Investigating How Design Storm Impact Simulated Peak Flows using SHETRAN

TEAM 5

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HYDROEUROPE

Hydroinformatics for water resources and water related hazards management in Europe

An ERASMUS+ program

Design Storms

- Design storms are hypothetical rainfall events
- To simulate extreme rainfall events that are rare but have a significant impact on water resources
- In the UK, design storms are used in the Flood Estimation Handbook (FEH) for flood impact assessment
- Very hard to have catchments with more than 100 years of data

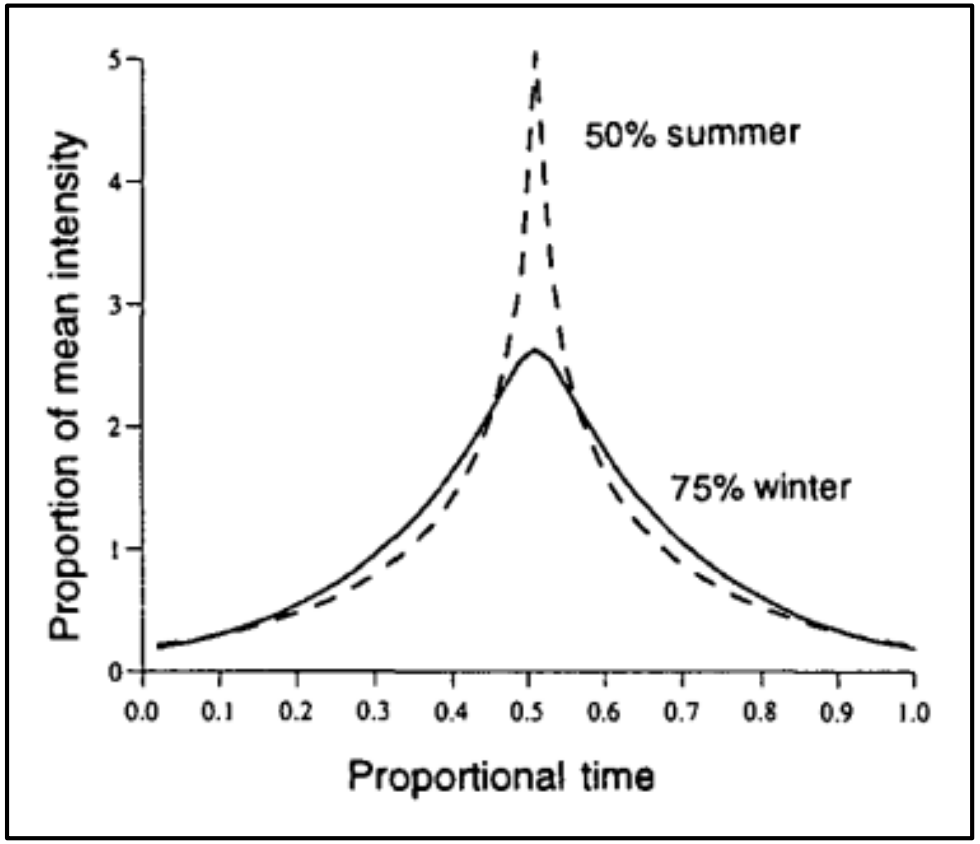
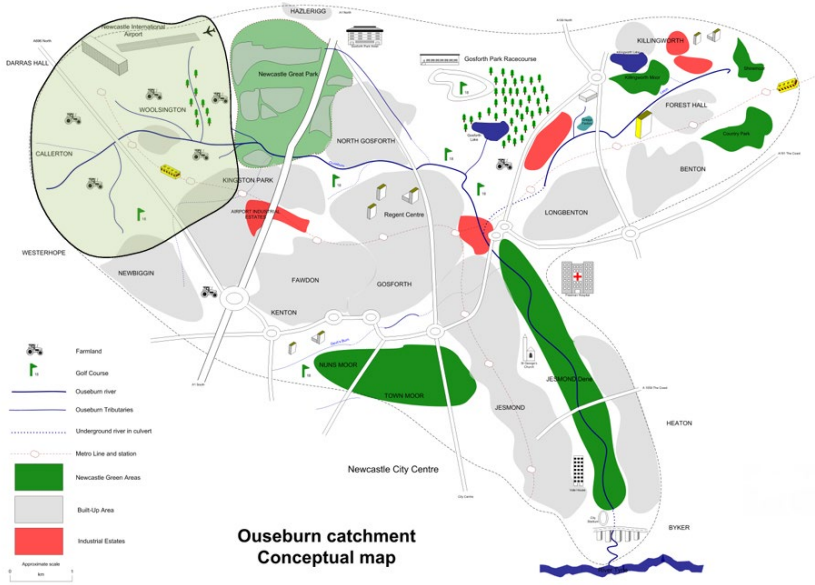


