

Recommendations from Floodnet Project 1-6

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Chapter 1

Welcome

IN CONSTRUCTION

A description of the objectives of the Floodnet Project can be found at the Floodnet webpage

PDF and EPUB versions of this book can be downloaded from the github repository

Chapter 2

Annual maximums

2.1 Introduction

In this document I will show how to use `floodnetRfa` to perform at-site frequency analysis using annual maximum discharge. First we will extract the annual maximums from the daily discharge data of the Saint-John River at Fort Kent (NB). Note that incomplet year with missing observations will be removed. In total 88 annual maximums are extracted and showed in a histogram.

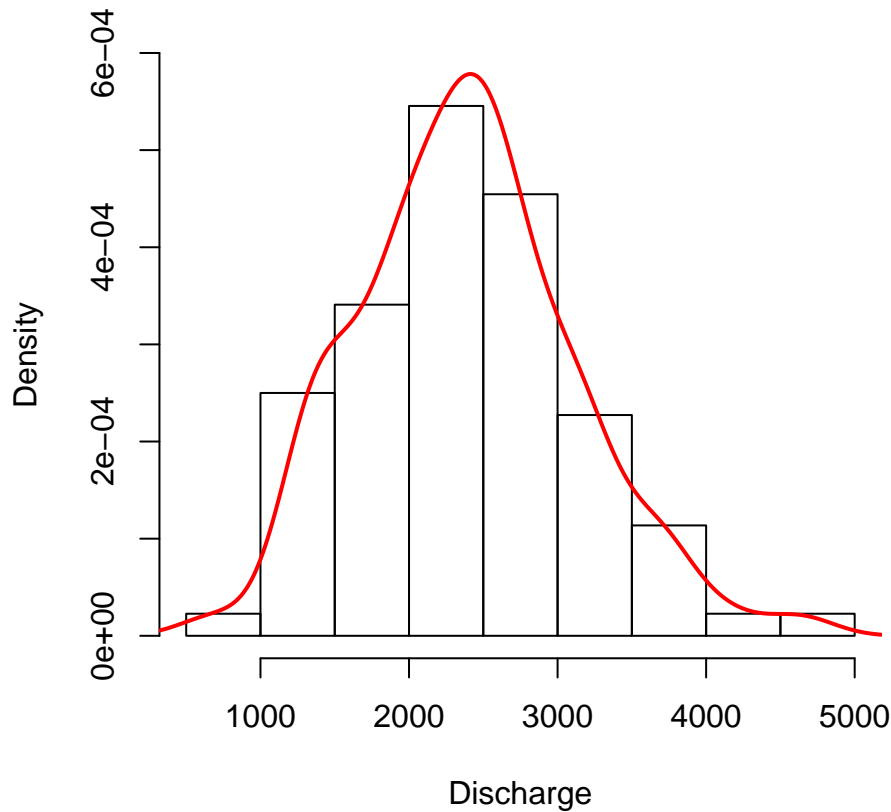
```
library(floodnetRfa)

anData <- ExtractAmax(flow ~ date, flowStJohn, tol = 365)

npDens <- density(anData$flow)

hist(anData$flow,
      freq = FALSE,
      main = '',
      xlab = 'Discharge',
      ylim = c(0, max(npDens$y)))

lines(npDens, col = 2, lwd = 2)
```



In stationary situation, the annual maximums are assumed to be independant and identically distributed. Risk is then measure in terms of return period that characterizes the average time separating two events of the same magnitude. In practice this is equivalent to calculate the probability $p = 1 - 1/T$ of a fitted distribution. The test of Mann-Kendall is frequently performed to verify if the data contains a significant trend that would invalidate the assumption of stationarity. The present data have a p-value of 0.21, which does not suggest the present of a trend.

```
plot(flow~date, anData)
```

```
MKendall(anData$flow)
```

```
##
##
## Mann-Kendall Test for trend
## S: 346
## p-value: 0.2136
```

2.2 Estimation of the flood quantiles

According to extreme value theory, as the number of annual maximums increase, their distribution converge to Generalized Extreme Value (GEV) distribution

