

ΔΙΑΧΕΙΡΙΣΗ ΥΔΑΤΙΚΩΝ ΠΟΡΩΝ - ΕΡΓΑΣΤΗΡΙΟ

Το πακέτο hydroTSM της R

Το πακέτο hydroTSM είναι ένα βασικό εργαλείο ανάλυσης υδρολογικών δεδομένων στην R.

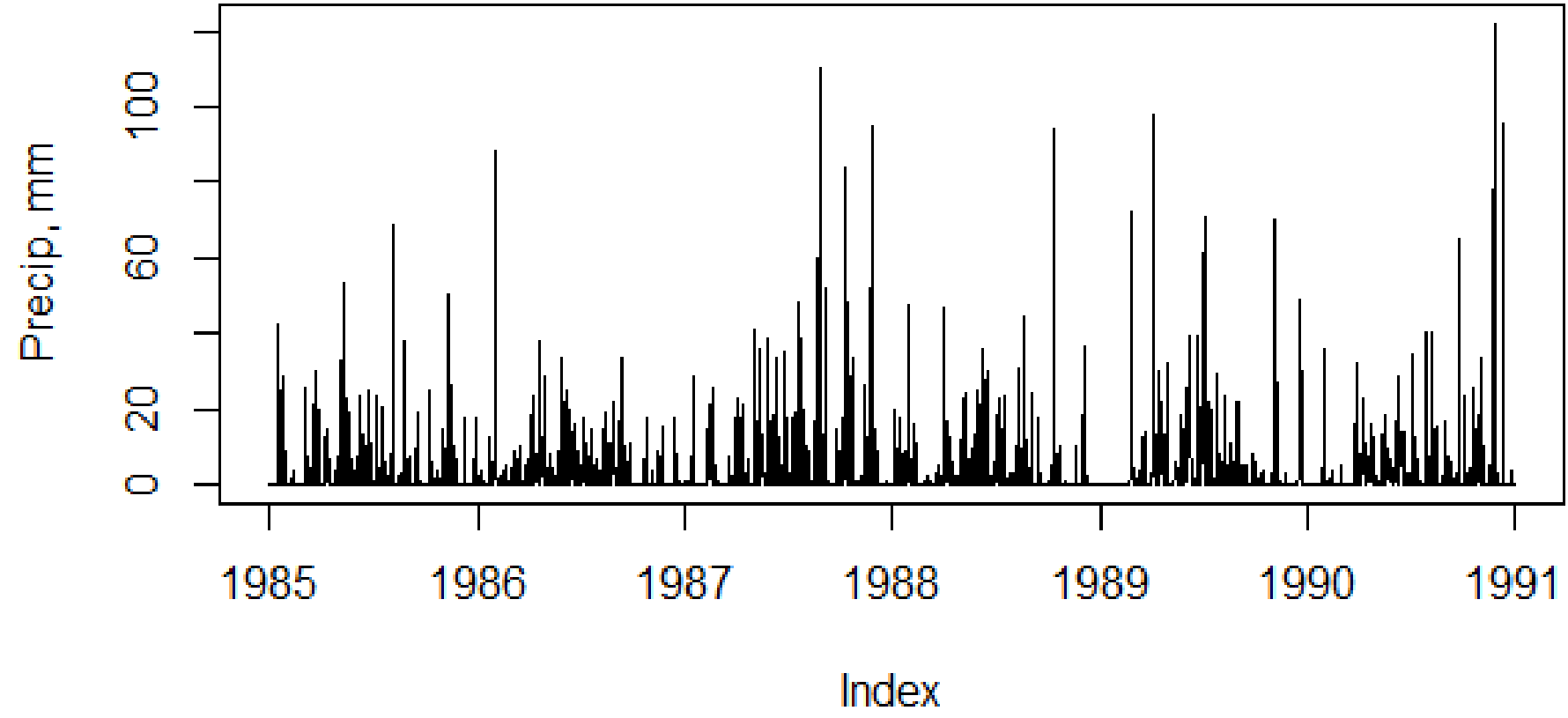
Κυρίως χρησιμοποιείται για την ανάλυση δεδομένων:

