Runoff-vikedal

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Example of downscaling high runoff events

This example shows how the number of events with high runoff (more than 30 cubic meters per second) is connected to precipitation statistics that can be downscaled through empirical-statistical means. Such a connection indicates that it may be possible to downscale number of high flow events through a hybrid scheme based on parameter downscaling (of the wet-day mean precipitation and wet day frequency) and number-of-event modelling.

The example here is for Vikedal, a small catchment in western Norway.

The hydrological data was provided by Yan Lin from NIVA (http://www.niva.no).

R Markdown

This is an R Markdown document. Markdown is a simple formatting syntax for authoring HTML, PDF, and MS Word documents. For more details on using R Markdown see http://rmarkdown.rstudio.com.

```
library(esd)
```

```
## Loading required package: ncdf4
```

```
## Loading required package: zoo
```

```
##
## Attaching package: 'zoo'
```

```
## The following objects are masked from 'package:base':
##
##     as.Date, as.Date.numeric
```

```
##
## Attaching package: 'esd'
```

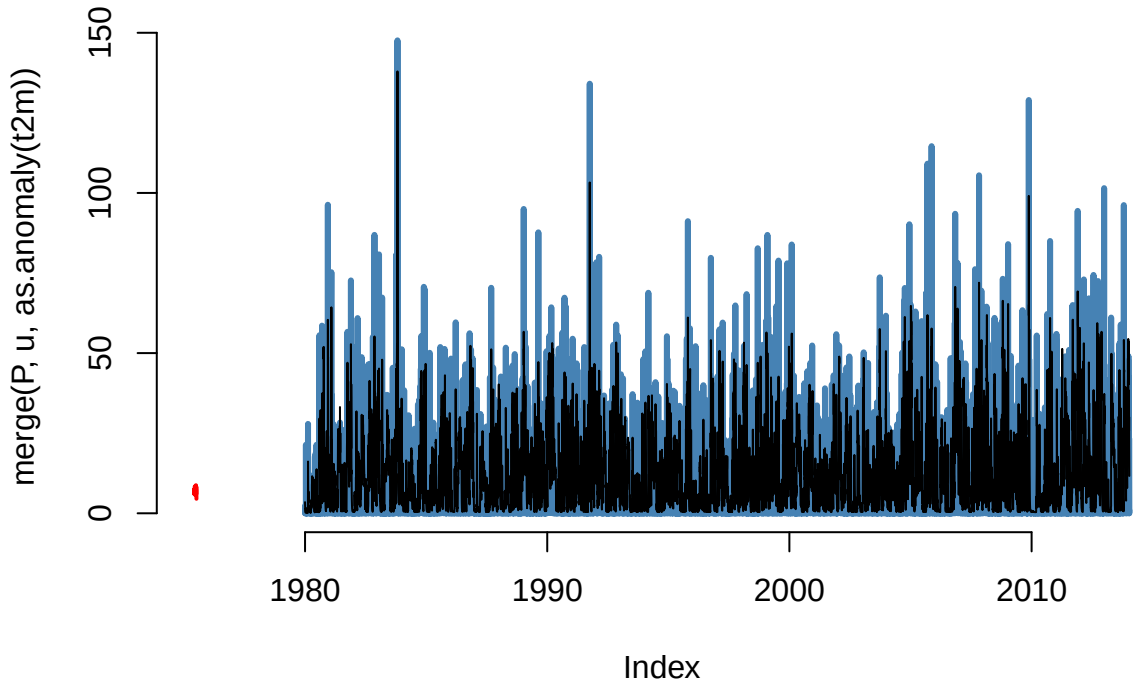
```
## The following object is masked from 'package:base':
##
##     subset.matrix
```

```
# VIKEDAL (met station no. 46850, LAT 59.5558N, LON 5.9955E
hydroIO <- read.table("~/Dropbox/data/Vikedal.csv",sep=";",header=TRUE)
loc <- 'Vikedal'
lon <- 5.9955
lat <- 59.5558
alt <- 159
stid <- 46850
```

```
hydroIO$Date <- as.character(hydroIO$Date)      # Fix
hydroIO$Date <- paste(substr(hydroIO$Date,7,10),substr(hydroIO$Date,4,5),substr(hydroIO$Date,1,2),sep='
hydroIO$Temperature.C <- hydroIO$Temperatrue.C  # Fix
P <- zoo(x=hydroIO$Precipitation..mm,order.by=as.Date(hydroIO$Date))
t2m <- zoo(x=hydroIO$Temperature.C,order.by=as.Date(hydroIO$Date))
u <- zoo(x=hydroIO$Flow..m3.s,order.by=as.Date(hydroIO$Date))
```

```
par(bty="n")
plot(merge(P,u,as.anomaly(t2m)),plot.type='single',col=c("steelblue","black","red"),lwd=c(3,1,2),new=FA
```

```
## Warning in merge.zoo(P, u, as.anomaly(t2m)): Index vectors are of different
## classes: Date Date numeric
```

