The CDD-Index

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The Consecutive dry days Index (CDD)

Extreme draught events have a large impact on the human society and the natural environment. Therefore the scientific interest of analysing the occurance and lenght of drougts is high, in particular regarding the climate change. The CDD-Index can be used to analyse droughts from precipitation data. It is a measure of the maximum number of consecutive dry days within a time period. A function to calculate the CDD is presented. The function is applied for precipitation data of weather stations in Baden-Würtemberg, the results are analysed visualy.

Methods

To calculate the CDD-Index from precipitation data, a function was programmed in "R". The function identifies the longest drougth period within a year and returns the number of dry days of the drought period. A day is classified as dry day if the precipitation is less than 1 mm. The function only uses data for the calculation, that contains less than 60 NA-values per year.

The functions input has to be a table with the precipitation data. There should be the column "id" in this table, that specifies the station where the data was logged. The function computes the maximum number of consecutive dry days of every year for one station. From this information an overall average is computed as well as a rate of change. The function has two optional outputs. "Standart" and "periodData". "Standart" returns a list containing the average, rate of change and a table with the yearly CDD-idices. With the option "periodData" a table is returned which contains the start- and end-dates of the longest drought period within each year. The well commented code of the function is in the appendix.

Results

For the Baden-Würtemberg data of the last 40 years, the drought periods didn't show a de- or increasing trend. Figure 1 shows the CDD-values of the station Baden-Baden-Geroldsau as a line-plot. Even if the data of all other weather stations of Baden-Würtemberg is included, the result shows no trend.

In the figure 2 the average CDD value and the elevation of every station is presented. Station with higher elevation tend to have shorter drought periods. There are higer precipitation rates in the west of the Black Forste and the Swabian Jura. This becomes apparent in the shorter drought periods visible on the map. Still it should be considered, that the differences only make a few days.

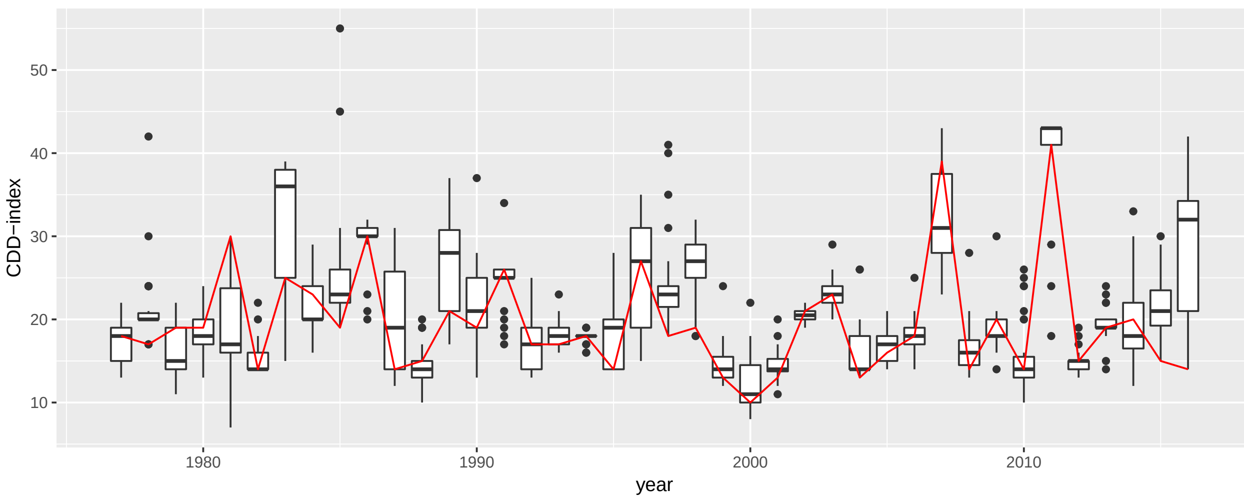

Figure 1: Boxplots for the CDD-index for all weather-stations of Baden-Würtemberg. The station of Baden-Baden is highlighted with a red line.

