HUTCHINSONDROUGHTINDEX

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November 6, 2013

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Contents

1   Introduction

The R code includes a demonstration of the Hutchinson Drought Index [1]. This climatic drought index is shown graphically for a location in the 'Central West' SD of NSW in Figure 2.

1.1   droughtIndex

```
> #######################
> #tools_droughtIndex,  droughtIndex
> #####################
>
>
>
>  droughtIndex<-function(data,years,droughtThreshold=.375){
+   # a drought index based on integrated six-monthly rainfall percentiles.
+   # based on Professor Mike Hutchinson's work described in
+   # Smith D, Hutchinson M, McArthur R. Climatic and Agricultural Drought: Payments and P
+   # Canberra, ACT: Centre for Resource and Environmental Studies, Australian National Un
+
+   # Ivan C Hanigan
+   # June 2011.
```

```
+
+    ############################################################################
+    ## Copyright 2011, Ivan C Hanigan <ivan.hanigan@gmail.com> and Michael F Hutchinson
+    ## This program is free software; you can redistribute it and/or modify
+    ## it under the terms of the GNU General Public License as published by
+    ## the Free Software Foundation; either version 2 of the License, or
+    ## (at your option) any later version.
+    ##
+    ## This program is distributed in the hope that it will be useful,
+    ## but WITHOUT ANY WARRANTY; without even the implied warranty of
+    ## MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
+    ## GNU General Public License for more details.
+    ## Free Software
+    ## Foundation, Inc., 51 Franklin Street, Fifth Floor, Boston, MA
+    ## 02110-1301, USA
+    ############################################################################
+
+
+    # my input data are always a data.frame with 4 columns 'date','year','month','rain'
+
+    #calculate M month totals
+    # started with 6 (current and prior months)
+    x<-ts(data[,4],start=1,end=c(years,12),frequency=12)
+    x<-c(rep(NA,5),x+lag(x,1)+lag(x,2)+lag(x,3)+lag(x,4)+lag(x,5))
+    # TASK need to use rollapply?
+    data$sixmnthtot<-x
+    data<-na.omit(data)
+
+    # rank in percentage terms with respect to the rainfall totals
+    # for the same sequence of 6-months over all years of record
+    dataout_final=matrix(nrow=0,ncol=7)
+
+    for(i in 1:12){
+            x<-data[data$month==i,5]
+            #x<-na.omit(x)
+            y<-(rank(x)-1)/(length(x)-1)
+            # checkpct<-cbind(data[data$month==i,],y)
+            # plot(checkpct$sixmnthtot,checkpct$y)
+            # rescale between -4 and +4 to replicate palmer index
+            z<-8*(y-.5)
+            # defualts set the threshold at -1 which is upper limit of mild drought in pal
+            drought<-x<=quantile(x,droughtThreshold)
+            # calculate the drought index for any months that fall below the threshold
+            zd<-z*drought
+            # save out to the data
+            dataout<-data[data$month==i,]
+            dataout$index<-z
+            dataout$indexBelowThreshold<-zd
+            dataout_final=rbind(dataout_final,dataout)
+            }
```

```
+
+    data<-dataout_final[order(dataout_final$date),]
+
+    # now calculate the indices
+    # newnode COUNTS
+    data$count<-as.numeric(0)
+    # OLD and SLOW
+    # for(j in 2:nrow(data)){
+            # data$count[j]<-ifelse(data$indexBelowThreshold[j]==0,0,
+            # ifelse(data$indexBelowThreshold[j-1]!=0,1+data$count[j-1],
+            # 1)
+            # )
+            # }
+
+    # NEW and FAST
+    # counts can be done with this funky bit of code
+    x<-data$index<=-1
+    xx <- (cumsum(!x) + 1) * x
+    x2<-(seq_along(x) - match(xx, xx) + 1) * x
+    data$count<-x2
+
+    # OLD and SLOW enhanced drought revocation threshold
+    # TASK make NEW and FAST? or add as an option?
+    # In the enhanced version rather than stop counting when the rescaled percentiles rise
+    # we keep counting the months (or adding the negative anomalies)
+    # if the rescaled percentile is below 0.0 AND the drought threshold has already been r
+    # If the threshold has not been reached, then stop counting (or adding) as before
+    # if the rescaled percentile rises above -1.0.
+
+    data$count2<-data$count
+    # j=1080 # 1980-06
+    # data[j,]
+
+    for(j in 2:nrow(data)){
+    data$count2[j] <- if(data$count2[j-1] >= 5 & data$index[j] <= 0){
+            data$count2[j-1] + 1
+            } else {
+            # ifelse(data$count[j-1] > 0 & data$index[j] < 0, 1+data$count[j-1],
+            data$count2[j]
+            }
+    }
+    ###########################################################
+    # newnode SUMS
+    # NEW and FAST? or add as an option?
+    data$sums<-as.numeric(0)
+    y <- ifelse(data$index >= -1, 0, data$index)
+    f <- data$index < -1
+    f <- (cumsum(!f) + 1) * f
+    z <- unsplit(lapply(split(y,f),cumsum),f)
+    data$sums <- z
```

```
+    # OLD and SLOW
+    # for(j in 2:nrow(data)){
+          # data$sums[j]<-ifelse(data$indexBelowThreshold[j]==0,0,
+          # ifelse(data$indexBelowThreshold[j-1]!=0,
+          # data$indexBelowThreshold[j]+data$sums[j-1],
+          # data$indexBelowThreshold[j]))
+          # }
+
+    # OLD and SLOW
+    # TASK make NEW and FAST
+    data$sums2<-data$sums
+    # j=1069 # 1980-06
+    # data[j,]
+
+    for(j in 2:nrow(data)){
+    data$sums2[j] <- if(data$sums2[j-1] <= -17.5 & data$index[j] <= 0){
+          data$sums2[j-1] + data$index[j]
+          } else {
+          # ifelse(data$count[j-1] > 0 & data$index[j] < 0, 1+data$count[j-1],
+          data$sums2[j]
+          }
+    }
+
+    droughtIndices<-data
+    return(droughtIndices)
+    }
>
>
```