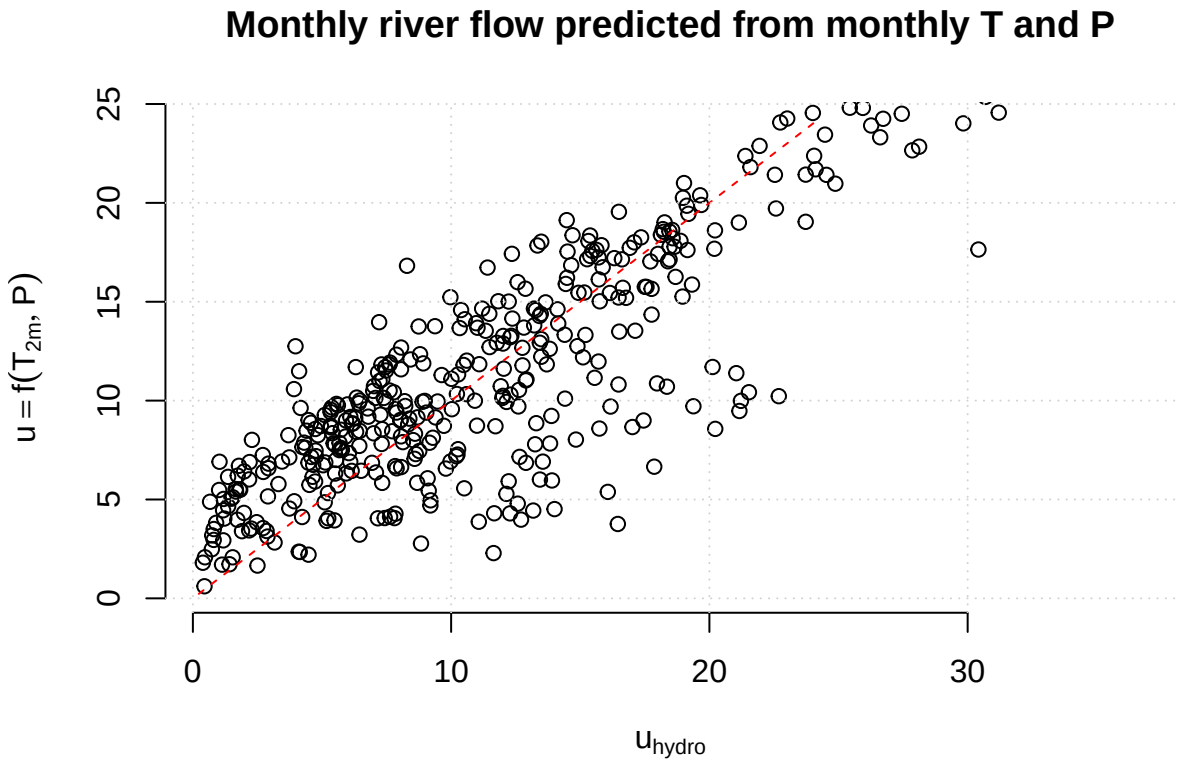



```
#dev2bitmap('hydroex-daily.png',res=150)

Pmm <- aggregate(P,as.yearmon,FUN='mean')
Tmm <- aggregate(t2m,as.yearmon,FUN='mean')
umm <- aggregate(u,as.yearmon,FUN='mean')

#plot(coredata(P),coredata(u))

cal <- data.frame(u=coredata(umm),t2m=coredata(Tmm),Pmm=coredata(Pmm))
fit <- lm(u ~ t2m + Pmm,data=cal)
print(summary(fit))
```

```
##
## Call:
## lm(formula = u ~ t2m + Pmm, data = cal)
##
## Residuals:
```

