Analyzing Soil Moisture & Precipitation Trends in Coweeta Basin LTER Site

Data Analysis

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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.

When you click the **Knit** button a document will be generated that includes both content as well as the output of any embedded R code chunks within the document. You can embed an R code chunk like this:

```
#Checking working directory
getwd()
```

```
## [1] "/home/guest/EDA-Fall2022/EDA-Fall2022/Zungailia_Davidson_McClaugherty"
```

```
#Loading necessary packages
library(dplyr)
```

```
##
## Attaching package: 'dplyr'

## The following objects are masked from 'package:stats':
##
##     filter, lag

## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```
library(lubridate)
```

```
##
## Attaching package: 'lubridate'

## The following objects are masked from 'package:base':
##
##     date, intersect, setdiff, union
```

```
library(tidyverse)
```

```
## -- Attaching packages --------------------------------------- tidyverse 1.3.2 --

## v ggplot2 3.4.0     v purrr   0.3.4
## v tibble  3.1.8     v stringr 1.4.1
## v tidyr   1.2.0     v forcats 0.5.2
## v readr   2.1.3
## -- Conflicts ------------------------------------------ tidyverse_conflicts() --
```

```
## x lubridate::as.difftime() masks base::as.difftime()
## x lubridate::date()        masks base::date()
## x dplyr::filter()          masks stats::filter()
## x lubridate::intersect()   masks base::intersect()
## x dplyr::lag()             masks stats::lag()
## x lubridate::setdiff()     masks base::setdiff()
## x lubridate::union()       masks base::union()
```

