LEARNING FROM PERFORMANCES OF MACHINE LEARNING - THE CASE OF CONVECTIVE STORMS AND FLOODS

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Occurrences of Convective Floods in Central Western Europe


[1]

Slowly developing inundations

- In the past, especially the 1990s
- Forecasting models appropriate


[2]

Rapidly developing convective floods

- Accumulation in recent years (2016/18)
- Conventional models struggle

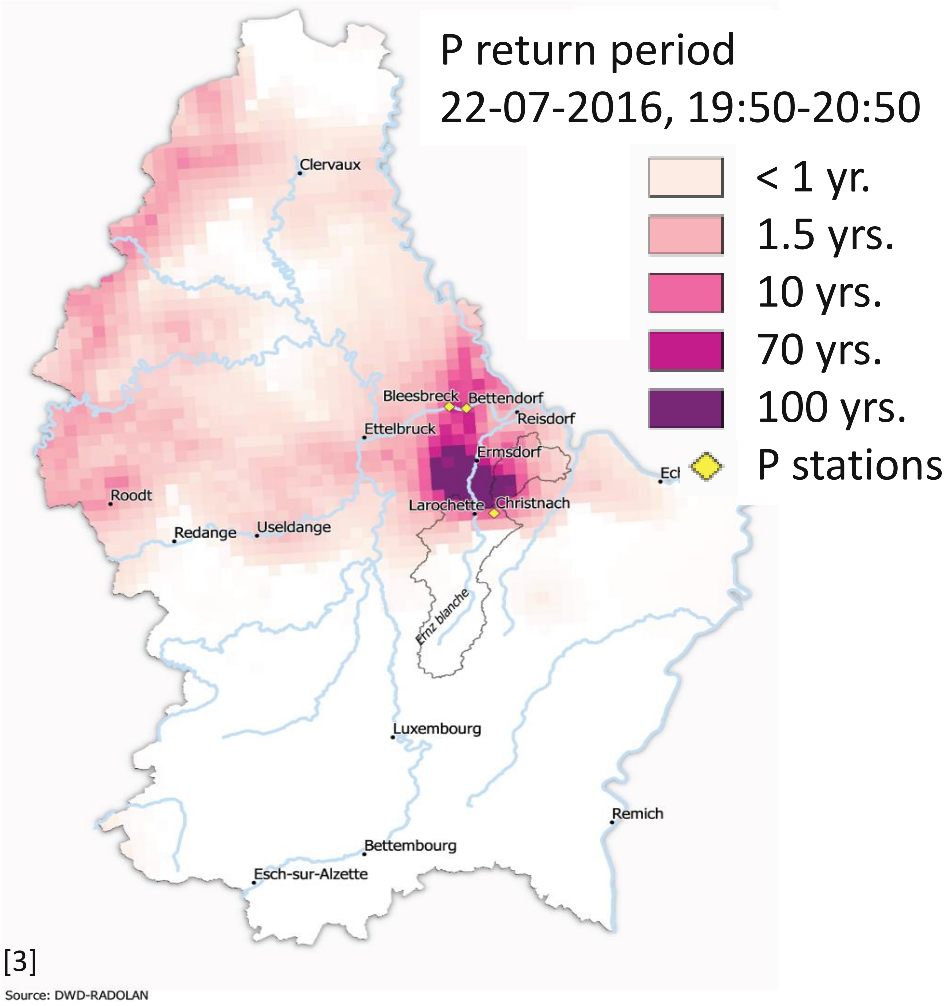
[1] Moselle, Remich, Luxembourg: Ministère de l'Environnement, du Climat et du Développement durable [2021-04-19]
[2] Bissen, Luxembourg: Luxemburger Wort [2020-06-17]

Motivation

Many hydrological models struggle to reproduce flashy discharge peaks

- Uncertainties
  - Precipitation (intensity, location)
  - Discharge observations
  - Catchment state (soil moisture)
  - Model structure
  - Combination of factors

Learn more from data we have



P during a flash flood event in July 2016.

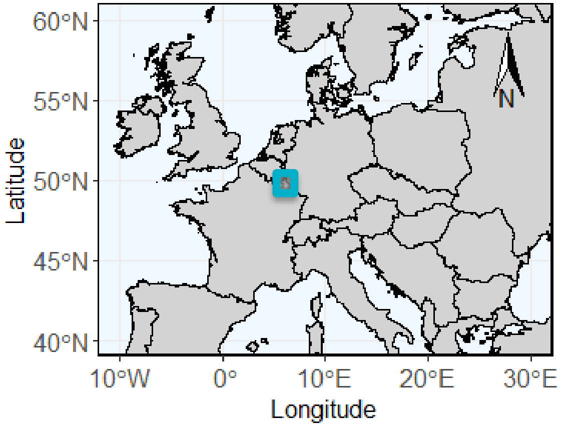
[3] Pfister, L. et al. (2018)