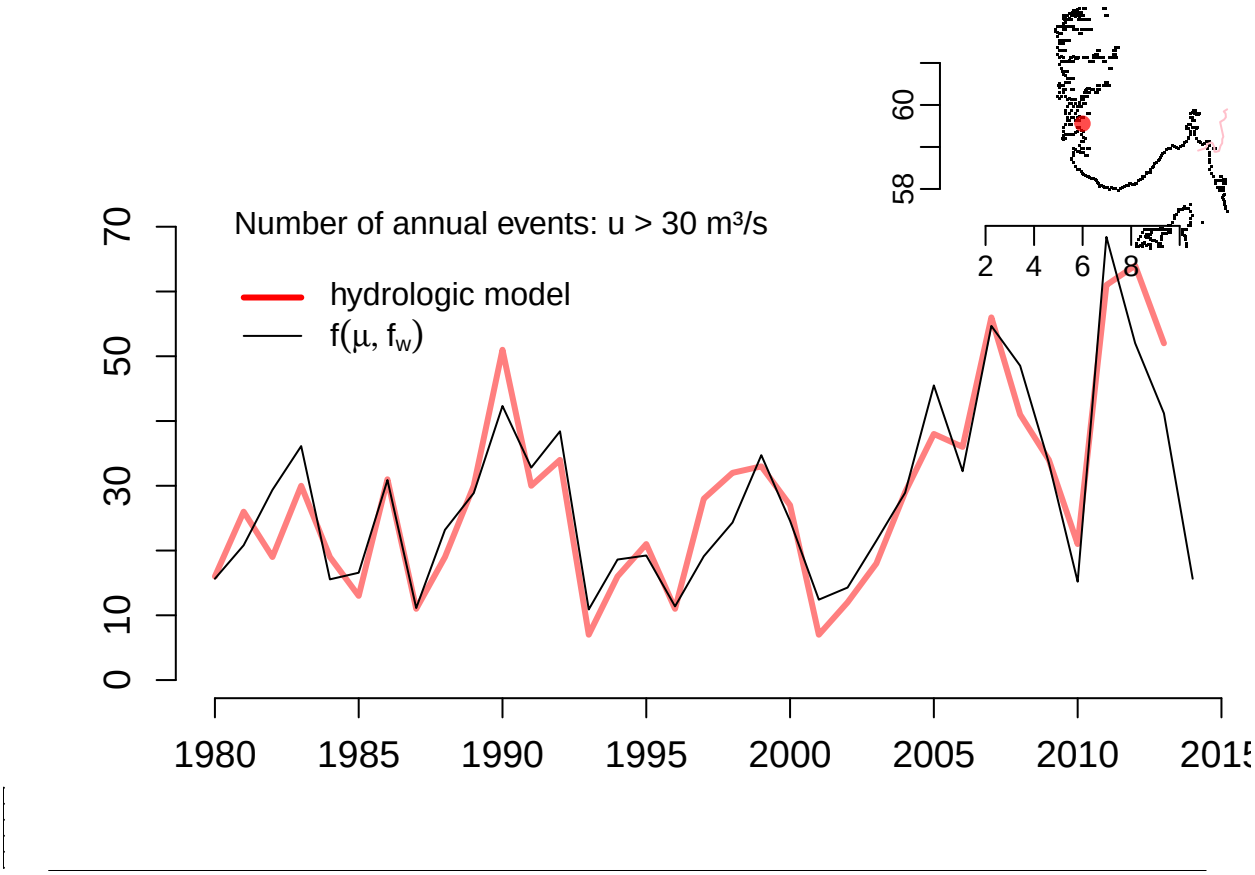
```
##     Min      1Q  Median      3Q     Max
## -8.7760 -2.7529 -0.8039  1.8511 12.7760
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  0.74519    0.47152   1.580  0.11479
## t2m          0.09238    0.03537   2.612  0.00934 **
## Pmm          1.29389    0.04058  31.882  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.803 on 406 degrees of freedom
## Multiple R-squared:  0.7152, Adjusted R-squared:  0.7138
## F-statistic: 509.8 on 2 and 406 DF,  p-value: < 2.2e-16
```

```
par(bty="n")
plot(coredata(umm),predict(fit),
     main='Monthly river flow predicted from monthly T and P',
     ylim=range(coredata(Pmm)),
     xlab=expression(u[hydro]),ylab=expression(u==f(T[2*m],P)))
lines(range(coredata(Pmm)),range(coredata(Pmm)),col="red",lty=2)
grid()
```




```
#dev2bitmap(file='hydroex.png',res=150)

temp <- as.station(t2m,lon=lon,lat=lat,alt=alt,unit='deg C',param='t2m',loc=loc,stid=stid)

if (FALSE) {
z.t2m <- try(DSensemble.t2m(temp,biascorrect=TRUE,plot=TRUE))
```

```
#dev2bitmap('hydroex-dse-z.t2m.png',res=150)
save(file='hydroex-dse-z.t2m.rda',z.t2m)
}

precip <- as.station(P,lon=lon,lat=lat,alt=alt,unit='mm/day',param='precip',loc=loc,stid=stid)
if (FALSE) {
z.pre <- try(DSensemble.precip(precip,biascorrect=TRUE,plot=TRUE))
#dev2bitmap('hydroex-dse-z.pre.png',res=150)
save(file='hydroex-dse-z.pre.rda',z.pre)
}

flow <- as.station(u,lon=lon,lat=lat,alt=alt,unit='m^3/s',param='u',loc=loc,stid=stid)

muam <- annual(precip,FUN='exceedance',threshold=1)
fwam <- annual(precip,FUN='wetfreq',threshold=1)
uamx <- annual(flow,FUN='count',threshold=30)
attr(uamx,'variable') <- 'n(X > m^3/s)'
attr(uamx,'unit') <- ' '

am <- data.frame(u=coredata(uamx),mu=coredata(muam),fw=coredata(fwam))
emu <- glm(u ~ mu + fw, data=am, family='poisson')

plot(uamx,lwd=3,ylim=c(0,70),col='red',new=FALSE)
lines(zoo(exp(predict(emu)),order.by=index(uamx)))

text(1980,70,pos=4,'Number of annual events: u > 30 m³/s')
legend(1980,65,c("hydrologic model",expression(f(mu,f[w]))),
       lty=1,col=c("red","black"),lwd=c(3,1),bty="n")
```




```
#dev2bitmap('hydroex-u.gt.30.png',res=150)
```