Figure 1: UK Design Storm Pattern, Balbastre-Soldevila & al. (2019)

Ouseburn catchment



- Surface area: 55km^2
- Location: Newcastle
- Low gradient - flat
- Moderate soil permeability
- Heavily urbanised
- 600/700mm average annual rainfall

Figure 2: Ouseburn Catchment igloo Regeneration | Ouseburn Valley, Newcastle

SHETRAN Model

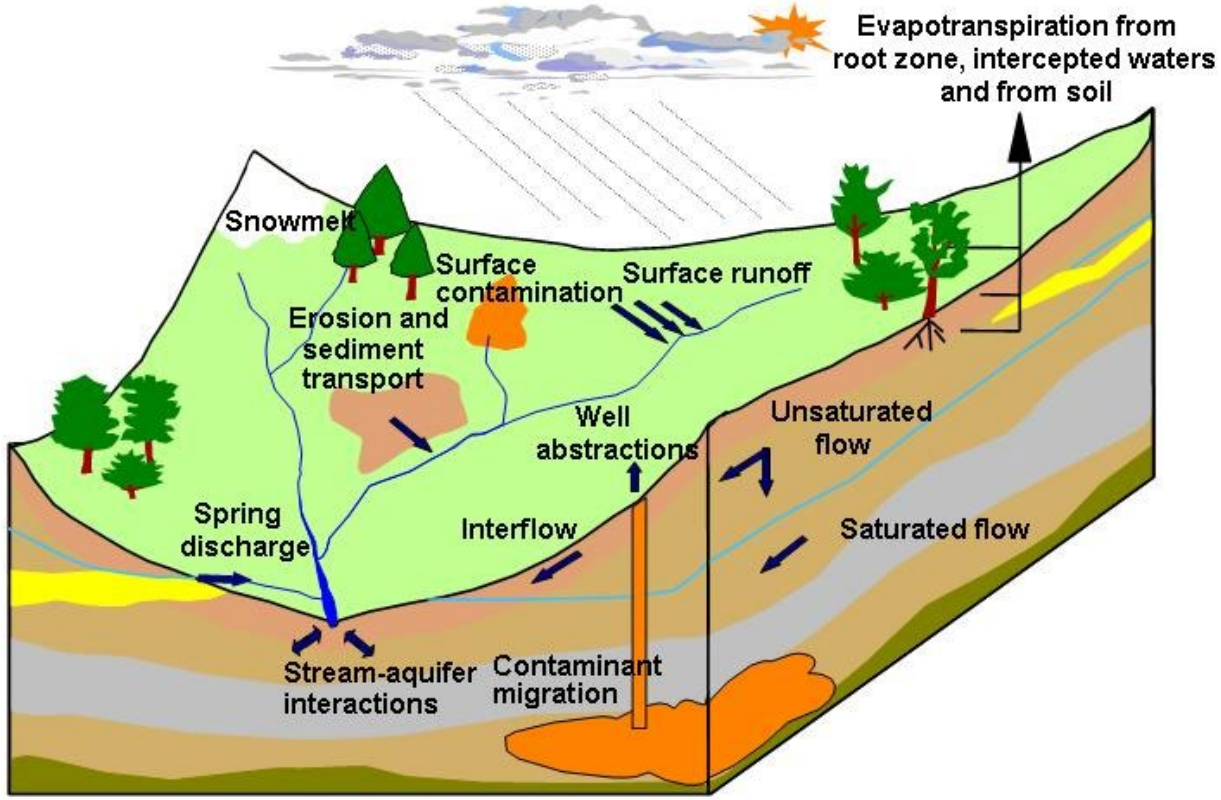


Figure 3: SHETRAN Model scheme, research.ncl.ac.uk/shetran/

Why SHETRAN?