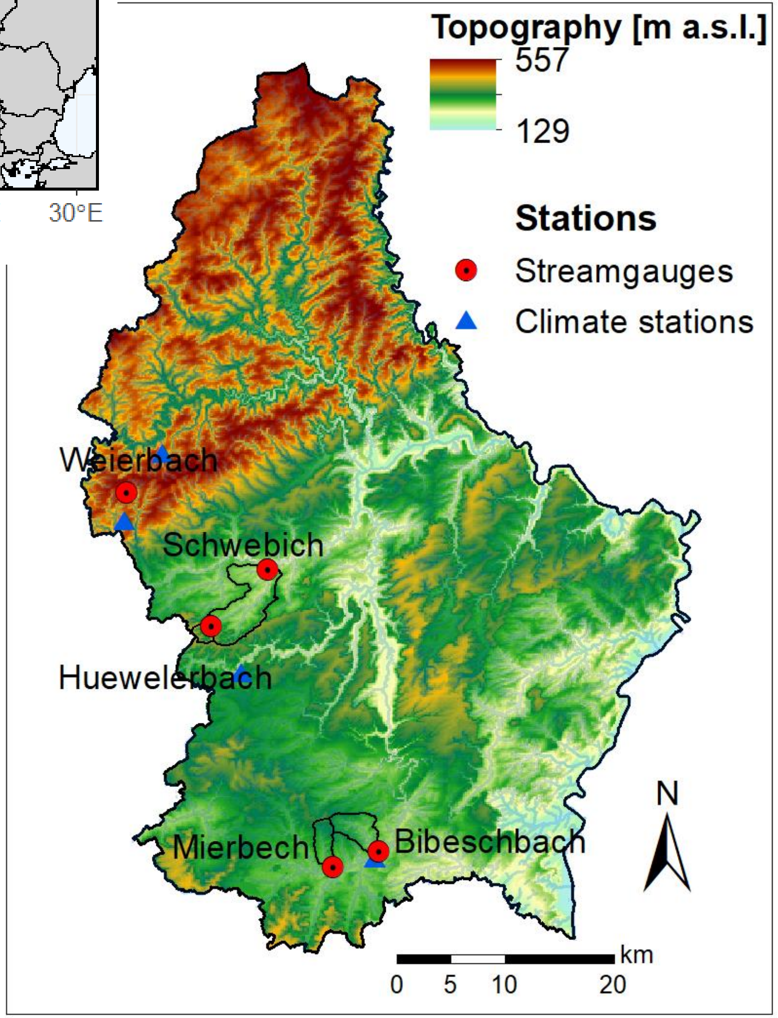
DATA – STUDY AREA

Time period: 2004-2021 (30 min)

- Station data
  - Q
  - P, T_a, ET

- Convection relevant atmospheric data (ERA5 data)[4]:
  - Instability: CAPE, CIN, K-Index
  - Humidity: q, TCWV, RH
  - System organisation and motion: WS, DLS, LLS
  - Soil moisture



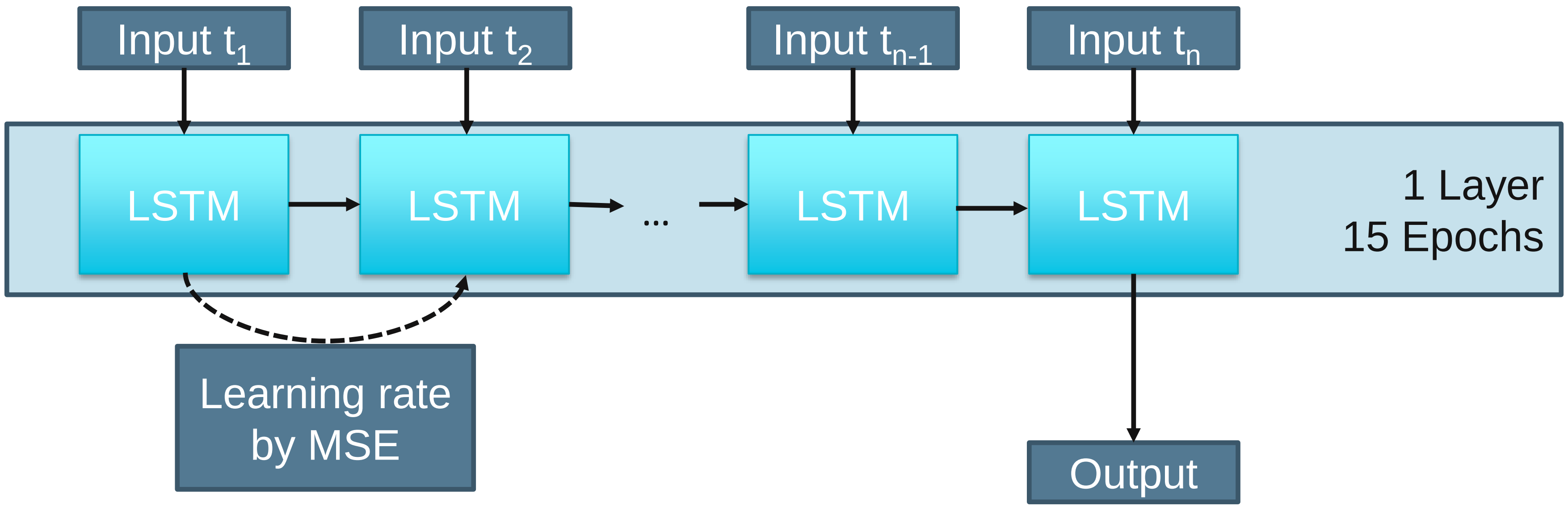


[4] Meyer, J., et al. (2021), HESS

Long Short-Term Memory Networks (LSTM)