- α) βροχόπτωσης
- β) παροχής ποταμών

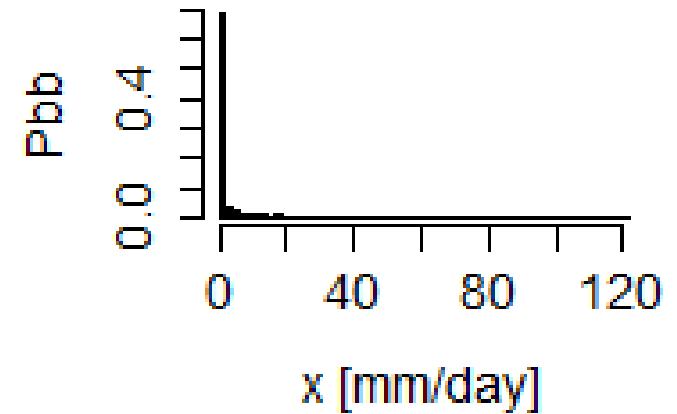
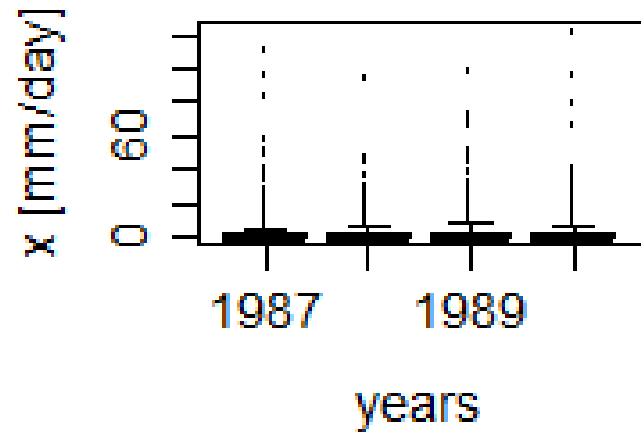
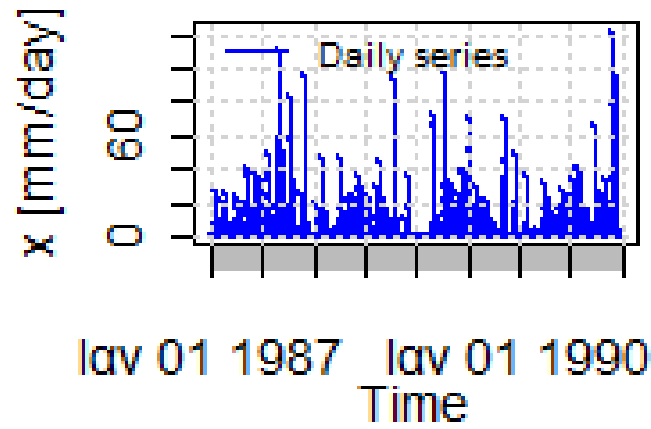
Όπως τα περισσότερα πακέτα της R το hydroTSM διαθέτει έτοιμα ενσωματωμένα δεδομένα ώστε ο χρήστης να αναλύσει και να εκπαιδευτεί στην χρήση του πακέτου.

Σήμερα θα αναλύσουμε το ενσωματωμένο σετ δεδομένων ημερήσιας βροχόπτωσης από έναν μετεωρολογικό σταθμό που ονομάζεται SanMartinoPPts

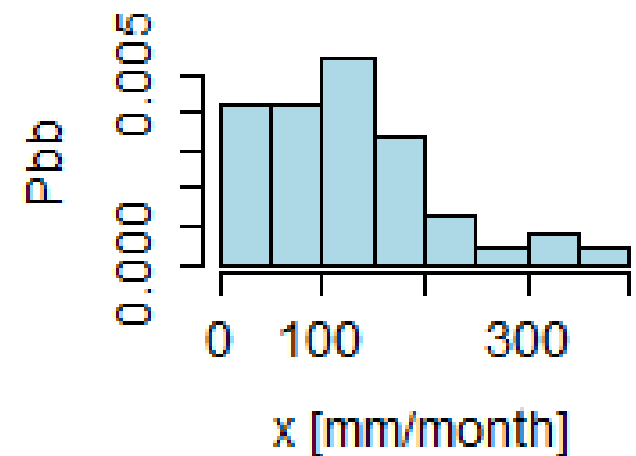
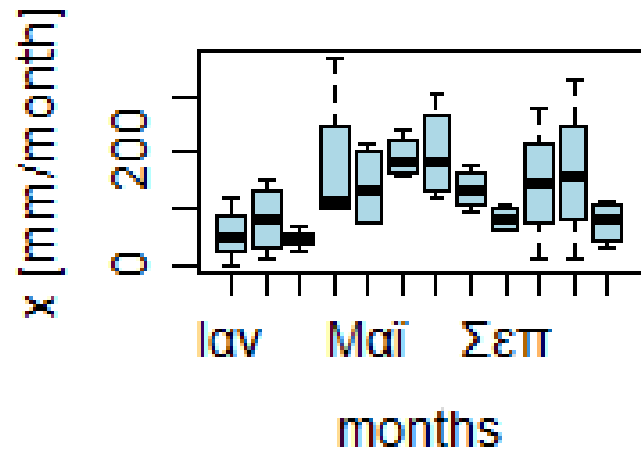
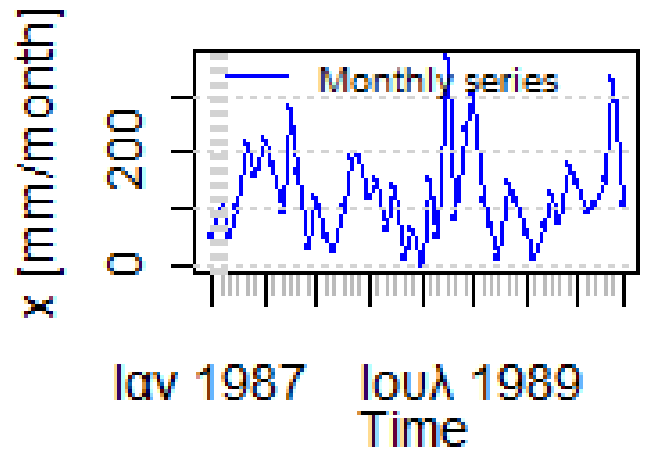
Άλλα ενσωματωμένα σετ δεδομένων είναι: EbroPPtsMonthly (μηνιαία δεδομένα βροχόπτωσης από την λεκάνη απορροής του ποταμού Ebro στην Ισπανία), OcaEnOnaQts (ημερήσια δεδομένα ποτάμιας παροχής από την λεκάνη του ποταμού Ebro).