```
library(cowplot)
```

```
##
## Attaching package: 'cowplot'
##
## The following object is masked from 'package:lubridate':
##
##     stamp
```

```
#install.packages("ggplot2")
library(ggplot2)
#install.packages("ggpubr")
library(ggpubr)
```

```
##
## Attaching package: 'ggpubr'
##
## The following object is masked from 'package:cowplot':
##
##     get_legend
```

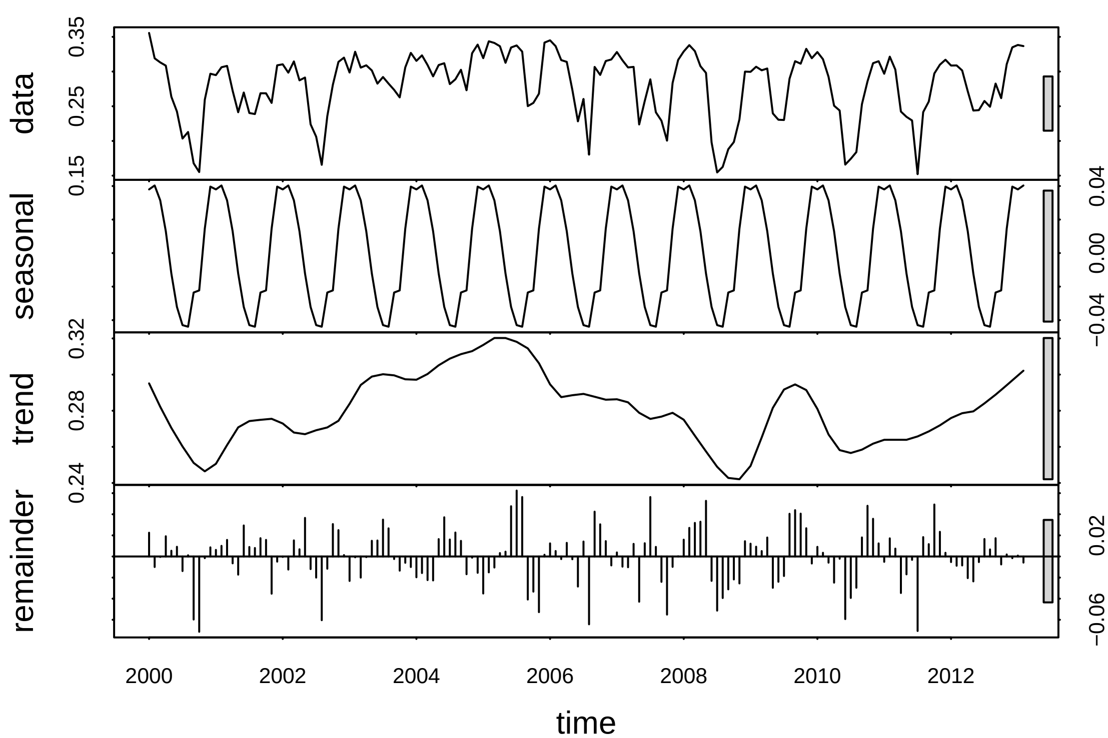
```
library(Kendall)

#Setting the ggplot theme
Project_theme <-
  theme_light(base_size = 14) +
  theme(axis.text = element_text(color = "dark gray"),
  legend.position = "top")
theme_set(Project_theme)
```

```
#Reading in csv files for each site
site1 <- read.csv("./Data/Processed/coweeta_site1_processed.csv")
site2 <- read.csv("./Data/Processed/coweeta_site2_processed.csv")
site3 <- read.csv("./Data/Processed/coweeta_site3_processed.csv")
site4 <- read.csv("./Data/Processed/coweeta_site4_processed.csv")

site1_soil_precip <- read.csv("./Data/Processed/site1_soil_precip_processed.csv")
site2_soil_precip <- read.csv("./Data/Processed/site2_soil_precip_processed.csv")
site3_soil_precip <- read.csv("./Data/Processed/site3_soil_precip_processed.csv")
site4_soil_precip <- read.csv("./Data/Processed/site4_soil_precip_processed.csv")
```

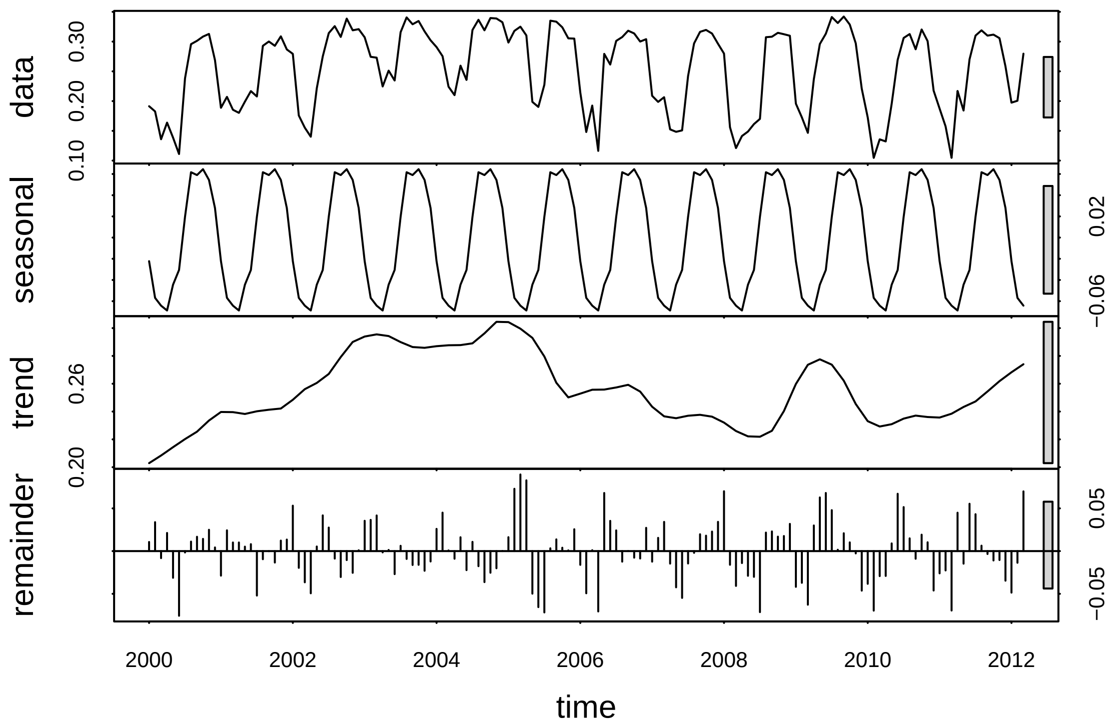
```
#Formatting Dates
site1$YearMonth <- as.Date(site1$YearMonth, format = '%Y-%m-%d')
site2$YearMonth <- as.Date(site2$YearMonth, format = '%Y-%m-%d')
site3$YearMonth <- as.Date(site3$YearMonth, format = '%Y-%m-%d')
site4$YearMonth <- as.Date(site4$YearMonth, format = '%Y-%m-%d')