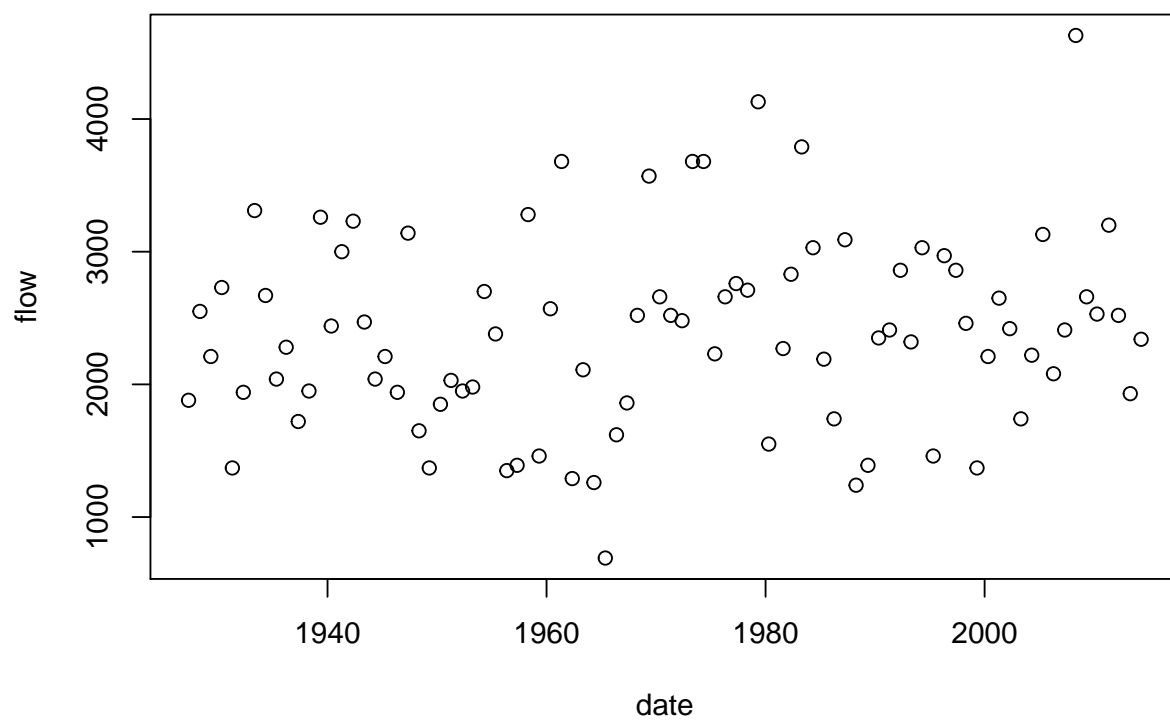


Figure 2.1: Trend in the annual maximums

$$F(x) = \exp \left\{ - \left[1 - \kappa \left(\frac{x - \xi}{\alpha} \right) \right]^{1/\kappa} \right\} \quad (2.1)$$

The GEV distribution in Equation (2.1) can be fitted using the `FitAmax` function. The example below shows how the parameter are estimated using the maximum likelihood method. See for instance (Coles, 2001). A brief summary of the fitted model is reported, including the estimated parameter, their standard deviation and the sample L-moments.

```
fit <- FitAmax(anData$flow, 'gev', method = 'mle')
print(fit)
```

```
##
## At-site frequency analysis
##
## Distribution: gev
## AIC: 1411
## Method: mle
## Estimate:
##      xi      alpha      kappa
## 2101.3761 668.9518 0.1667
##
## Std.err:
##      xi      alpha      kappa
## 78.39437 54.31311 0.06214
##
## Lmoments:
##      l1 lcv      lsk      lkt
## 1 2390 0.17 0.05924 0.1399
```

The flood quantile of the GEV distribution can be obtained from the formula

$$x_T = \mu + \frac{\alpha}{\xi} [1 + \log(1/T)^\kappa].$$

These predicted value are computed using the `predict` function. In the example below show the flood quantile for return period 2, 5, 10, 20, 50 and 100. The standard deviation of the flood quantiles is estimated using the Delta method that assume that the estimated parameter follow a Normal distribution.

```
predict(fit, se = TRUE, ci = 'delta')
```

```
##      pred      se      lower      upper
## 1 2339.216 82.44124 2177.634 2500.798
## 2 2989.156 99.81724 2793.518 3184.794
## 3 3356.637 117.79148 3125.770 3587.504
## 4 3668.464 144.52611 3385.198 3951.730
## 5 4020.327 193.47341 3641.126 4399.528
## 6 4250.404 238.46296 3783.025 4717.783
```

2.3 Verification of the model

The return level plot in 2.2 provide a visual assessment of the fitted distribution by comparing the sample and the predicted flood quantiles. The graphic below shows a good agreement between the two.