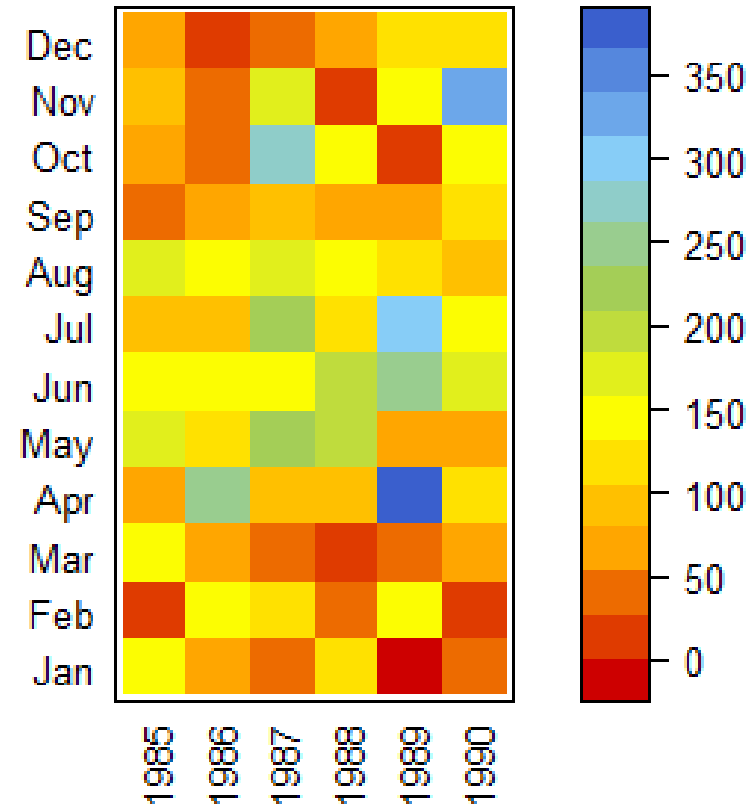
Daily time series at San Marti Daily Boxplot at San Martin Daily Histogram at San Marti

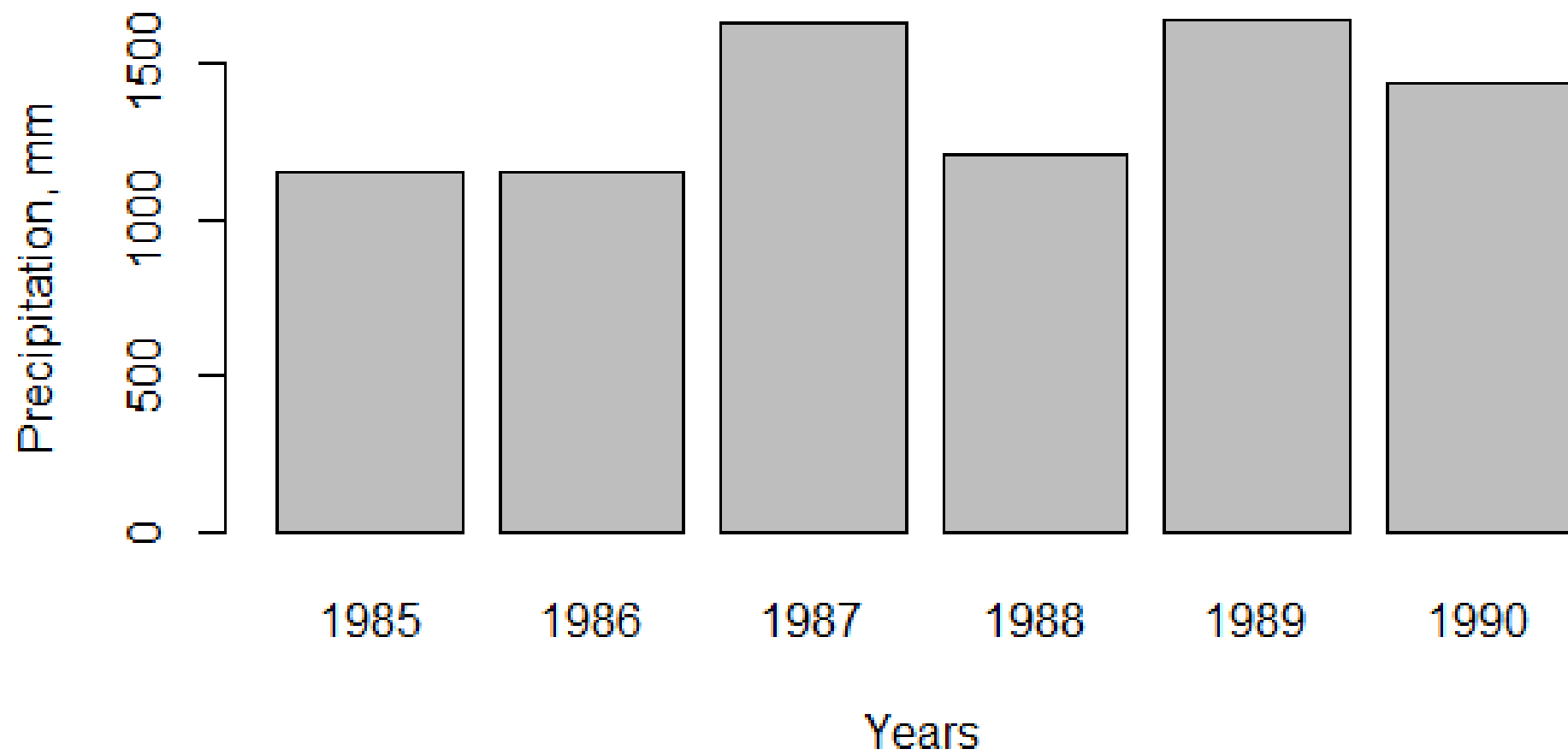


lonthly time series at San Ma Monthly Boxplot at San Mart Monthly Histogram at San Mar

