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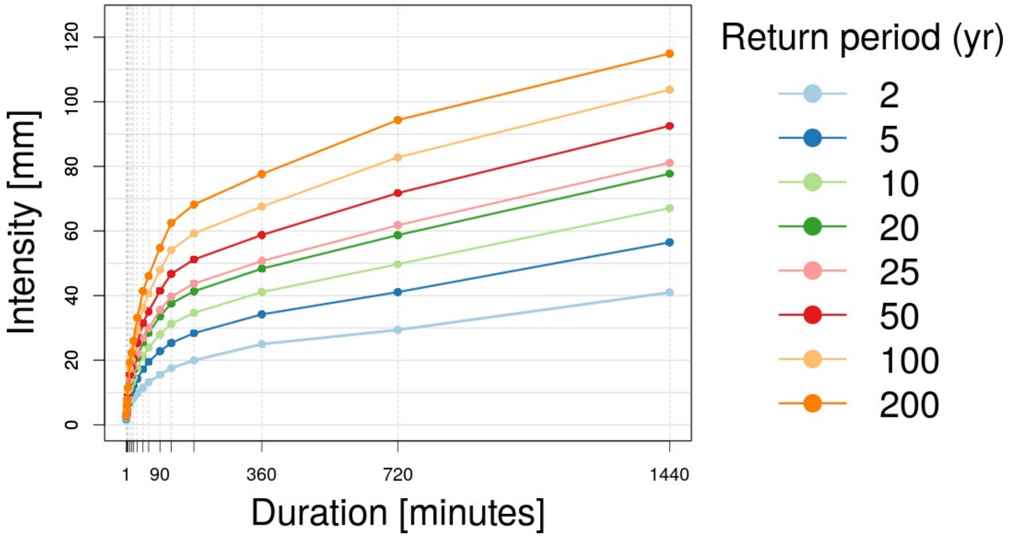
A Bayesian framework to derive consistent intensity-duration-frequency curves from multiple data sources

Thordis Thorarinsdottir, Thea Roksvåg, Julia Lutz,
Lars Grinde and Anita V. Dyrrdal

IDF curves for rainfall extremes

IDF curves show estimated rainfall intensity (**I**) for a duration (**D**) and return period, or frequency, (**F**)



How to estimate IDF-curves?

- Fit GEV distributions to **annual maximum precipitation data**.
- Fit one GEV distribution for each target duration *d*.

$$G(x;\mu_d,\sigma_d,\xi_d)=\exp\left\{-\left[1+\xi_d\left(\frac{x-\mu_d}{\sigma_d}\right)\right]^{-1/\xi_d}\right\}\quad \text{for } 1+\xi_d\left(\frac{x-\mu_d}{\sigma_d}\right)>0$$

$$\boldsymbol{x}_{d_1} \longrightarrow \mathrm{GEV}(\boldsymbol{x}_{d_1};\mu_{d_1},\sigma_{d_1},\xi_{d_1})$$

$$\boldsymbol{x}_{d_2} \longrightarrow \mathrm{GEV}(\boldsymbol{x}_{d_2};\mu_{d_2},\sigma_{d_2},\xi_{d_2})$$

$$\vdots$$

$$\boldsymbol{x}_{d_n} \longrightarrow \mathrm{GEV}(\boldsymbol{x}_{d_n};\mu_{d_n},\sigma_{d_n},\xi_{d_n})$$

The GEV quantile function yields return level for a fixed duration & return period:

$$z_{d,T}=\mu_d-\frac{\sigma_d}{\xi_d}\left(1-\left\{-\log\left(1-\frac{1}{T}\right)\right\}^{-\xi_d}\right)$$

