Recommendations from Floodnet Project 1-6

Martin Durocher

2019-01-28

Contents

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.

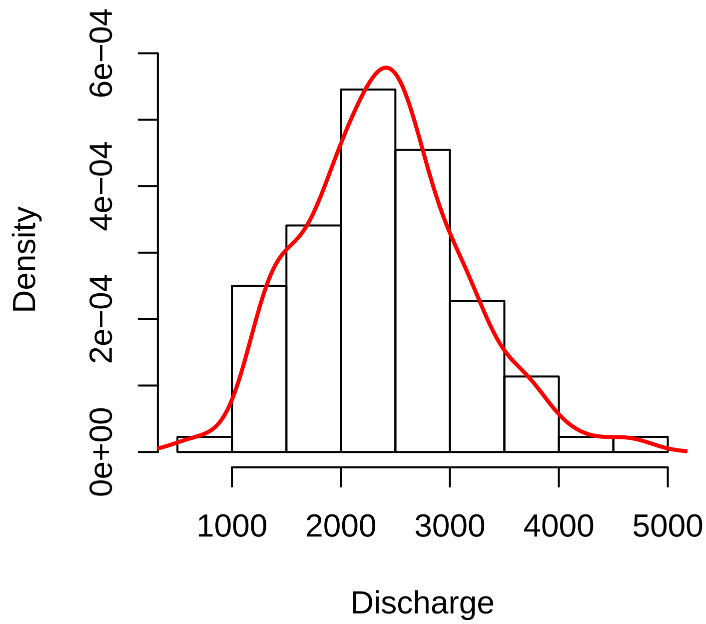
```r
library(floodnetRfa)

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

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

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

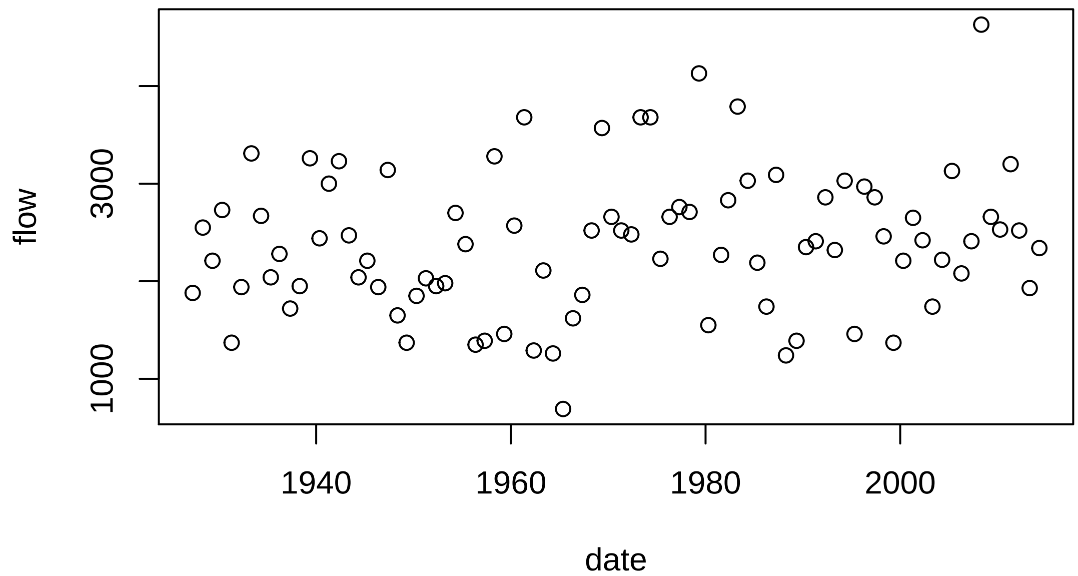


Figure 2.1: Trend in the annual maximums

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

Table 2.1: Predicted return levels

pred	se	lower	upper
2339.216	82.44124	2177.634	2500.798
2989.156	99.81724	2793.518	3184.794
3356.637	117.79148	3125.770	3587.504
3668.464	144.52611	3385.198	3951.730
4020.327	193.47341	3641.126	4399.528
4250.404	238.46296	3783.025	4717.783

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

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.

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

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.

```
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
```

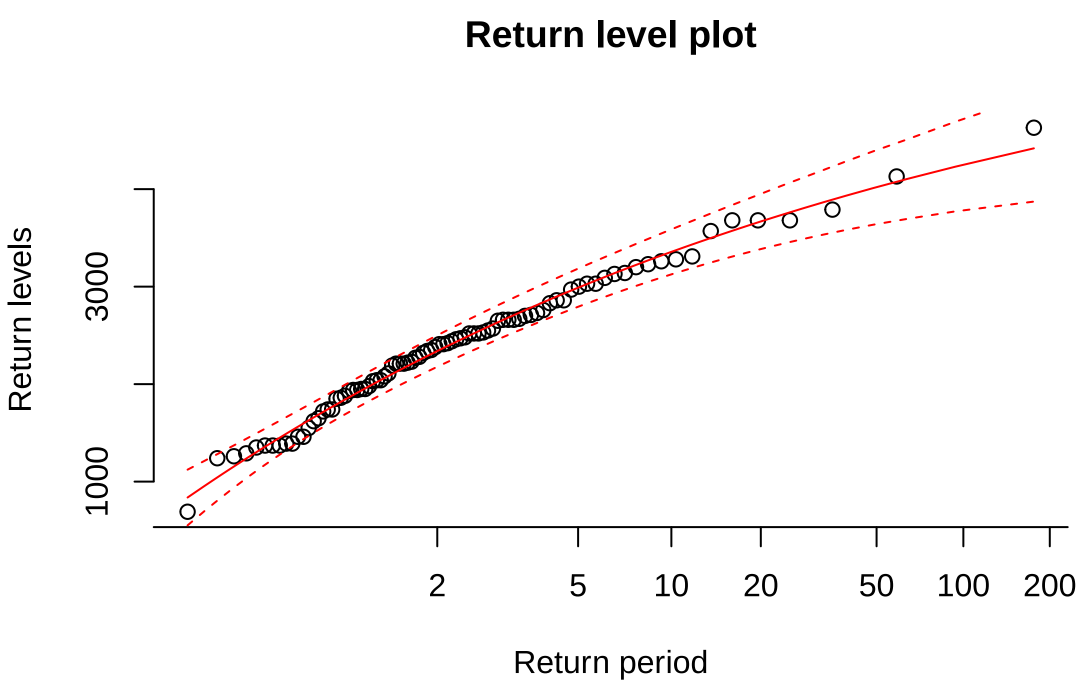


Figure 2.2: Return level plot for Saint-John River at Fort Kent, NB.

Bibliography

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