site1_soil_precip$YearMonth <- as.Date(site1_soil_precip$YearMonth, format = '%Y-%m-%d')
```

```r
site2_soil_precip$YearMonth <- as.Date(site2_soil_precip$YearMonth, format = '%Y-%m-%d')
site3_soil_precip$YearMonth <- as.Date(site3_soil_precip$YearMonth, format = '%Y-%m-%d')
site4_soil_precip$YearMonth <- as.Date(site4_soil_precip$YearMonth, format = '%Y-%m-%d')
```

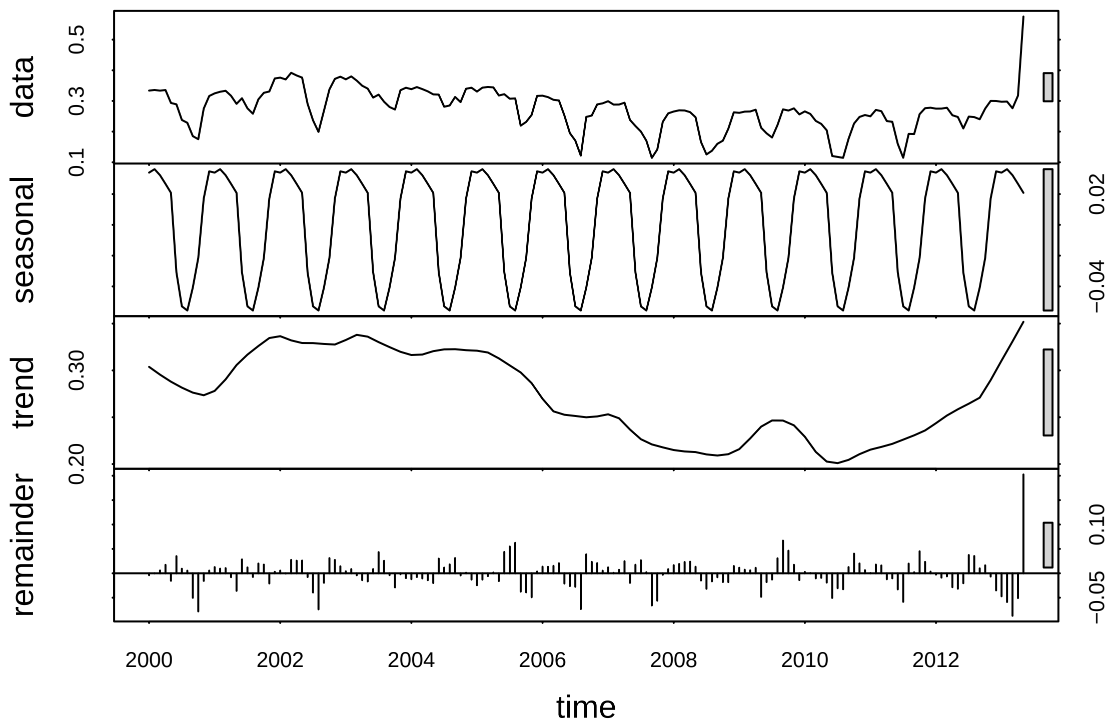
```r
#Creating a time series for average monthly soil moisture at each site
site1_ts <- ts(site1$AverageMonthlySmois30, start = c(2000, 1), frequency = 12)
site2_ts <- ts(site2$AverageMonthlySmois30, start = c(2000,1), frequency = 12)
site3_ts <- ts(site3$AverageMonthlySmois30, start = c(2000,1), frequency = 12)
site4_ts <- ts(site4$AverageMonthlySmois30, start = c(2000,1), frequency = 12)

#Decomposing the time series
site1_decomposed <- stl(site1_ts, s.window = "periodic")
site2_decomposed <- stl(site2_ts, s.window = "periodic")
site3_decomposed <- stl(site3_ts, s.window = "periodic")
site4_decomposed <- stl(site4_ts, s.window = "periodic")

#Plotting decomposed time series
plot(site1_decomposed)
```



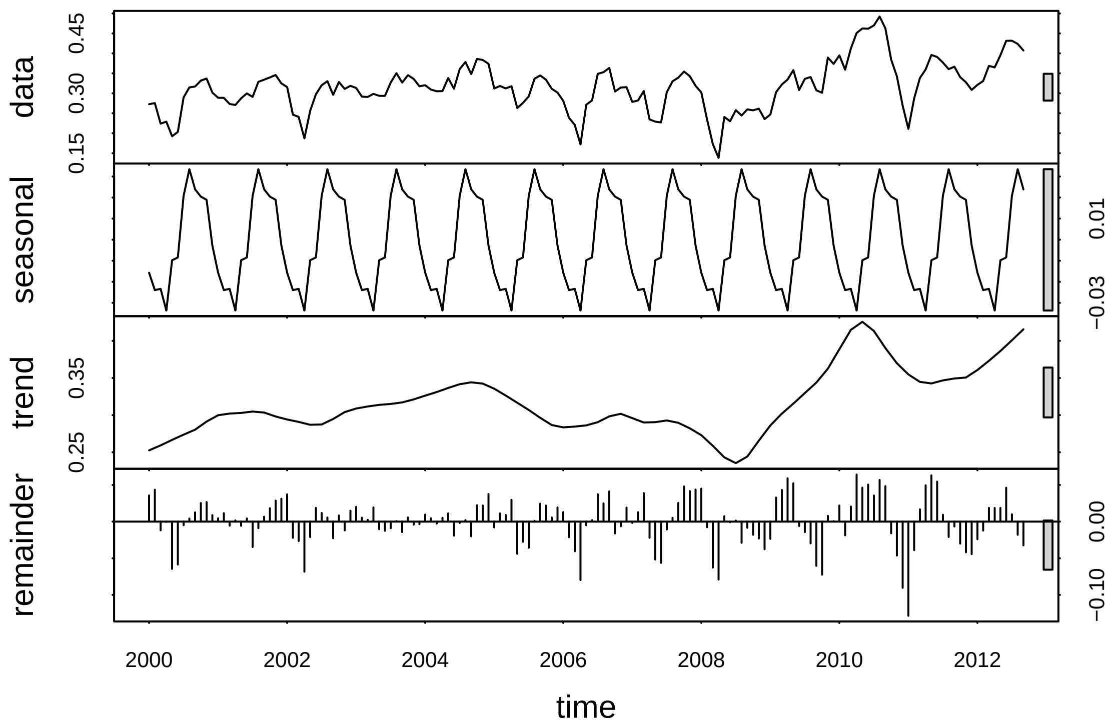

```r
plot(site2_decomposed)
```




```
plot(site3_decomposed)
```




```
plot(site4_decomposed)
```




```r
#Running the Seasonal Mann-Kendall trend analysis of average monthly soil moisture
site1_trend <- Kendall::SeasonalMannKendall(site1_ts)
summary(site1_trend)
```

```
## Score =  -14 , Var(Score) = 3354
## denominator =  961.9999
## tau = -0.0146, 2-sided pvalue =0.80898
```

```r