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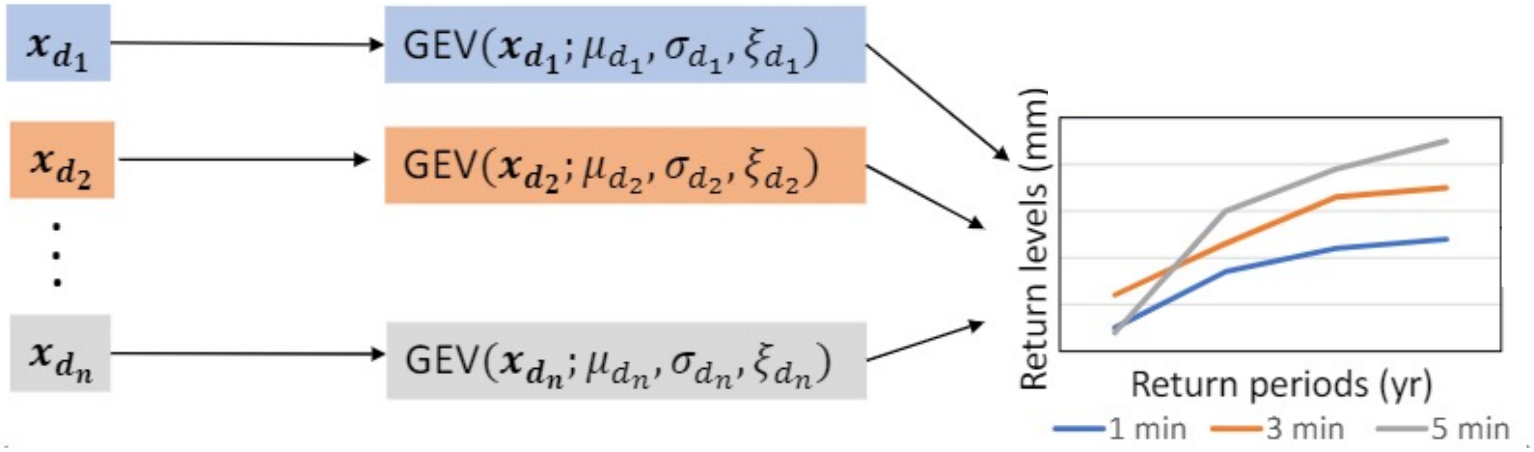
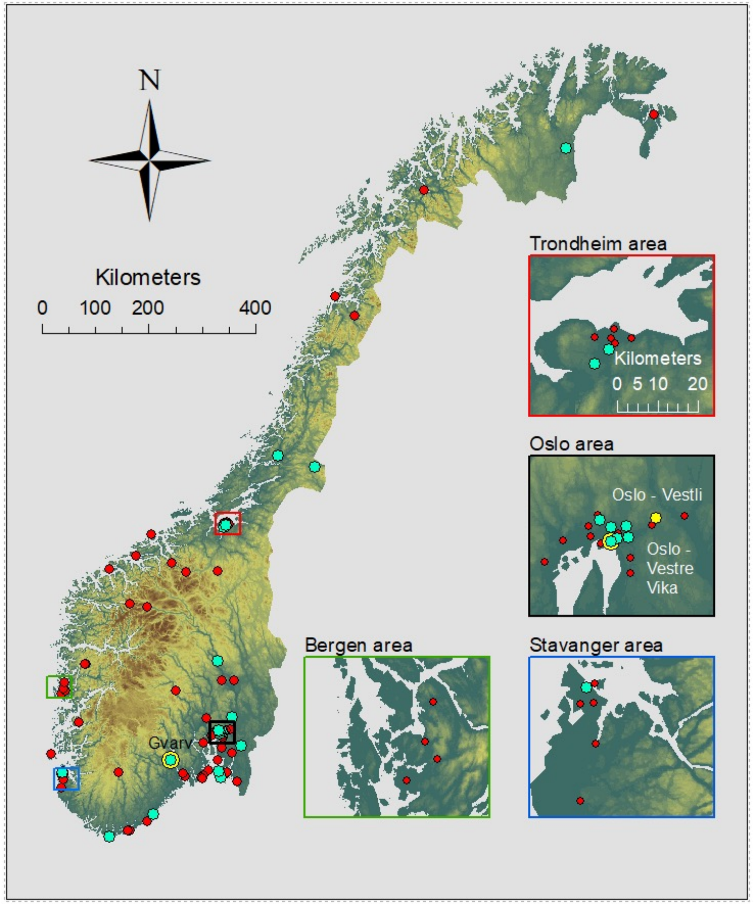
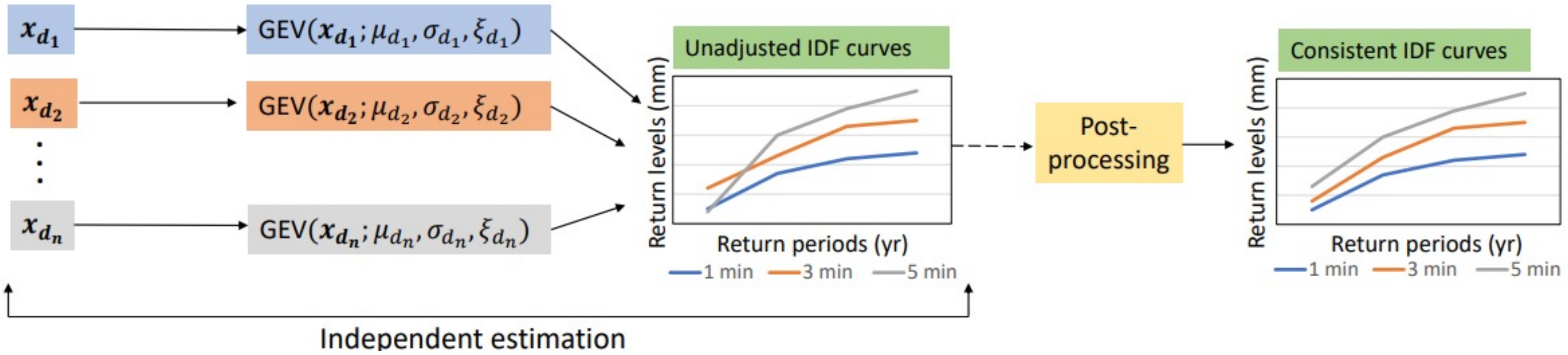