Recurrent neural networks

Model training:



Hyperparameters	
Batch size	256
Sequence length	512
Hidden size	256
Layer	1
Epochs	15
Drop out	0.4
Learning rate	0.001
Loss	MSE
Gates	0
Adapted learning rate per epoch	5

Adopted from: [5] Kratzert, F. (2018), HESS

First results – Input Parameter Sets

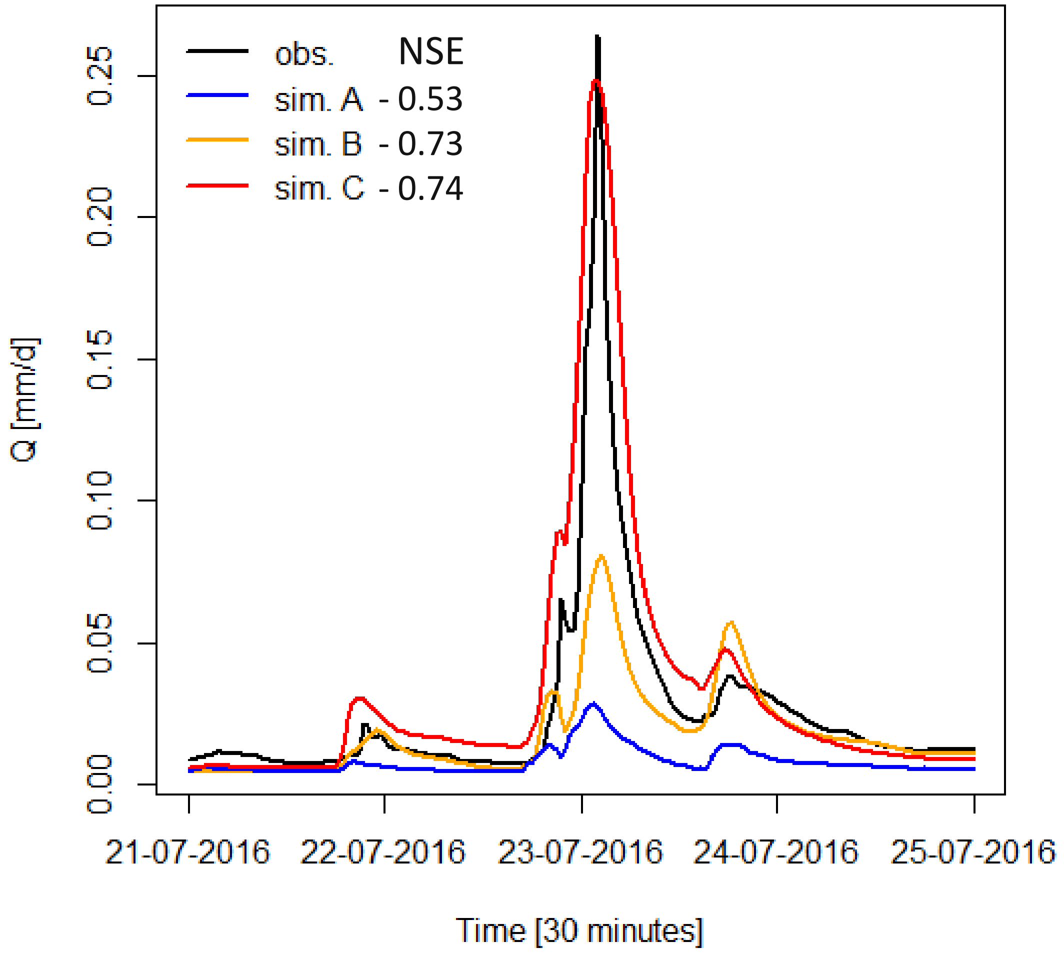
- A: Standard Input

  P, T_a, Q, ET

- B: Including neighbouring P stations and sensitive atm. parameters:

  CAPE, K-Index, relative humidity, soil moisture

- C: Including all parameters that we suggested



Q_{obs} and Q_{sim} in Schwebich during a convective event.

Further Study…

- Optimization of ML model and direct comparison with a HBV model

- Including atmospheric parameters might help to characterise convective floods

Are data-driven models feasible for non-stationary systems and able to simulate unprecedented extreme events?

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Appendix to Slide 6

Nash-Sutcliffe efficiencies for different simulation versions A, B, C in the 5 different catchments.

NSE	A	B	C
Weierbach	0.50	0.77	0.77
Huewelerbach	0.54	0.43	0.6
Bibeschbach	0.42	0.53	0.68
Schwebich	0.53	0.73	0.74
Mierbech	0.37	0.42	0.48