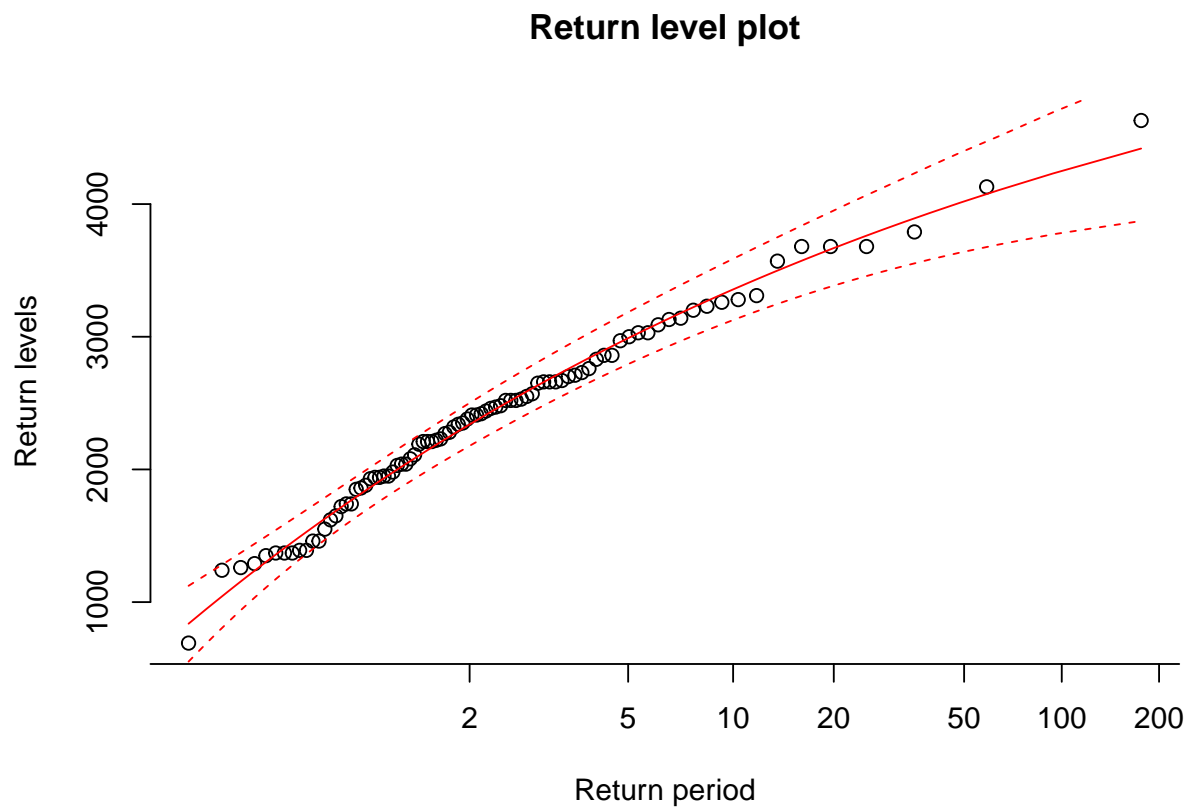


Figure 2.2: Return level plot for Saint-John River at Fort Kent, NB.

```
plot(fit, ci = TRUE)
```

Another diagnostic to ensure that the GEV distribution is appropriate is the Anderson-Darling test. The p-value superior to 0.05 indicates that the hypothesis of a GEV cannot be rejected.

```
## Time consuming when estimated by 'mle'
GofTest(fit, nsim = 500)
```

```
##
## Goodness-of-fit test for annual maxima
##
## Test = Anderson-Darling
## Distribution = gev
## statistic : 0.266
## p-value : 0.602
```


Chapter 3

Introduction

You can label chapter and section titles using `{#label}` after them, e.g., we can reference Chapter 3. If you do not manually label them, there will be automatic labels anyway, e.g., Chapter ??.