Is this really a problem?



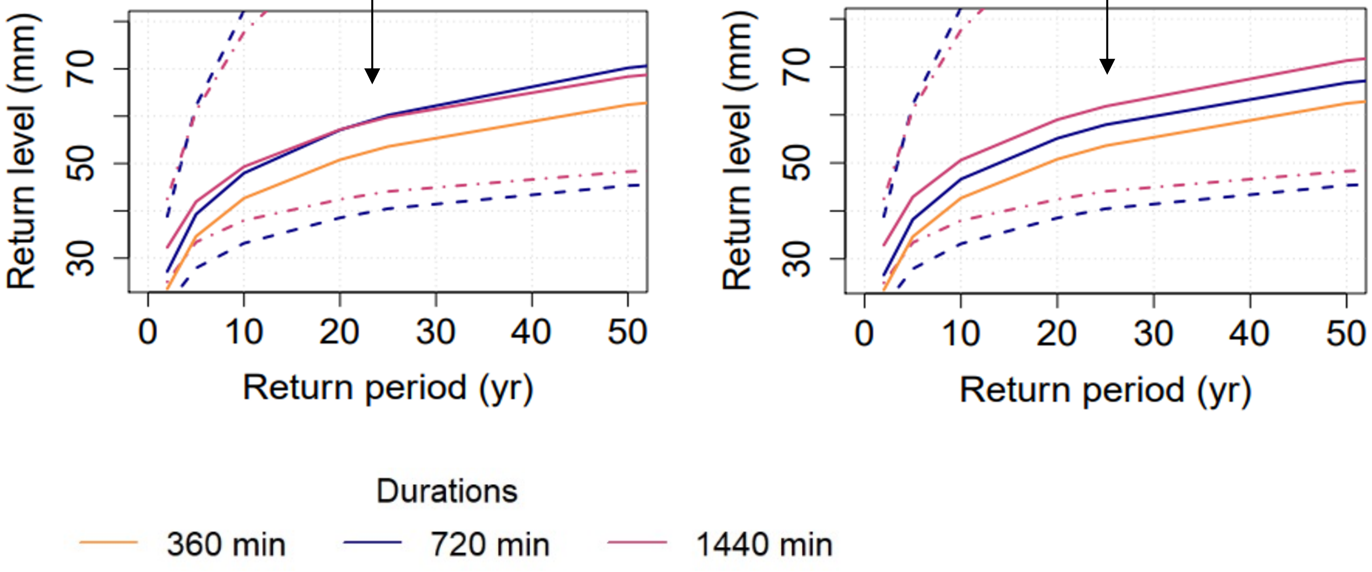
- 83 stations in Norway with 1 min data
- Estimate IDF curves for 16 durations:
  1 min to 24 hours
- **Inconsistent IDF-curves for 25% of the stations**

