Representation of different flood types in rainfall-runoff modelling

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1 Motivation & Objectives

Are rainfall-runoff models able to reproduce different flood types?

Evaluating the performance of the HBV-IWW model in representing different flood types introduced by Fischer et al. (2019) [1] and Tarasova et al. (2020) [2]:

- ➢ Is the HBV-IWW model representing certain flood types better than others?
- ➢ If so, is the model performance poor because the event is poorly reproduced or because the preconditions are not properly met?

2 Study Area & Data

129 meso- and macroscale (30km² - 1500 km²) catchments in Germany (Fig. 1) with:

- Observed daily mean (dme) and monthly peak (mma) runoff.
- 15132 classified flood events after [1] from 1979 – 2002 (approx. 5 events per catchment and year).
- 60236 classified flood events after [2] from 1979 – 2002 (approx. 20 events per catchment and year).
- Input for the HBV-IWW model: areal mean precipitation, temperature and potential evaporation from ERA5 [3].

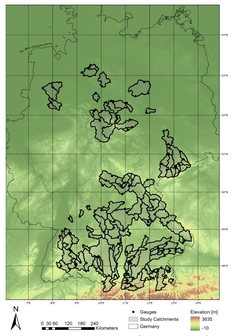

Fig. 1: Location of 129 study catchments in Germany

3 Methods

a. Rainfall-Runoff Modelling with HBV-IWW [4]

lumped

Δt = 1h

Calibration & Validation

$OF = 0.6 \cdot dme_{NSE} + 0.4 \cdot mma_{NSE}$

Runoff Simulation

Time Period: 1979 – 2002

Δt = 1h → Δt = 1d

b. Evaluation of model performance

Comparison of observed and simulated runoff

Δt = 1d

NSE of 15132 obs. events → 5 flood types after [1] → Tab. 1 → 10 days → Pre-Event → Fig. 2a; Event → Fig. 2b

NSE of 60236 obs. events → 16 flood types after [2] → Tab. 2 → 10 days → Pre-Event → Fig. 2c; Event → Fig. 2d

4 Results

- Similar patterns in the pre-event and event phase NSE. The model performance for the event phase is better than for the pre-event phase. Especially for the event classification after [2]. For flood types with dry preconditions (type 1-7 after [2]) the preconditions seem not to be met.
- The results depend on the classification method: For the event classification after [1] the model performance is similar for the 5 types. For event classification after [2] the model performance differs significantly for the 16 types.
- Snowmelt floods (type S2 and type 16) seem to be associated with large uncertainties in both classifications.

Tab 1. Flood Types according to [1]

R1	Rainfall-induced short/intense
R2	Rainfall-induced moderate
R3	Rainfall-induced long
S1	Snowmelt-affected rain-on-snow
S2	Snowmelt-affected snowmelt

Tab 2. Flood Types according to [2]

1	Rain.Dry.Intensity.Local.Steady
2	Rain.Dry.Intensity.Unsteady
3	Rain.Dry.Intensity.Extensive.Steady
4	Rain.Dry.Volume.Local
5	Rain.Dry.Volume.Extensive.Steady
6	Rain.Dry.Volume.Extensive.Unsteady
7	Rain.Wet.Intensity.Local
8	Rain.Wet.Intensity.Extensive
9	Rain.Wet.Volume.Local.No.Overlap
10	Rain.Wet.Volume.Local.Overlap
11	Rain.Wet.Volume.Extensive.No.Overlap
12	Rain.Wet.Volume.Extensive.Overlap
13	Rain-on-ice
14	Mixture.Rain.Snowmelt
15	Rain-on-snow
16	Snowmelt

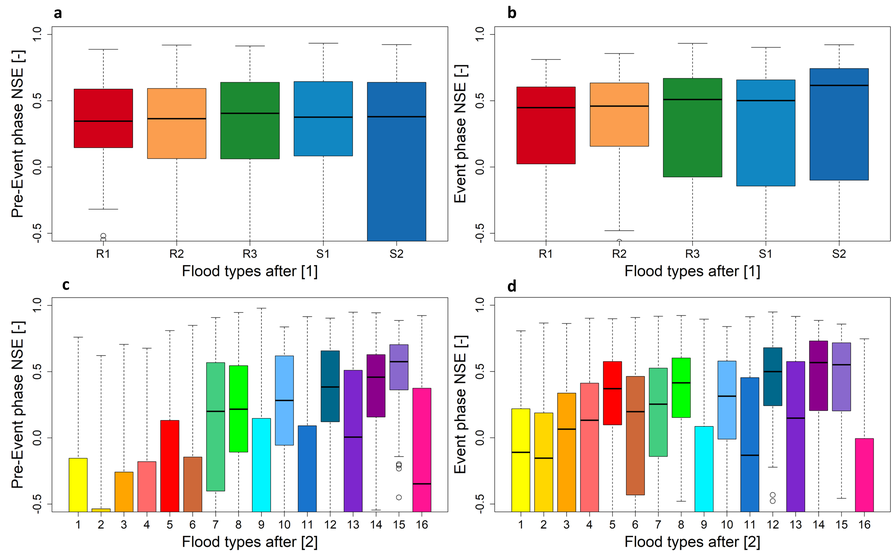

Fig. 2: NSE results for 5 flood types after [1] for 10 days pre-event (a) and event phase (b) and for 16 flood types after [1] for 10 days pre-event (c) and event phase (d). Each boxplot shows the results for all observed events between 1979 and 2002 in 129 catchments of one flood type

5 Conclusion

- It depends on the classification method considered, but **yes, the HBV-IWW reproduces certain flood types better than others**. Volume-dominated, extensive events are better represented than rainfall-induced events with dry preconditions or snowmelt events.
- Events that are poorly reproduced also show poor performance in the pre-event phase. In particular events with dry preconditions are not properly modelled during the pre-event phase.

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References

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