site2_trend <- Kendall::SeasonalMannKendall(site2_ts)
summary(site2_trend)
```

```
## Score =  -48 , Var(Score) = 2720
## denominator =  828
## tau = -0.058, 2-sided pvalue =0.35739
```

```r
site3_trend <- Kendall::SeasonalMannKendall(site3_ts)
summary(site3_trend)
```

```
## Score =  -415 , Var(Score) = 3549
## denominator =  1001
## tau = -0.415, 2-sided pvalue =3.2565e-12
```

```r
site4_trend <- Kendall::SeasonalMannKendall(site4_ts)
summary(site4_trend)
```

```
## Score =  244 , Var(Score) = 3056
## denominator =  900
## tau = 0.271, 2-sided pvalue =1.0157e-05
```

```r
#Running a linear model to determine the strength of the statistical relationship between precipitation
lm_site1 <- lm(data = site1_soil_precip, formula = AverageMonthlySmois30 ~ AverageMonthlyPrecip)
summary(lm_site1)
```

```
##
## Call:
## lm(formula = AverageMonthlySmois30 ~ AverageMonthlyPrecip, data = site1_soil_precip)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.15988 -0.02851  0.01186  0.03249  0.08229
##
## Coefficients:
##                      Estimate Std. Error t value Pr(>|t|)
## (Intercept)          0.254351   0.008133  31.275  < 2e-16 ***
## AverageMonthlyPrecip 0.047911   0.013030   3.677 0.000325 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.04456 on 155 degrees of freedom
## Multiple R-squared:  0.08024,    Adjusted R-squared:  0.0743
## F-statistic: 13.52 on 1 and 155 DF,  p-value: 0.0003247
```

```r
lm_site2 <- lm(data = site2_soil_precip, formula = AverageMonthlySmois30 ~ AverageMonthlyPrecip)
summary(lm_site2)
```

```