Proposed solution



Posterior medians

Some other posterior quantiles



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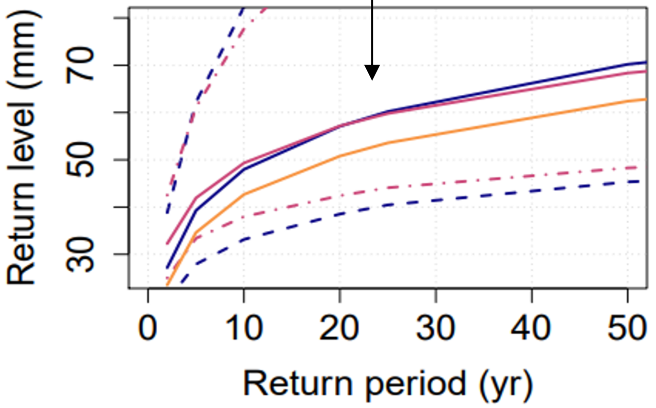
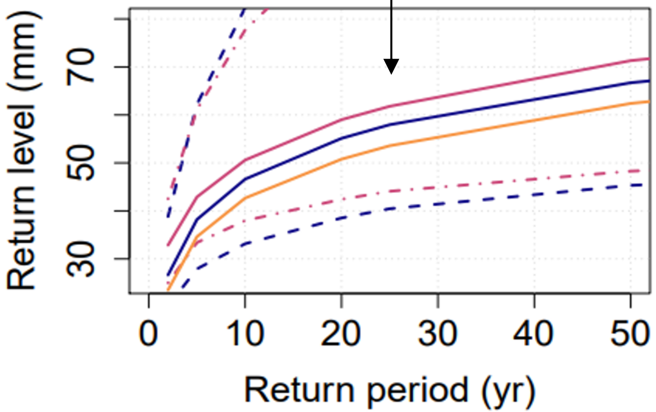
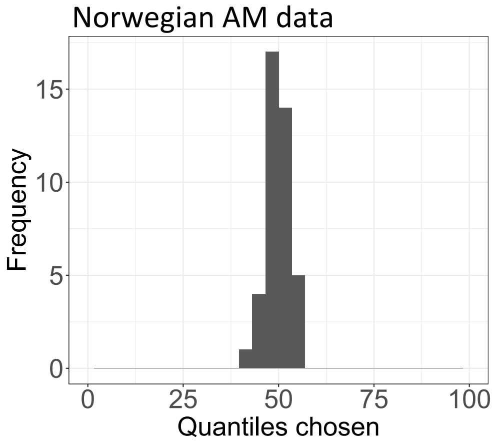
Some other posterior quantiles