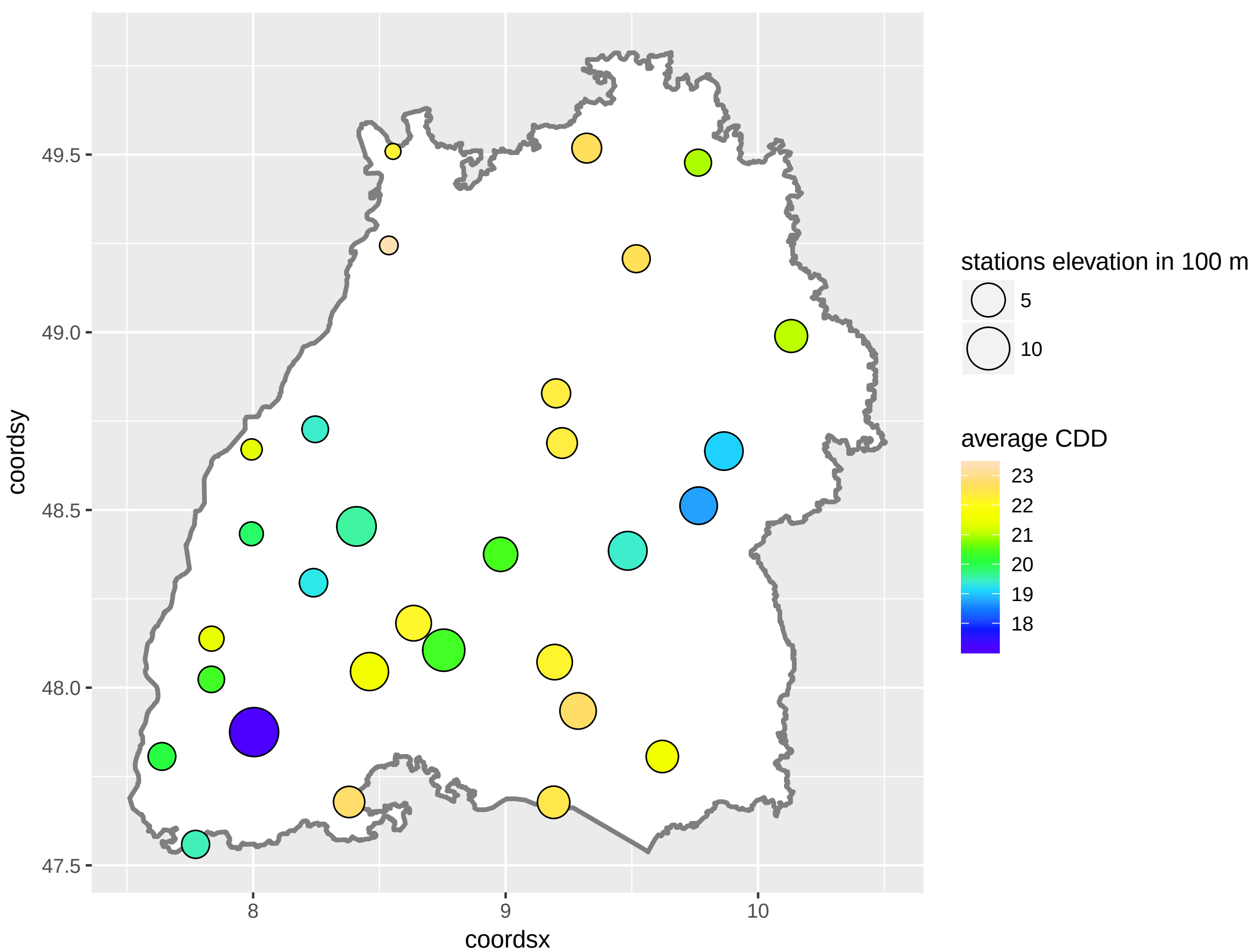

Figure 2: This map presents the average CDD values of all weather stations in Baden-würtemberg. Additional the elevation of the stations is represented in the size of the markers.

Appendix

```
##CDD: maximum number of consecutive dry days (Rday < 1mm)
CDD <- function(x , ID, startyear = 1977, endyear = 2016, output= "standart"){
  library(readr)
  library(dplyr)
  library(lubridate)
  library(zoo)
#1. filter Dataset by the station-id: -----------
BW_id <- x %>%
  filter(id==ID) %>%
  mutate(year = year(date)) %>%
#2. count NAs for every year, if more than 60, exclude the years data --------------
  mutate(na.count = is.na(RSK)) %>% ## add column with T/F where values are NAs
  group_by(year) %>% ## group by year to calculate sum of T (=the amount of NAs per year)
  mutate(na.count = sum(na.count)) %>%
  filter(na.count <= 60) %>%
  ungroup()

# 3. calculate CDD --------------
## All the precipitation-values (RSK) smaller than 1 mm will be encoded with dryDay = T.
## to figure out wich consecutive period of time with dryDays was the longest,
## all the False values were dropped.
testfun <- function(x){
  return(cumsum(c(1, diff(x) != 1)))
} ## The tesfun-function than calculates the cumulative sum of all consecutive dryDays.
## At every break in the timeseries of dry days, the encoding-number rises by one.
BW_id1 <- BW_id %>%
  mutate(dryDay = ifelse(RSK < 1, T, F)) %>%
  filter(dryDay == T) %>%
  mutate(codierung = testfun(date)) %>%
  group_by(codierung)

## with the grouping of the encoding the longest CDD period for every year is calculated:
BW_count <- BW_id1 %>%
  group_by(year) %>%
  count(codierung) %>%
  filter(n==max(n))

## to get start and end date of each CDD period, the result from above (BW_Count)
## is joined with the BW_id1, where the date-information is stored.
BW_id2 <- BW_count %>%
  left_join(BW_id1, by=c("codierung","year")) %>%
  group_by(year, codierung, n) %>%
  summarise( start = first(date), end= last(date)) %>%
  ungroup() %>%
  select(year, n, start, end)

## duplicate years with more than one CDD-period of the same length are removed.
uniqueCDD <- unique(BW_id2[,c("year", "n")])

# the average of CDD in the time-period:
avg <- mean(uniqueCDD$n)
```

```r
## Calculating rate-of-change-index:
## values of last twenty years of measurment divided by first twenty years. Output in %
firsttwenty <- uniqueCDD %>%
  filter(year >= startyear  & year <= (startyear+19) )
lasttwenty <- uniqueCDD %>%
  filter(year >= (endyear-19)  & year <= endyear )

## There have to be values of at least 10 years to get a result of the rate-of-change-index.
if(length(firsttwenty$n) < 10 | length(lasttwenty$n) < 10){
  ABC <- NA
} else {
  ABC <- (mean(lasttwenty$n) / mean(firsttwenty$n))*100
}

if(output== "standart" ){
  return(list( average = avg, rate.of.change= ABC, yearlyData = uniqueCDD))}
if(output == "periodData"){
  return(BW_id2)}
} # end of function
```