1.2 Download spatial data

Instructions for using R to download and analyse data from the Australian
Bureau of Statistics (`http://www.abs.gov.au`) and the Australian Bureau of
Meteorology (`http:/www.bom.gov.au`) websites are included.

1.3 get stations within study region

We will use all the stations within 150km of the centroid of the Statistical
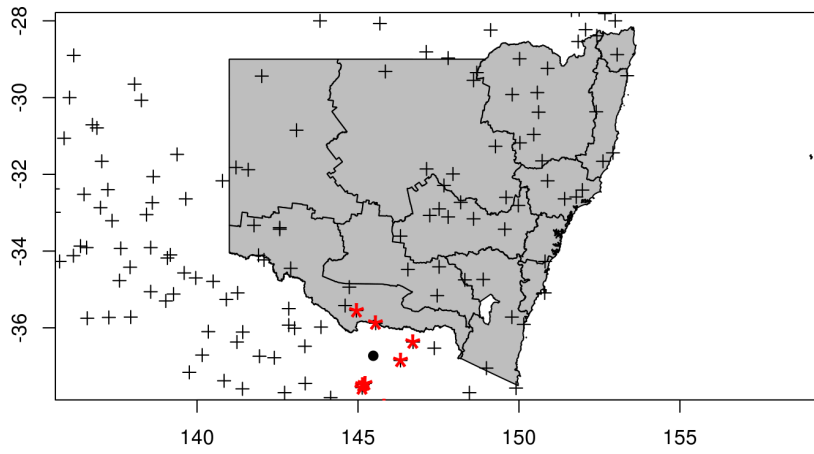Division.

Figure 1: nswsds.png

1.4 Calculate the drought index

The Drought index is shown in Figure 2 for the SD of 'Central West NSW' during a period which includes a strong drought (1979-83). The raw monthly rainfall totals are integrated to rolling 6-monthly totals (both shown in first panel) which are then ranked into percentiles by month and this is rescaled to range between -4 and +4 in keeping with the range of the Palmer Index [2] (second panel). Mild drought is below -1 in the Palmer index and so consecutive months below this threshold are counted. In the original method 5 or more consecutive months was defined as the beginning of a drought, which continued until the rescaled percentiles exceed -1 again (third panel). The enhanced method imposes a more conservative threshold of zero (the median) to break a drought (fourth panel).