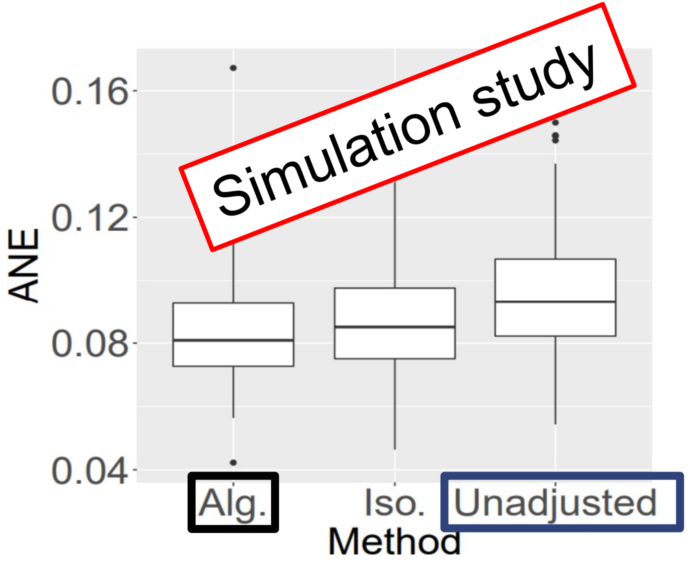


Durations

360 min 720 min 1440 min

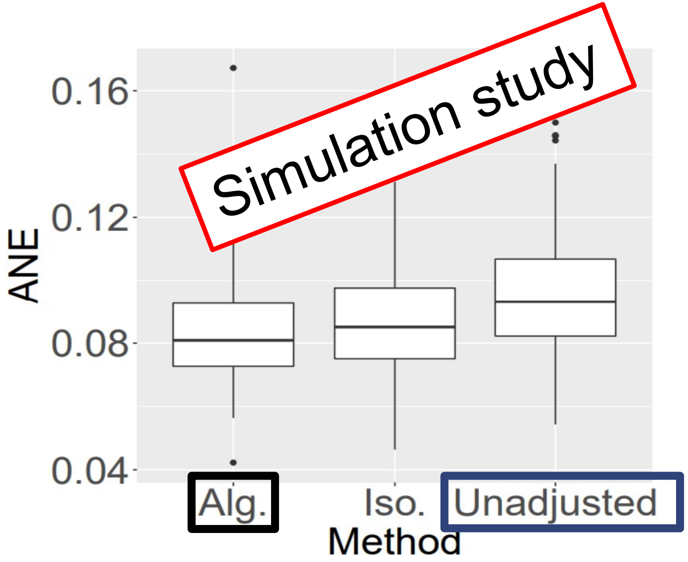


Result: curves are now consistent *and* return level estimates are more precise



ANE = Absolute normalized error

Result: curves are now consistent *and* return level estimates are more precise



ANE = Absolute normalized error

Pros:

- Flexible and quick
- Can be used with any Bayesian model for estimating return levels

Cons:

- Gives less smooth curves than fully parametric models
- Not suitable for extrapolation to out-of sample durations

github.com/ClimDesign/fixIDF

More information:

water

MDPI

Article

Estimating Rainfall Design Values for the City of Oslo, Norway—Comparison of Methods and Quantification of Uncertainty

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Consistent Intensity-Duration-Frequency curves by post-processing of estimated Bayesian posterior quantiles

Thea Roksvåg [a], Julia Lutz [b], Lars Grinde [b], Anita Verpe Dyrrdal [b], Thordis L. Thorarinsdottir [a]

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ClimDesign/fixIDF: R package for

github.com/climdesign/fixIDF

README.md

The fixIDF package

Thea Roksvåg roksvag@nr.no 28 1 2021

Overview

An intensity duration frequency (IDF) curve shows the relations (return levels), the duration of the intensity and how often the time (frequency or return period). Often, IDF curves are fitted t data, one duration at the time, independently of other duratio inconsistent return levels across return periods and durations. two functions for adjusting IDF-curves such that they become durations: `fixcurves_alg()` and `fixcurves_iso()`.

The package can be downloaded in R by writing:

```
Sys.setenv(R_REMOTES_NO_ERRORS_FROM_WARNINGS=TRUE)
library(devtools)
install_github("ClimDesign/fixIDF",ref="main")
```

NR