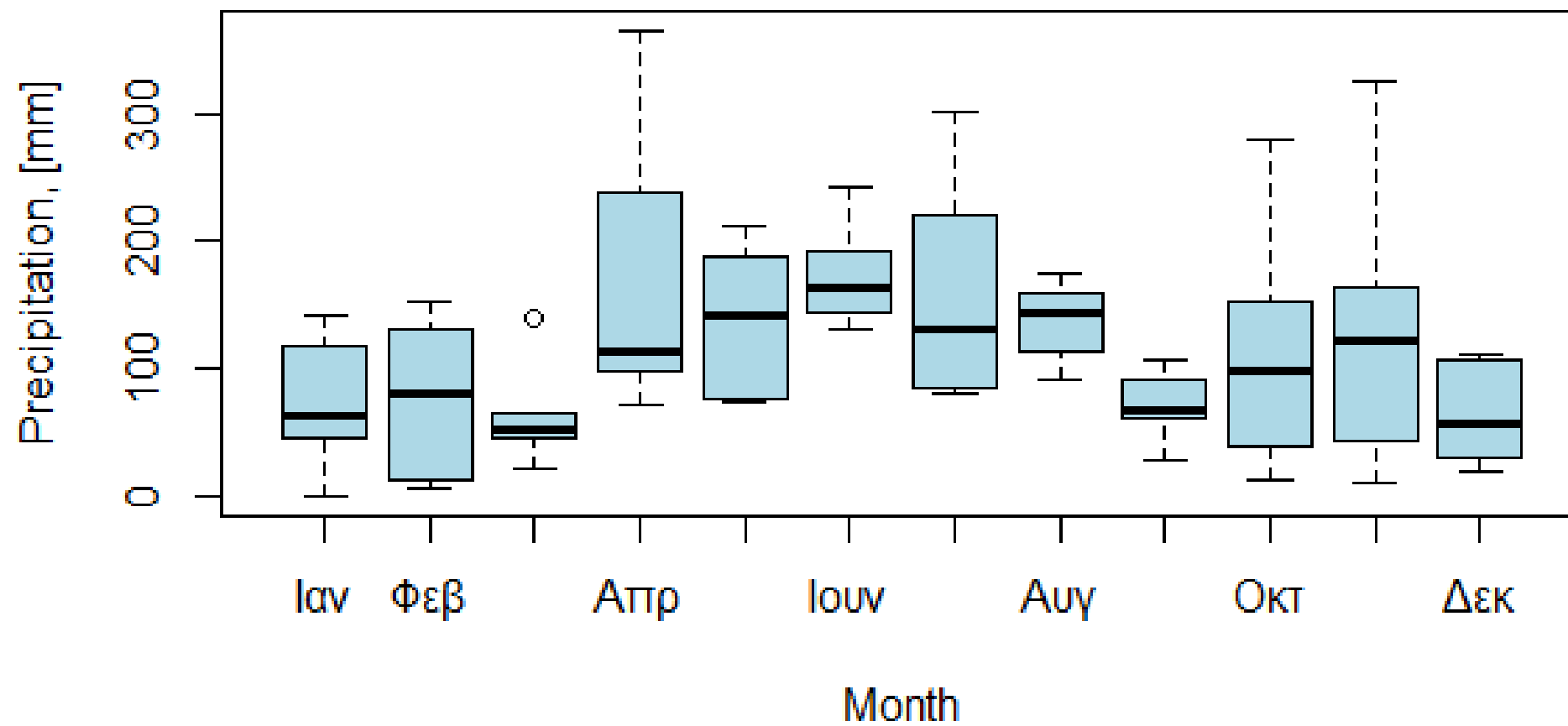


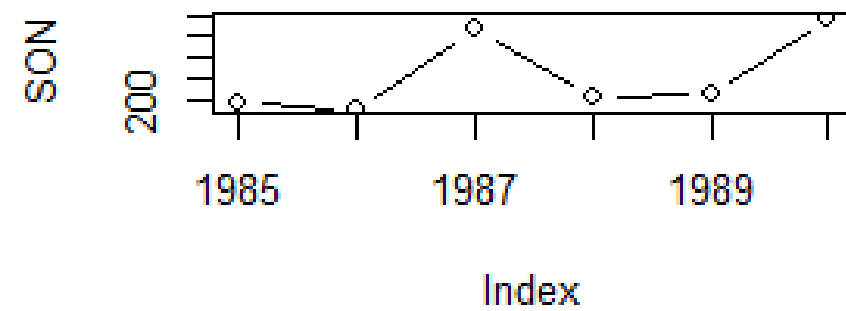
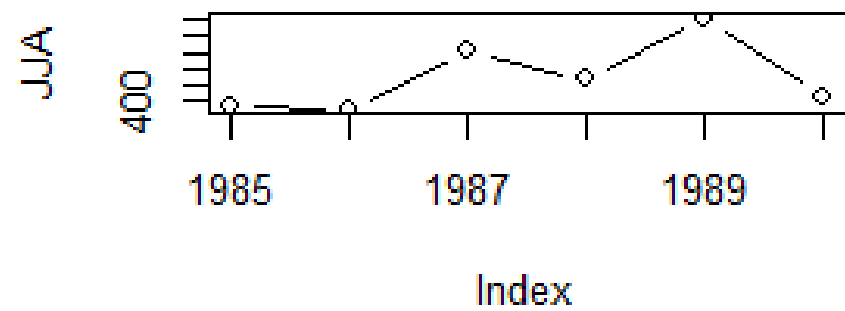
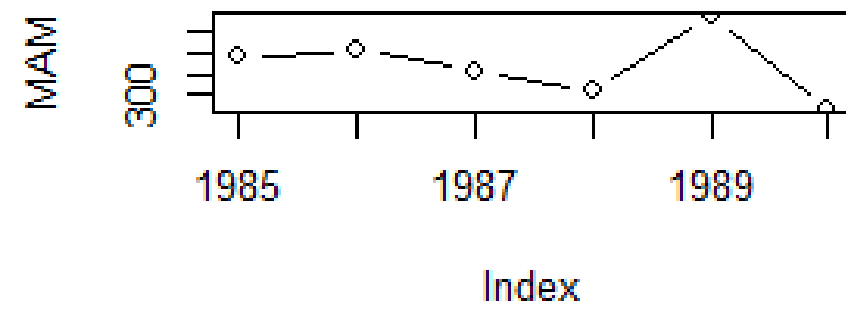
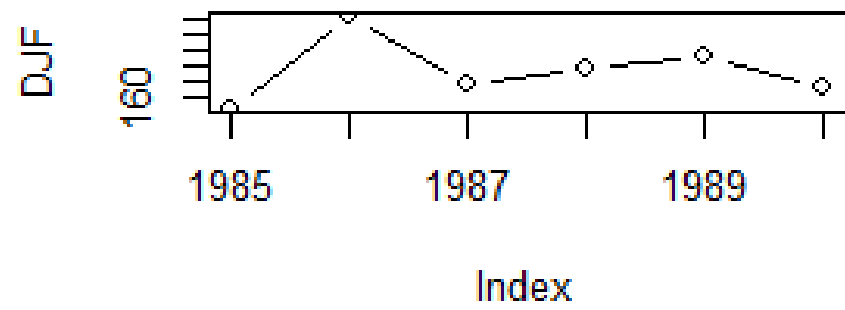
Monthly precipitation at San Martino st., [mm/month]