Figures and tables with captions will be placed in `figure` and `table` environments, respectively.

```
par(mar = c(4, 4, .1, .1))
plot(pressure, type = 'b', pch = 19)
```

Reference a figure by its code chunk label with the `fig:` prefix, e.g., see Figure 3.1. Similarly, you can reference tables generated from `knitr::kable()`, e.g., see Table 3.1.

```
knitr::kable(
  head(iris, 20), caption = 'Here is a nice table!',
  booktabs = TRUE
)
```

You can write citations, too. For example, we are using the **bookdown** package (?) in this sample book, which was built on top of R Markdown and **knitr** (?).

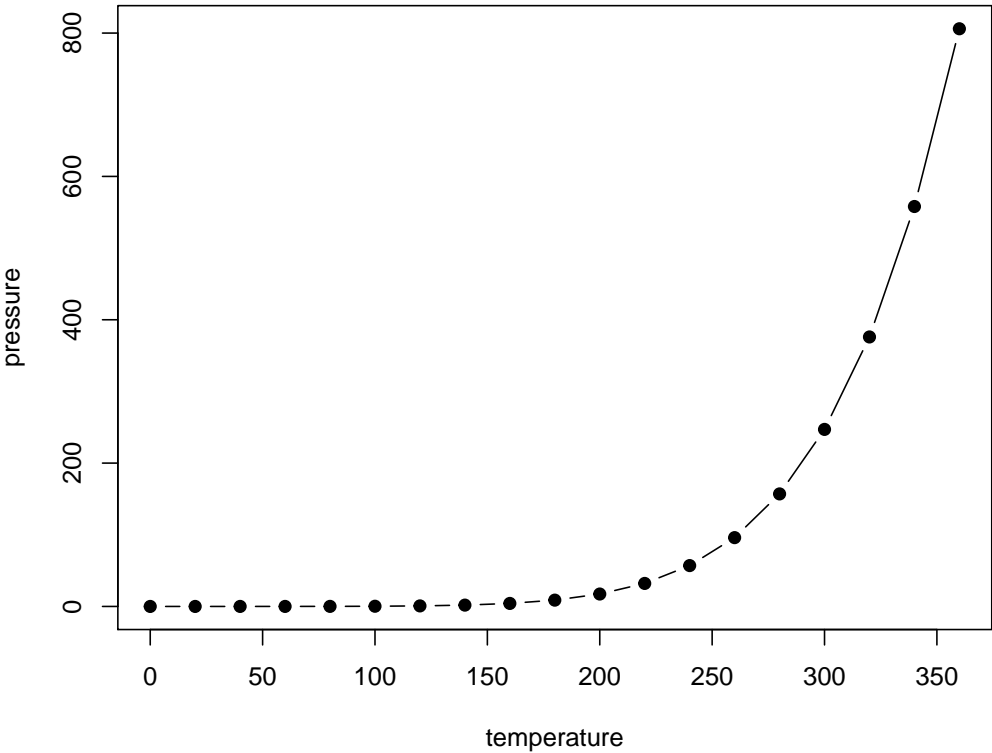


Figure 3.1: Here is a nice figure!

Table 3.1: Here is a nice table!

Sepal.Length	Sepal.Width	Petal.Length	Petal.Width	Species
5.1	3.5	1.4	0.2	setosa
4.9	3.0	1.4	0.2	setosa
4.7	3.2	1.3	0.2	setosa
4.6	3.1	1.5	0.2	setosa
5.0	3.6	1.4	0.2	setosa
5.4	3.9	1.7	0.4	setosa
4.6	3.4	1.4	0.3	setosa
5.0	3.4	1.5	0.2	setosa
4.4	2.9	1.4	0.2	setosa
4.9	3.1	1.5	0.1	setosa
5.4	3.7	1.5	0.2	setosa
4.8	3.4	1.6	0.2	setosa
4.8	3.0	1.4	0.1	setosa
4.3	3.0	1.1	0.1	setosa
5.8	4.0	1.2	0.2	setosa
5.7	4.4	1.5	0.4	setosa
5.4	3.9	1.3	0.4	setosa
5.1	3.5	1.4	0.3	setosa
5.7	3.8	1.7	0.3	setosa
5.1	3.8	1.5	0.3	setosa

Bibliography

Coles, S. (2001). *An introduction to statistical modeling of extreme values*. Springer Verlag.