- Spatially distributed
- Comprehensive
- Customisable
- Open-Source

Sensitivity Analysis

- Used NSE and Bias as Objective Functions
- +50% and -50% variations were applied to the initial values

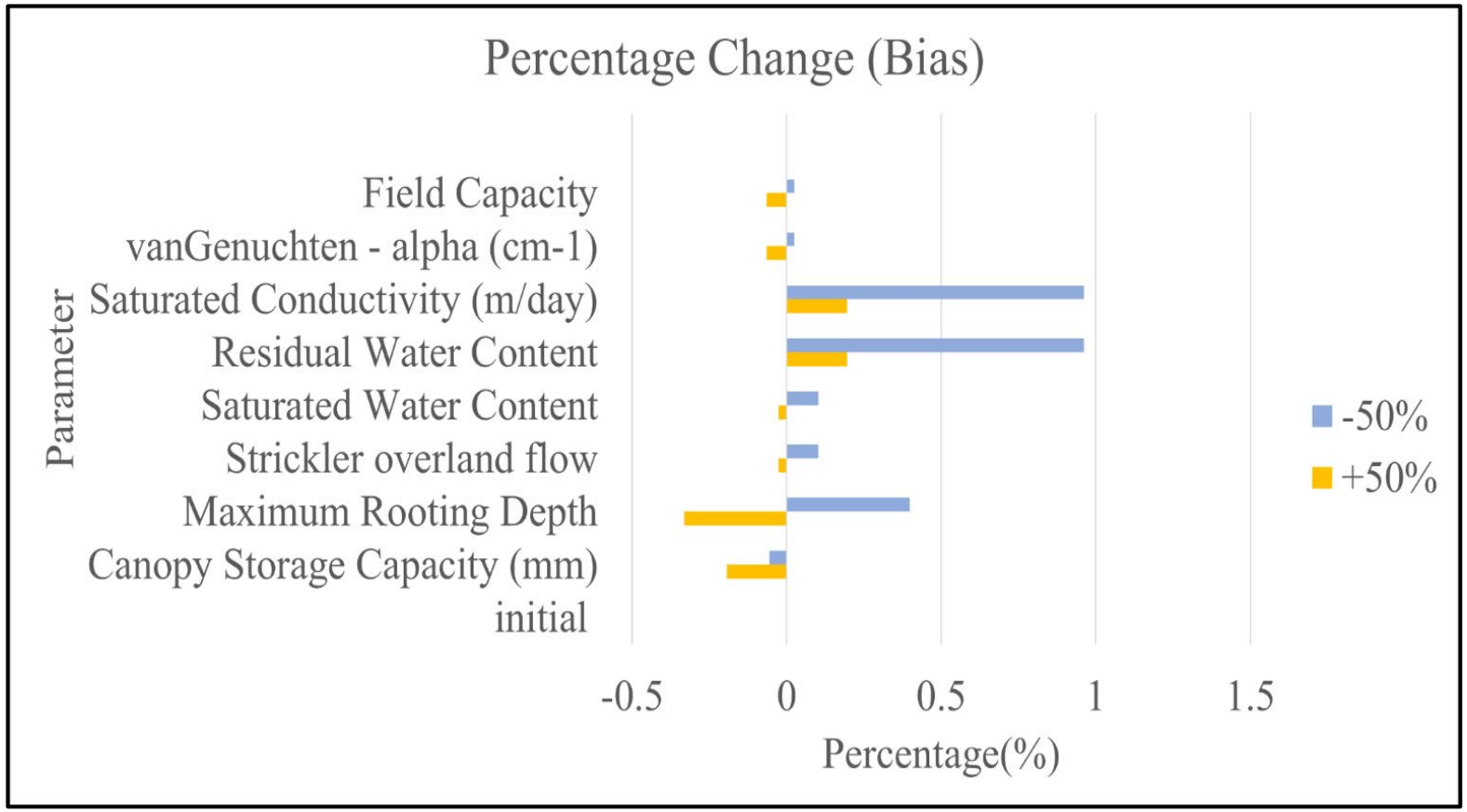


Figure 4: Percentage change of Bias

Sensitivity Analysis

Parameters Sensitivity:

- AE/PE Field capacity
- Saturated Conductivity
- Strickler Coefficient

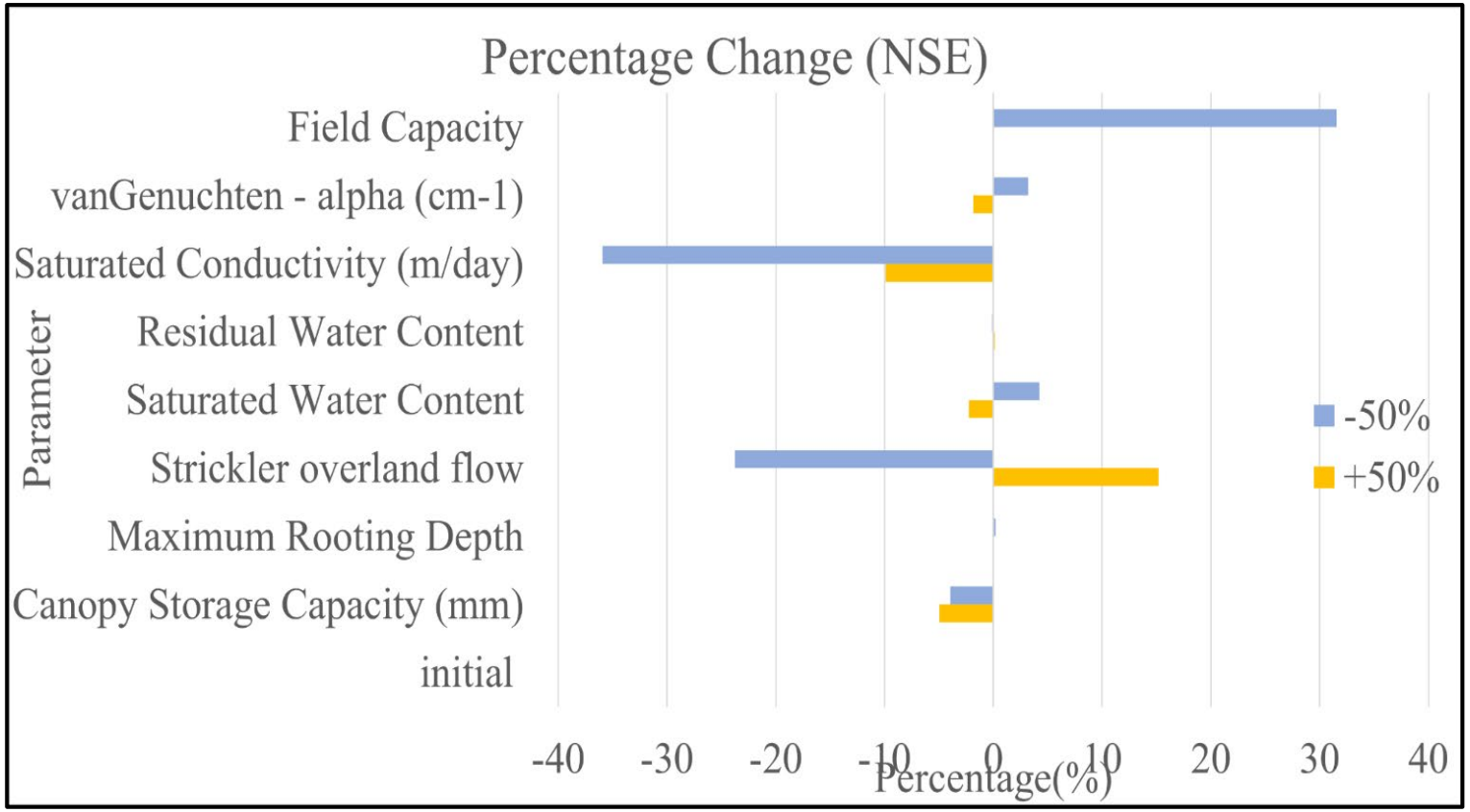
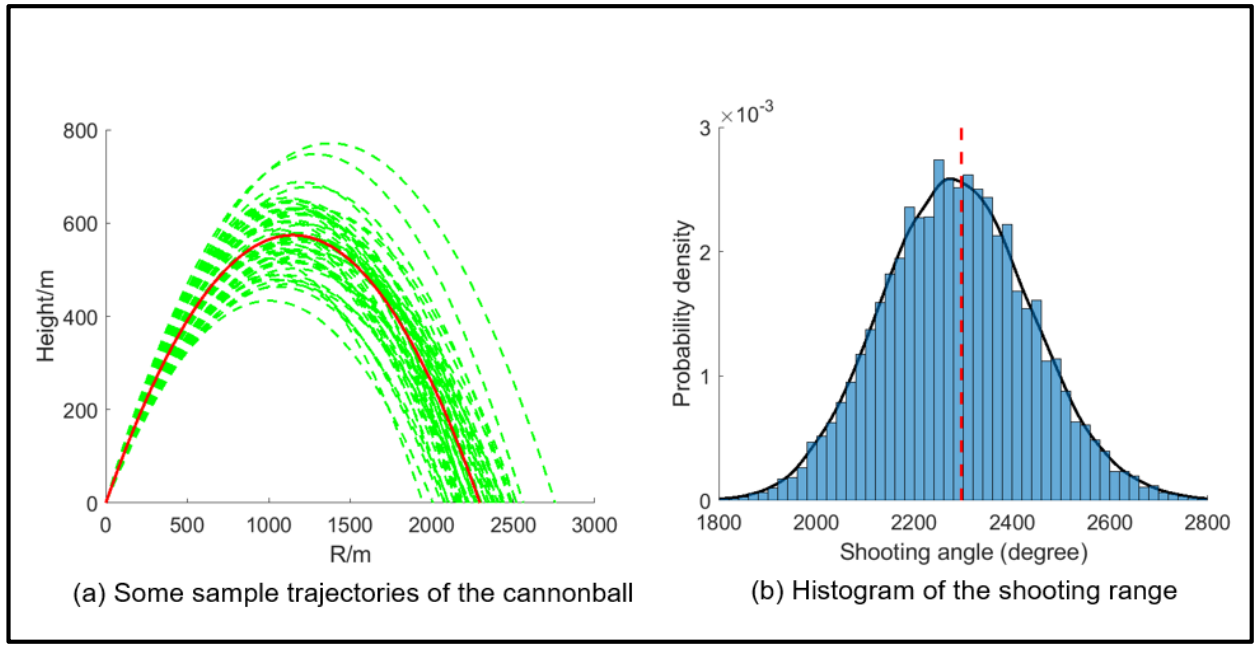