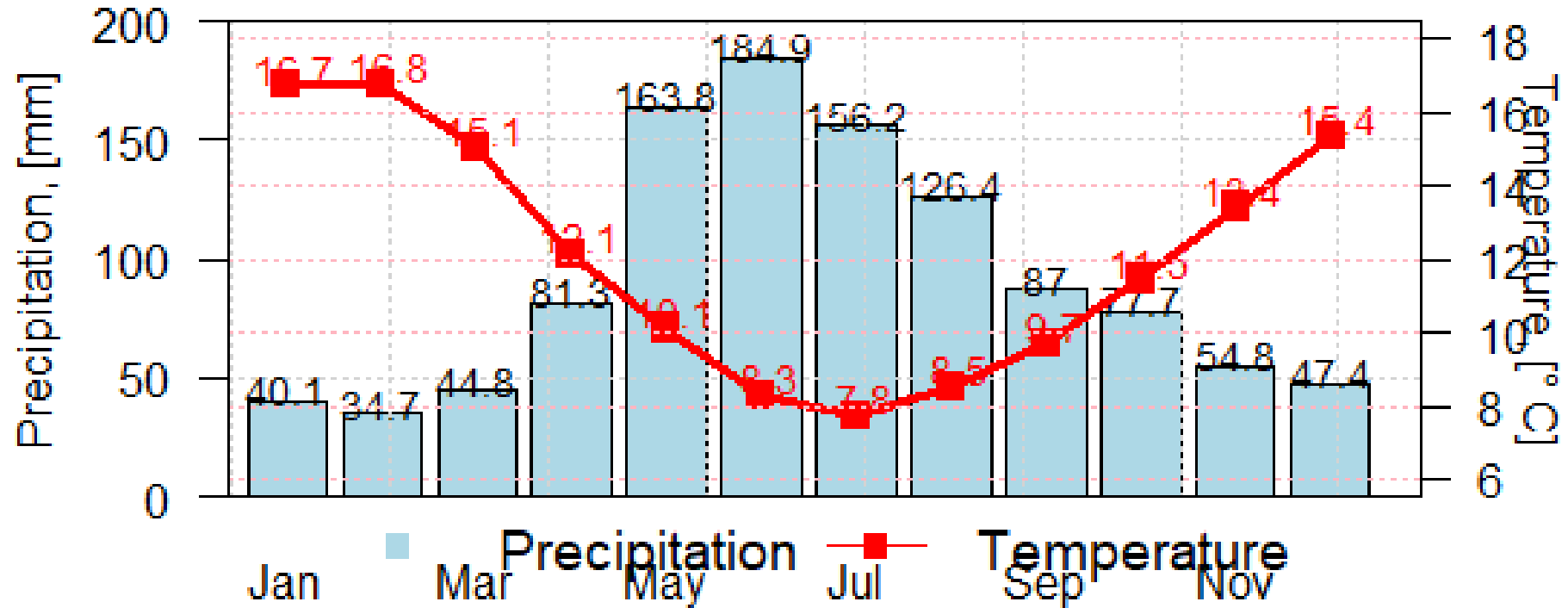


Monthly Precipitation





Climograph



Προσαρμογή της βέλτιστης συνάρτησης πυκνότητας πιθανότητας πάνω στα δεδομένα

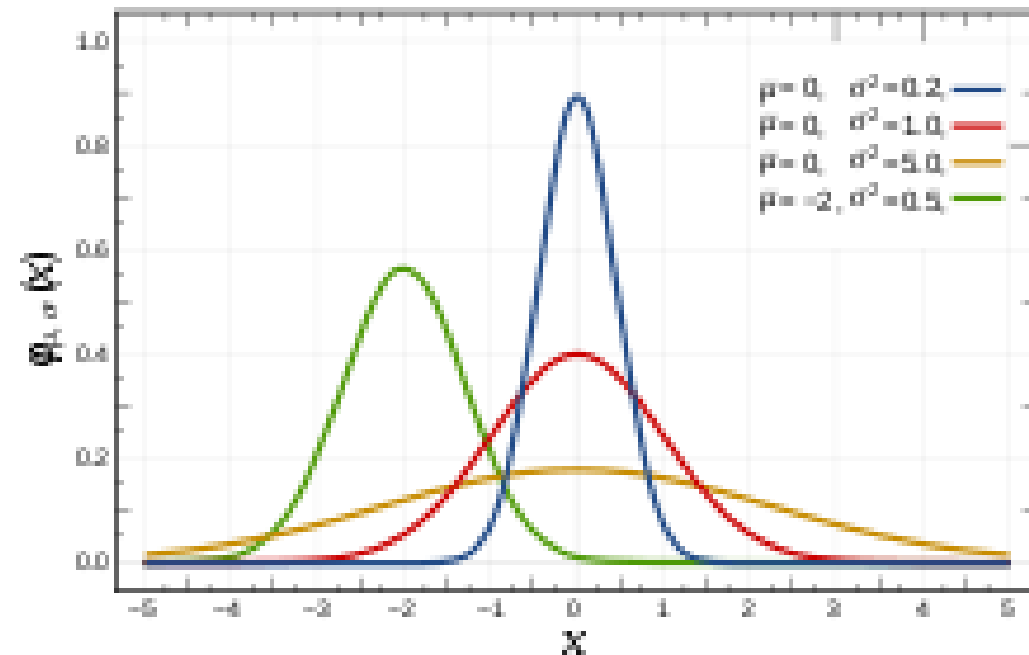
1. Κανονική συνάρτηση πυκνότητας πιθανότητας

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2}$$

Μέσα από την προσαρμογή αναζητούμε δύο παράγοντες:

α) την μέση τιμή (μ),

β) την τυπική απόκλιση (σ)



Προσαρμογή της βέλτιστης συνάρτησης πυκνότητας πιθανότητας πάνω στα δεδομένα

2. Gamma συνάρτηση πυκνότητας πιθανότητας

$$f(x; k, \theta) = \frac{x^{k-1} e^{-\frac{x}{\theta}}}{\theta^k \Gamma(k)}$$

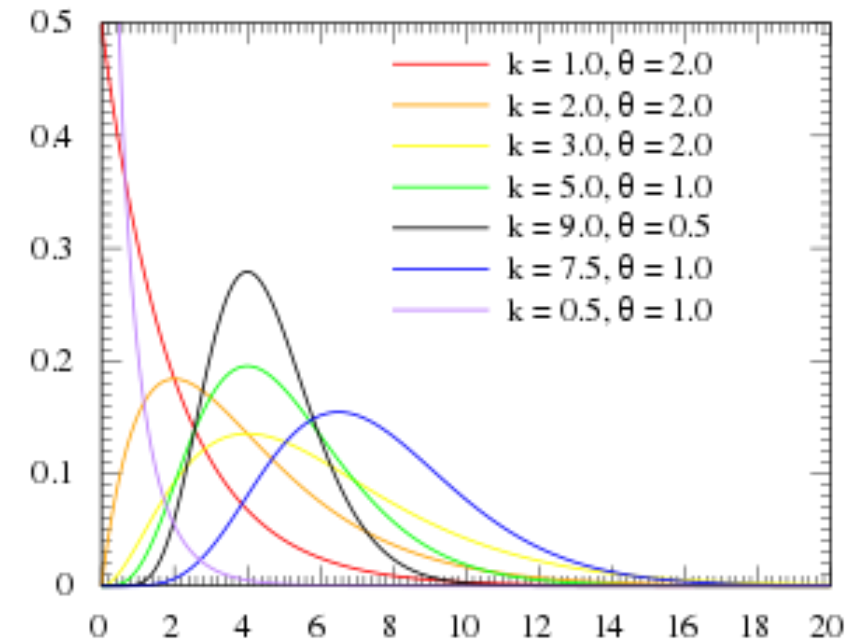
$$\Gamma(k) = (k-1)!$$

Μέσα από την προσαρμογή αναζητούμε δύο παράγοντες:

α) την παράμετρο μορφής (shape, k),

β) την παράμετρο κλίμακας (scale, θ)

Το αντίστροφο της κλίμακας λέγεται rate $\beta = 1/\theta$



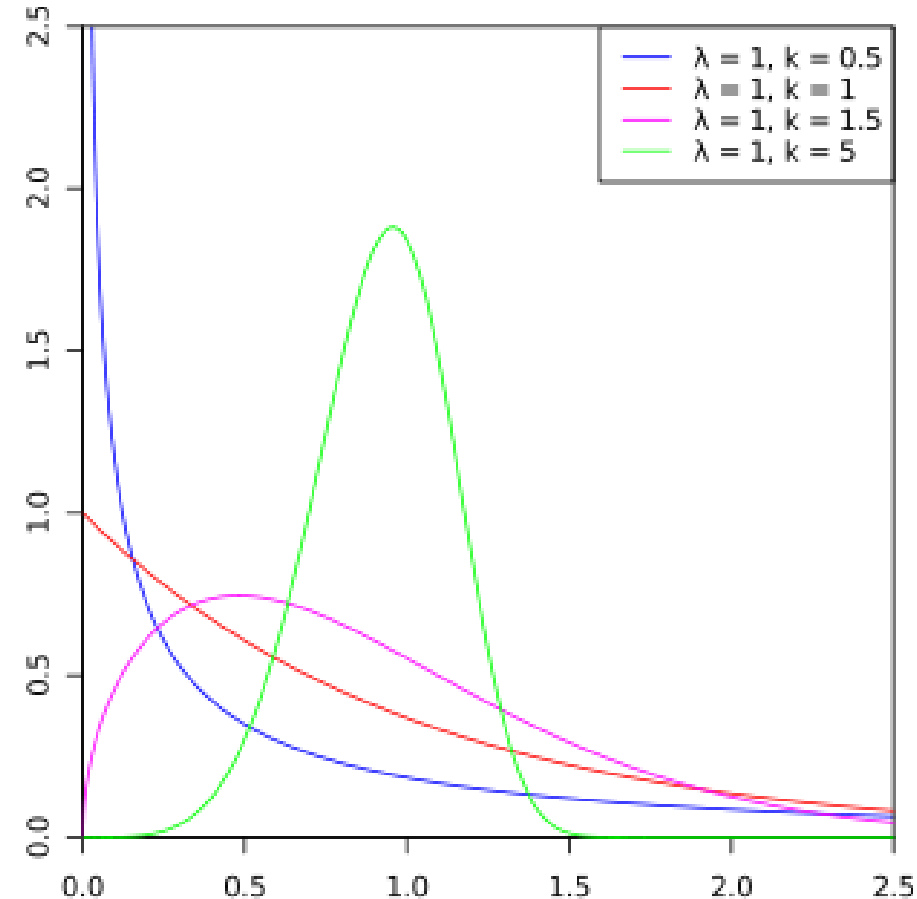
Προσαρμογή της βέλτιστης συνάρτησης πυκνότητας πιθανότητας πάνω στα δεδομένα

3. Weibull συνάρτηση πυκνότητας πιθανότητας

$$f(x; \lambda, k) = \begin{cases} \frac{k}{\lambda} \left(\frac{x}{\lambda}\right)^{k-1} e^{-(x/\lambda)^k}, & x \geq 0 \\ 0, & x < 0 \end{cases}$$

Μέσα από την προσαρμογή αναζητούμε δύο παράγοντες:

- α) την παράμετρο μορφής (shape, k),
- β) την παράμετρο κλίμακας (scale, λ)



```
install.packages("hydroTSM")  
install.packages("plyr")  
install.packages("devtools")  
install.packages("lattice")  
install.packages("fitdistplus")
```

```
library(hydroTSM)  
library(plyr)  
library(devtools)  
library(lattice)  
library(fitdistrplus)
```

```
#Import data from hydroTSM package  
#Daily precipitation data  
data(SanMartinoPPTs)
```

```
#Select only the data from 1985  
x <- window(SanMartinoPPTs, start=as.Date("1985-01-01"))
```

#Check the starting date
start(x)

#Check the ending date
end(x)

#Check if the time-series is regular or not
is.regular(x)

#Strict check on time-series
is.regular(x,strict=TRUE)