There was also an alternative method devised by Hutchinson where the rescaled percentile values are integrated using conditional cumulative sums. That method is included in the R code however we decided not to use it in this study because the counting method is simpler and gives similar results.
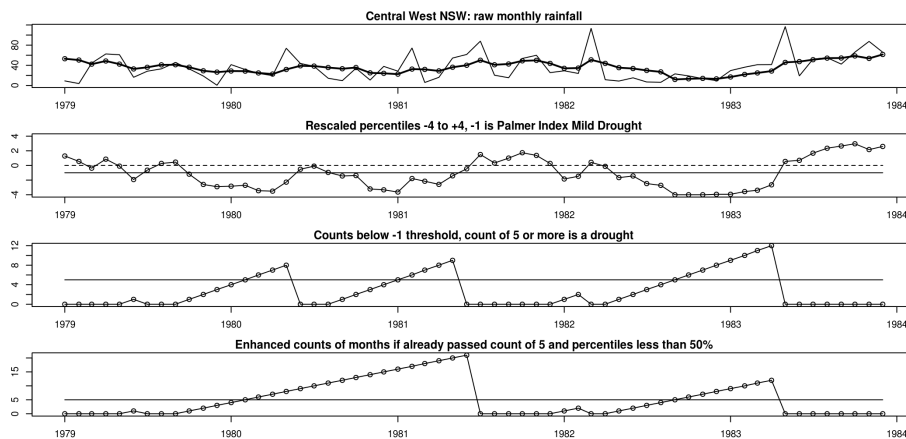

Figure 2: The Drought index in Central West NSW with the enhanced method shown in the fourth panel.

1.5 replicate Fig3.5 from Hutchinson

Figure 3.5 from the original paper shows the index at Seymour Victoria 1966-1986. This town is in the Goulburn Statistical Division
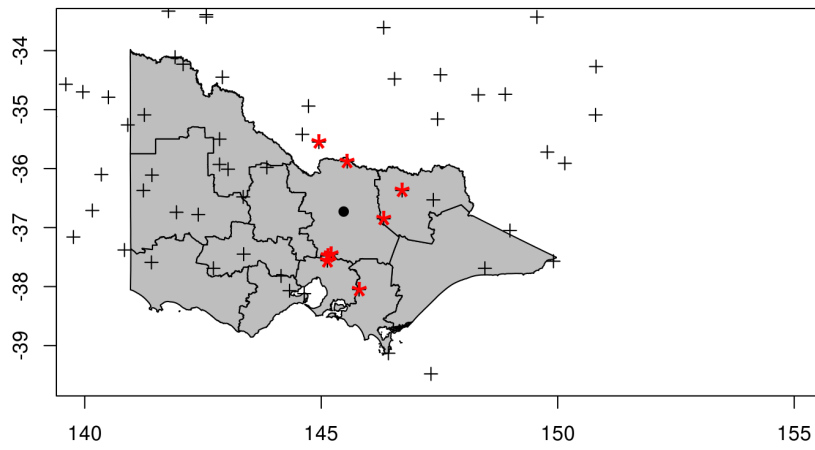
Figure 3: vicsds.png

1.6 Seymour drought index

1.7 Integration by Conditional Summation

1.8 The Summation Method

When the index is calculated using the sum of each consecutive month's rainfall deficiency score the resulting measure addresses the question of how intense the drought is, rather than just the duration which is provided by the counting method. This version of the index is shown in Figure 4.
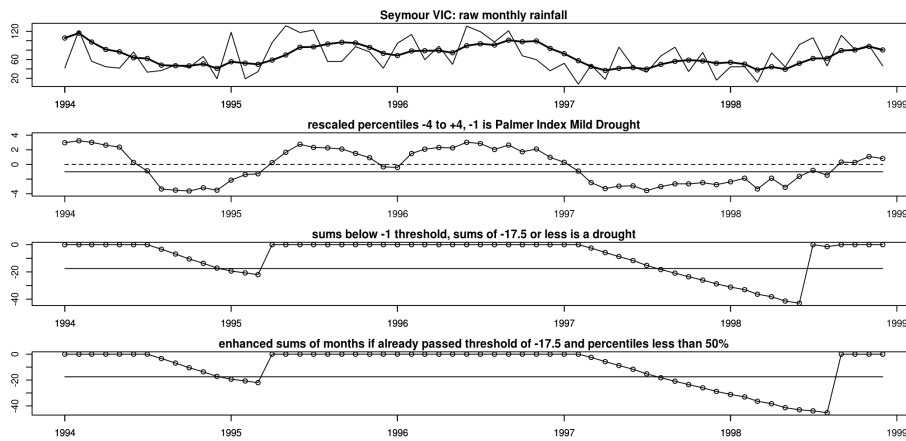

Figure 4: SeymourDrought9499enhanced.png

1.9 References

References

[1] Smith, D. I, Hutchinson, M. F, & McArthur, R. J. (1992) *Climatic and Agricultural Drought: Payments and Policy.* (Centre for Resource and Environmental Studies, Australian National University, Canberra, Australia).

[2] Palmer, W. (1965) *Meteorological drought. Research paper No. 45.* (U.S. Department of Commerce Weather Bureau, Washington, D.C.).