Figure 5: Percentage change of NSE

Monte Carlo Calibration



Gao, S. 2020

- Create parameter ranges based on published values.
- Randomly generate a large number of parameter scenarios within the range.
- Compare the parameter scenarios objective functions.
- Reduce parameter equifinity uncertainty

Figure 6: Monte Carlo Calibration Technique Example

Calibration Results

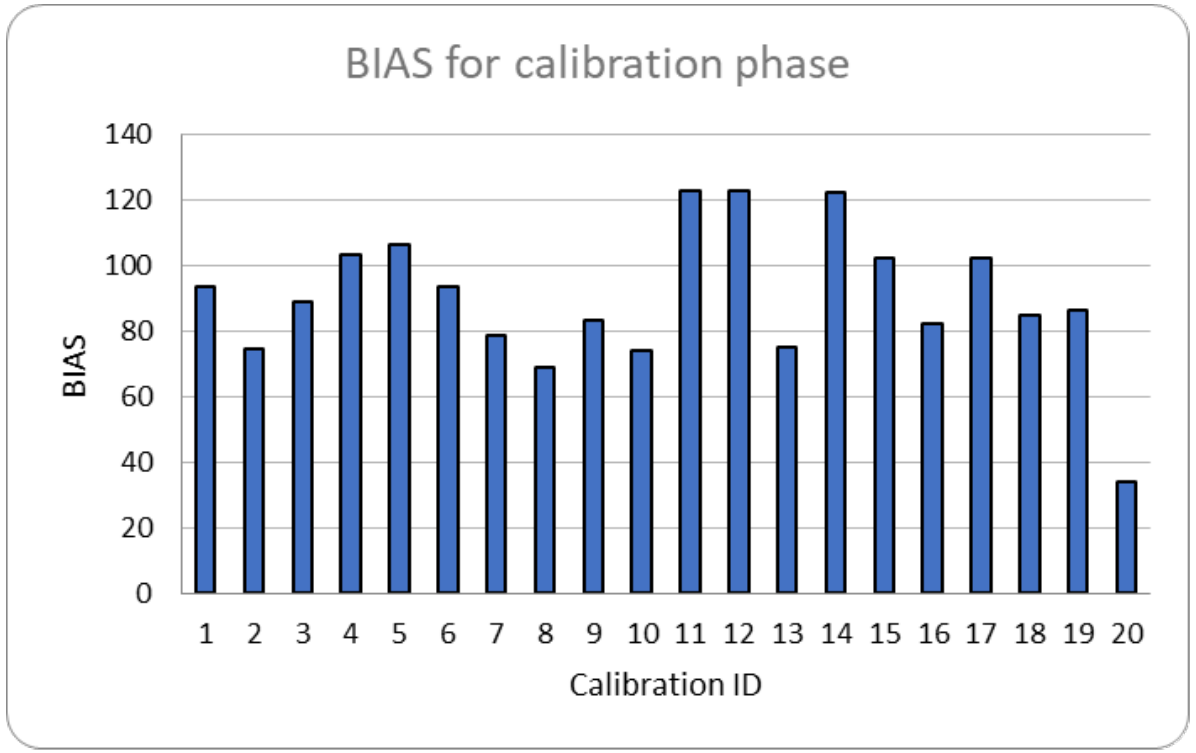


Figure 7: Bias results in calibration

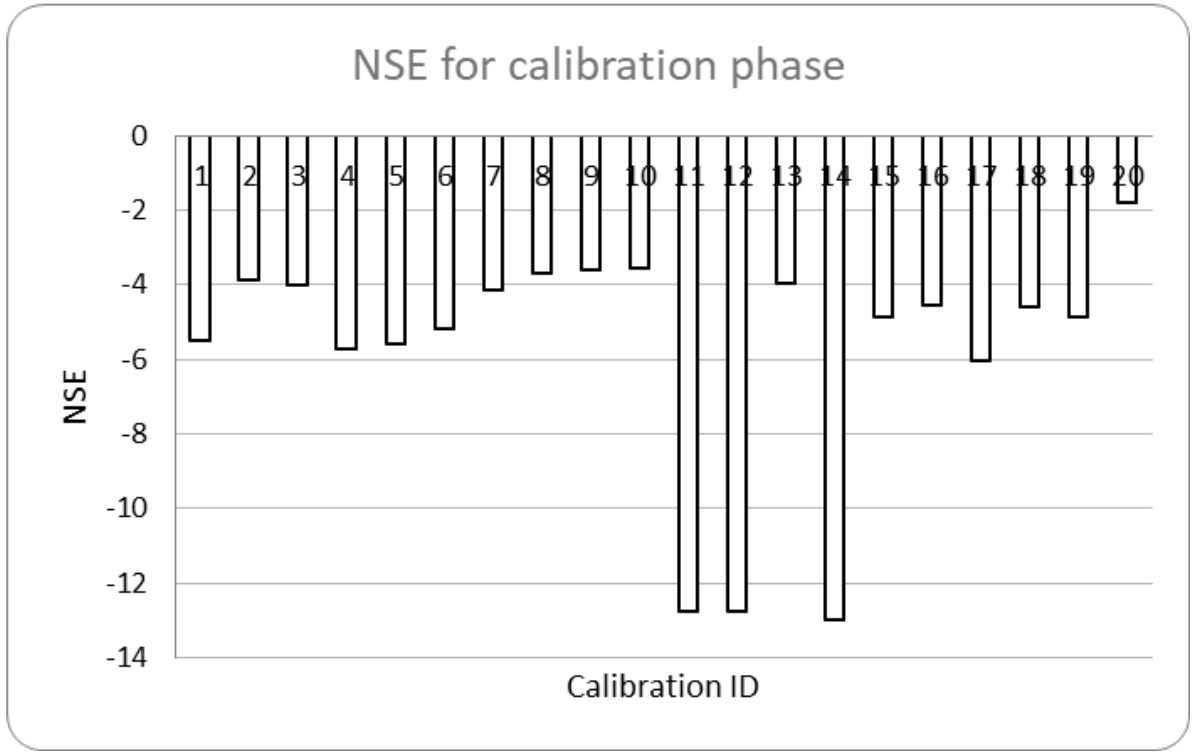


Figure 8: NSE results in calibration

Calibration Results

Simulated flows:

- Poorly represent baseflow.
- Over estimate flood peak magnitude.
- Fail to accurately capture receding limbs

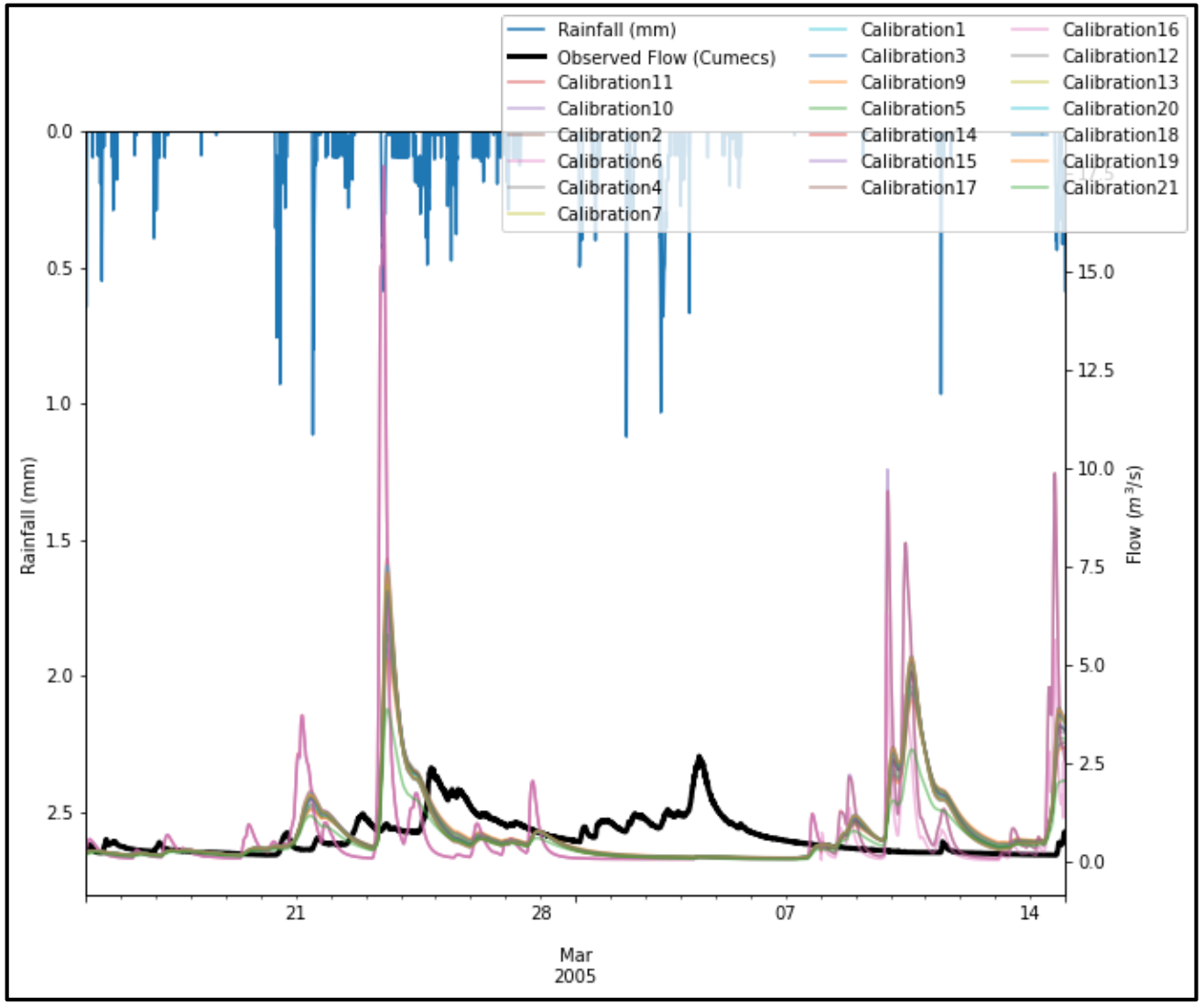


Figure 9: Calibration simulations plots

Design Storm Methodology

- Two sources-

  -Winter and summer profiles which are from the flood study report (used in industry)

  -Front, Centre and Back are used from study that was done in 2023(Roberto Villalobos, 2023)

- Spin up period model

- Model is run for 12hr

Design Storm Simulations

The different design storms simulate different peak flows and thus it is important to consider different storm profiles.