#Omit the third value and check regularity again
is.regular(x[-3],strict=TRUE)

```
#move the time-series one step forward  
lag(x, k =-1 )  
merge(x, lag1 = lag(x, k=1))
```

```
#move the time-series one step forward  
merge(x, lag1 = lag(x, k=1))
```

```
#Get data summary  
summary(x)  
smry(x)
```

```
#Create a simple plot of data-set  
plot(x, ylab = "Precip, mm")
```

```
#Plot data with the hydroplot function  
hydroplot(x,  
  var.type="Precipitation",  
  main="at San Martino",  
  pfreq = "dm",  
  from="1987-01-01")
```

```
#Transform daily into monthly values
m <- daily2monthly(x, FUN=sum)
smry(m)

# Creating a matrix with monthly values per year in each column
M <- matrix(m, ncol=12, byrow=TRUE)

colnames(M) <- month.abb
rownames(M) <- unique(format(time(m), "%Y"))

# Plotting the monthly precipitation values
# with a heat plot
print(matrixplot(M, ColorRamp="Precipitation",
                 main="Monthly precipitation at San Martino st., [mm/month]"))

#Transform daily into yearly values
z = daily2annual(x, FUN=sum, na.rm=TRUE)
smry(z)
```



```
#Plot annual time-series
```

```
barplot(z,  
       xlab = "Years",  
       ylab = "Precipitation, mm")
```

```
#Get Years from time-series
```

```
yr = as.numeric(format(index(z),"%Y"))
```

```
#plot again with year-values in x-axis
```

```
barplot(z,  
       yr,  
       xlab = "Years",  
       ylab = "Precipitation, mm")
```

```
#Compute annual mean value
```

```
z.mean = sum(z)/length(z)
```

```
#Monthly data analysis
```

```
#Median of the monthly values of dataset x
```

```
monthlyfunction(m, FUN=median, na.rm=TRUE)
```

```
cmonth <- format(time(m), "%b")
```

```
months <- factor(cmonth,  
               levels=unique(cmonth),  
               ordered=TRUE)
```

```
#Create boxplot of monthly values
boxplot(coredata(m) ~ months,
        col="lightblue",
        main="Monthly Precipitation",
        ylab="Precipitation, [mm]",
        xlab="Month")
```

```
#Seasonal Analysis
```

```
#Compute the mean-seasonal values of precipitation
seasonalfunction(x, FUN=sum) / length(z)
```

```
#Extracting the seasonal values for each year
```

```
DJF <- dm2seasonal(x, season="DJF", FUN=sum)
```

```
MAM <- dm2seasonal(m, season="MAM", FUN=sum)
```

```
JJA <- dm2seasonal(m, season="JJA", FUN=sum)
```

```
SON <- dm2seasonal(m, season="SON", FUN=sum)
```

```
#Plot Seasonal Precipitation plots
```

```
par(mfrow = c(1,1))
```

```
plot(DJF,type="b")
```

```
plot(MAM,type="b")
```

```
plot(JJA,type="b")
```

```
plot(SON,type="b")
```

```
#Extreme value analysis
```

```
hydroplot(x,  
  ptype="ts",  
  pfreq="o",  
  var.unit="mm")
```

```
#Counting and plotting the number of days
```

```
#in the period where precipitation is > 10 [mm]
```

```
R10mm <- length( x[x>10] )
```

```
#Identifying the wet days
```

```
#daily precipitation >= 10 mm
```

```
wet.index <- which(x >= 10)
```

```
smry(wet.index)
```

```
#Computing the 95th percentile
```

```
#of precipitation on wet days
```

```
quantile(wet.index)
```

```
PRwn95 <- quantile(wet.index,
```

```
  probs=0.95,
```

```
  na.rm=TRUE)
```

```
#Identifying the very wet days  
#daily precipitation >= PRwn95  
very.wet.index <- which(x >= PRwn95)
```

```
#Computing the total precipitation on the very wet days  
R95p <- sum(x[very.wet.index])
```

```
#Create Climograph  
data(MaquehueTemuco)
```

```
# extracting individual ts of precipitation, maximum and minimum temperature  
pcp <- MaquehueTemuco[, 1]  
tmx <- MaquehueTemuco[, 2]  
tmn <- MaquehueTemuco[, 3]
```

```
# Plotting the climograph
par(mfrow=c(1,1))
m <- climograph(pcp=pcp,
               tmx=tmx,
               tmn=tmn,
               pcp.label="Precipitation, [mm]",
               tmean.label="Temperature, [\U00B0 C]",
               na.rm=TRUE)
```

```
#Transform daily to monthly precipitation values
#Transform daily into yearly values
mon = daily2monthly(x, FUN=sum, na.rm=TRUE)
```

```
#Compute monthly precipitation descriptive statistics
mean.mon.prec = mean(mon)
median.mon.prec = median(mon)
range = range(mon)
range.mon.prec = range[2]-range[1]
sd.mon.prec = sd(mon)
var.mon.prec = var(mon)
IQR.mon.prec = IQR(mon)
summary(mon)
```

```
#Plot the location of monthly precipitation
#in relation to other theoretical probability density distributions
mon1 = data.frame(mon)
descdist(mon1$mon)

#Fit the normal probability density distribution
#to the monthly precipitation data
fn <- fitdist(mon1$mon,
              "norm",
              method = "mle")
#Get summary of normal model output
summary(fn)
#Make a plot of data and normal distribution curve
plot(fn)
```

```
#Fit the gamma probability density distribution
```

```
#to the monthly precipitation data
```

```
fg = fitdist(replace(mon1$mon,  
                    which(mon1$mon==0),0.1),  
            "gamma",  
            method = "mle")
```

```
summary(fg)
```

```
plot(fg)
```

```
#Fit the most appropriate Weibull probability density
```

```
#distribution model to the monthly precipitation data
```

```
fw <- fitdist(replace(mon1$mon,  
                    which(mon1$mon==0),0.1),  
            "weibull",  
            method = "mle")
```

```
#Get summary of Weibull model output
```

```
summary(fw)
```

```
plot(fw)
```



```
#Get the probability of an event
#with precipitation from 50 to 400 mm/month with step 50 m^3/s
dweibull(seq(50,400,by=50),
  shape=1.440047, scale = 124.590789,
  log = FALSE)
```

```
#Get the cumulative probability of an event
#with discharge higher than 300 mm/month
pweibull(300,
  shape=1.440047, scale = 124.590789,
  log = FALSE,
  lower.tail=TRUE)
```