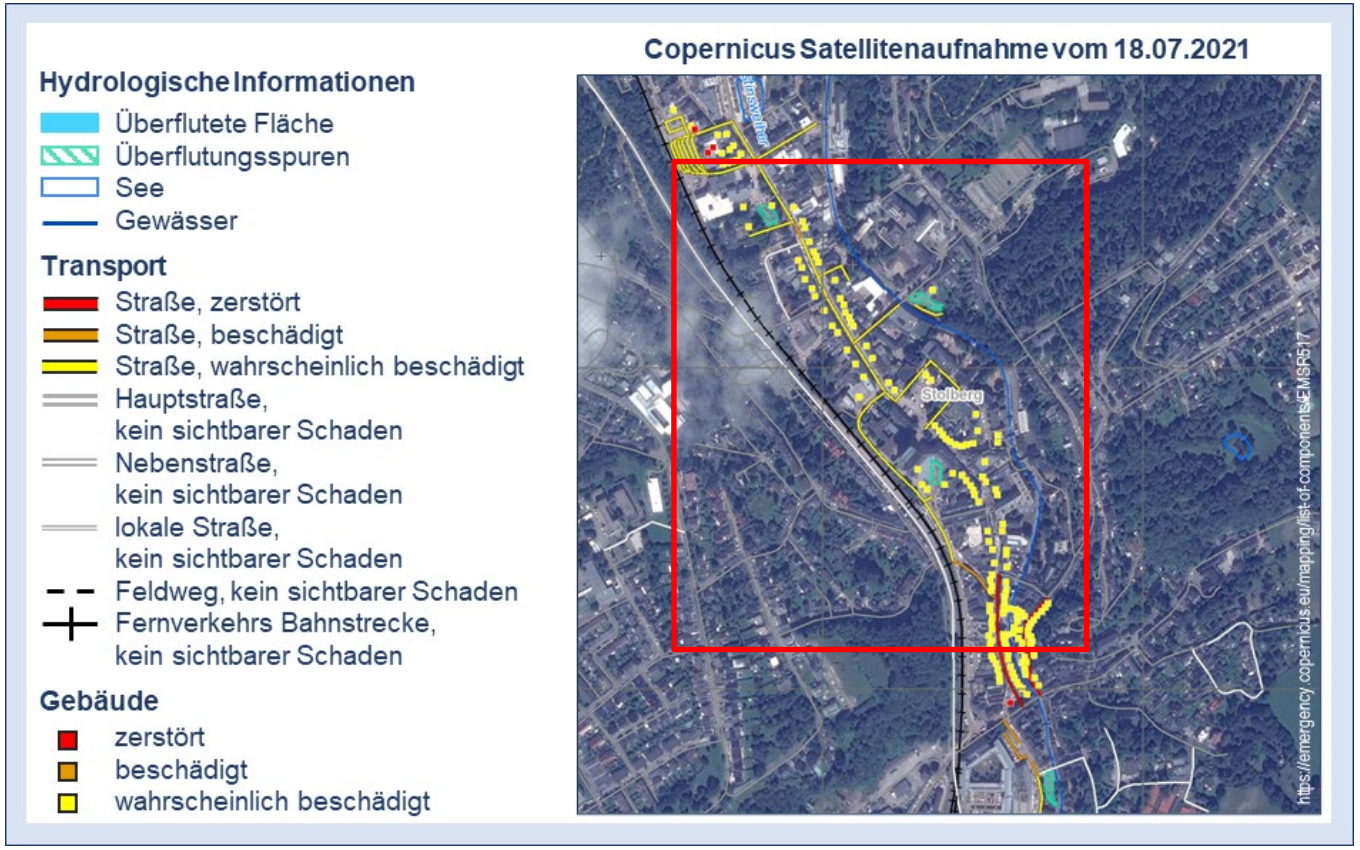


Single Fluvial Model

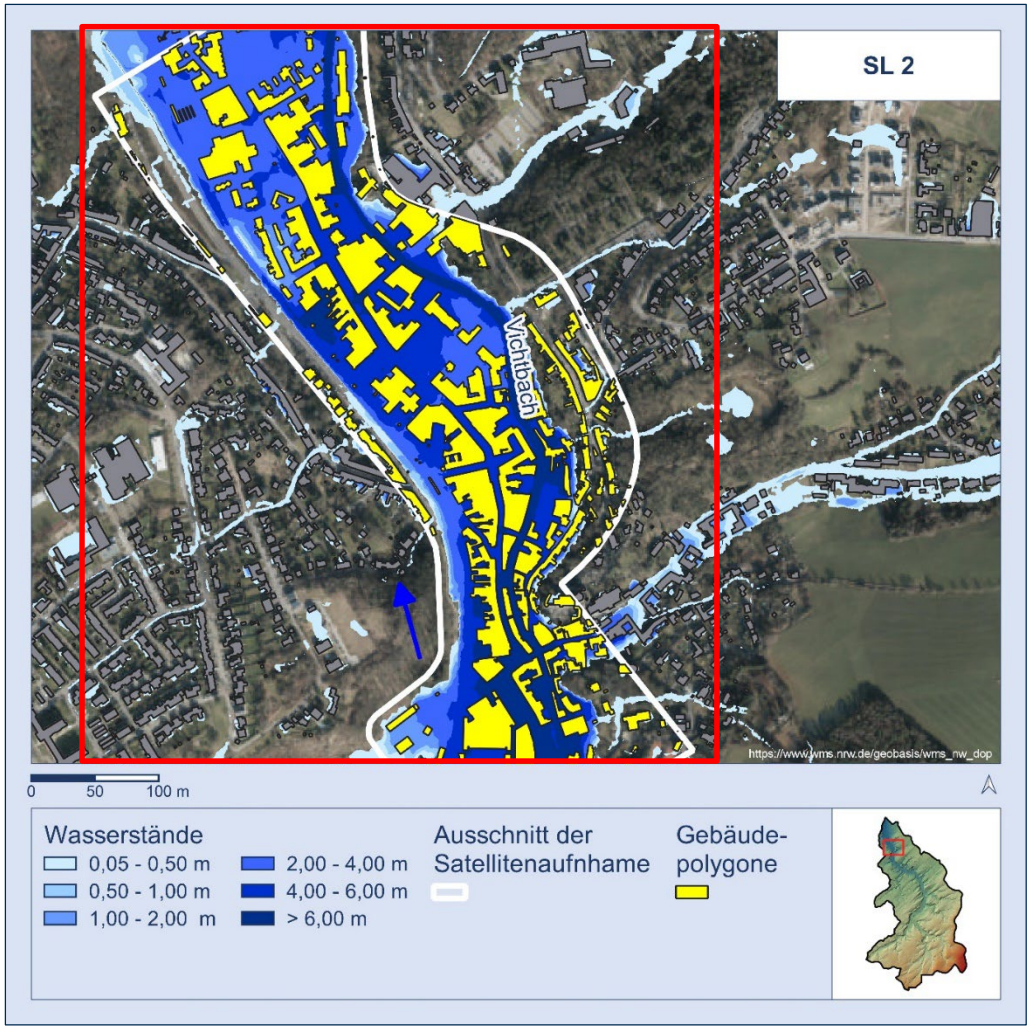


Fluvial + Pluvial Model

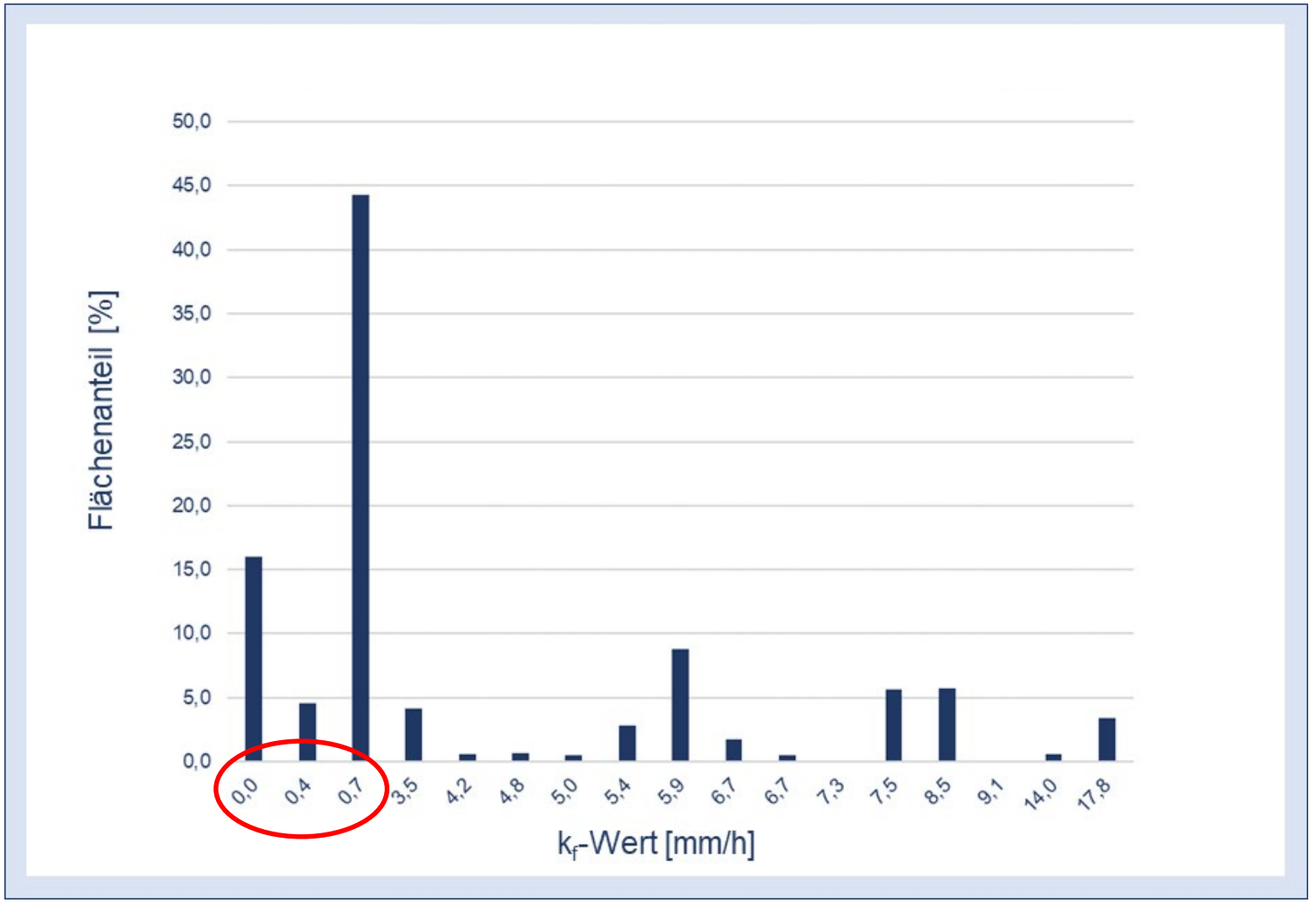
Preliminary Results: Validation using Satellite Data



(angelehnt an COPERNICUS EMS, 2021)



Influence of Infiltration Capacity



Small differences between simulation results

> 50% of the area infiltration rate of < 1 mm/h

Thank you very much for your attention!