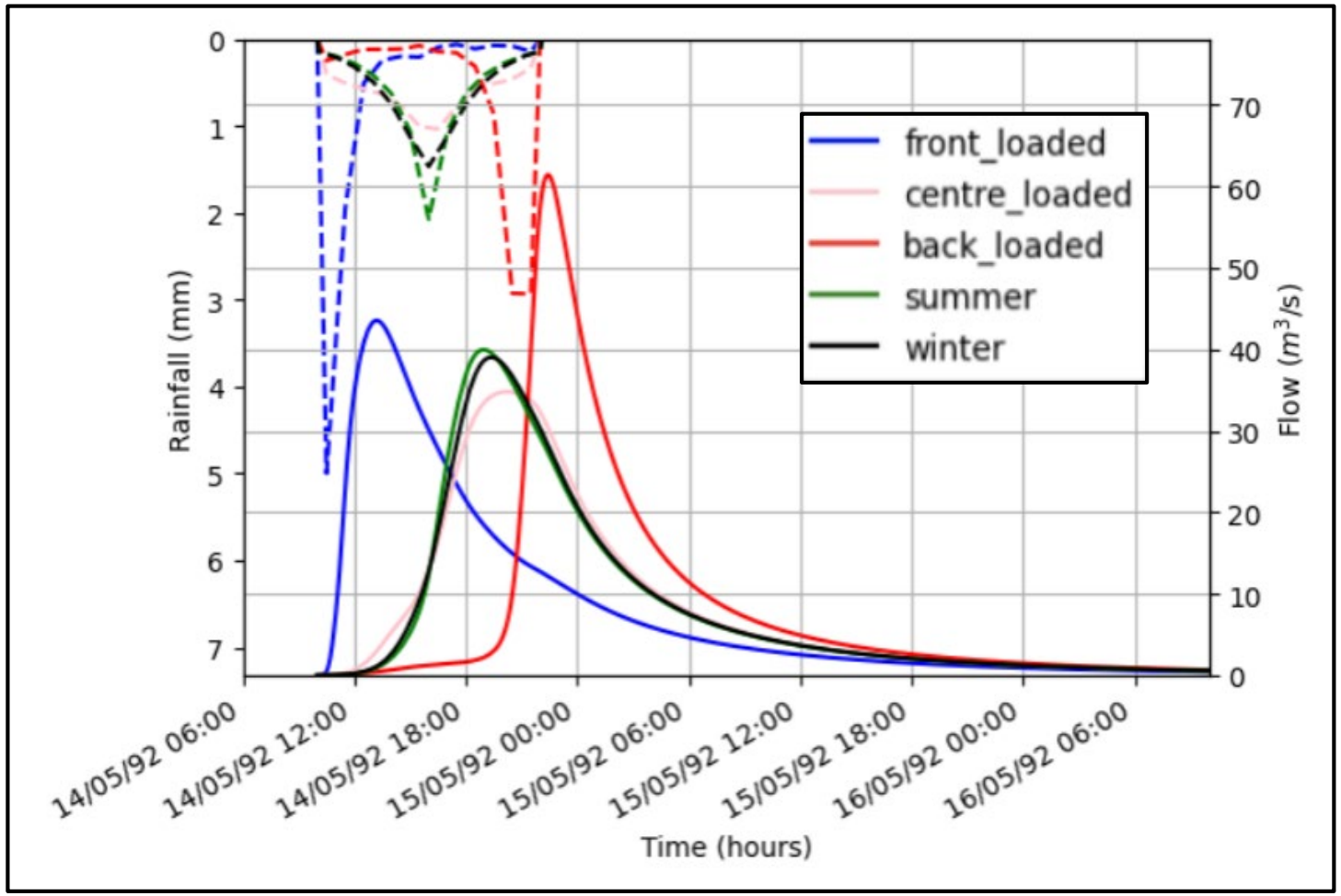


Figure 10: Design storm simulations

Conclusions

- UK should begin to use design storms with different profiles.
- Substantial impact of new storm design profiles on UK infrastructure
- Limitations of SHETRAN model
  - Parameter uncertainty
  - Long run times
  - Hard to find accurate measured parameter


THANK YOU
Any questions?