##
## Call:
## lm(formula = AverageMonthlySmois30 ~ AverageMonthlyPrecip, data = site2_soil_precip)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.14799 -0.05494  0.02679  0.05620  0.09101
##
## Coefficients:
##                      Estimate Std. Error t value Pr(>|t|)
## (Intercept)           0.23841    0.01229  19.402   <2e-16 ***
## AverageMonthlyPrecip  0.02341    0.01525   1.535    0.127
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.06706 on 144 degrees of freedom
## Multiple R-squared:  0.0161, Adjusted R-squared:  0.009264
## F-statistic: 2.356 on 1 and 144 DF,  p-value: 0.127
```

```r
lm_site3 <- lm(data = site3_soil_precip, formula = AverageMonthlySmois30 ~ AverageMonthlyPrecip)
summary(lm_site3)
```

```
##
## Call:
## lm(formula = AverageMonthlySmois30 ~ AverageMonthlyPrecip, data = site3_soil_precip)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.159797 -0.035338  0.002079  0.045007  0.301711
```

```
##
## Coefficients:
##                      Estimate Std. Error t value Pr(>|t|)
## (Intercept)          0.272335   0.011640  23.396   <2e-16 ***
## AverageMonthlyPrecip 0.001753   0.015808   0.111    0.912
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.06814 on 158 degrees of freedom
## Multiple R-squared:  7.783e-05,  Adjusted R-squared:  -0.006251
## F-statistic: 0.0123 on 1 and 158 DF,  p-value: 0.9118
```

```
lm_site4 <- lm(data = site4_soil_precip, formula = AverageMonthlySmois30 ~ AverageMonthlyPrecip)
summary(lm_site4)
```

```
##
## Call:
## lm(formula = AverageMonthlySmois30 ~ AverageMonthlyPrecip, data = site4_soil_precip)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.22173 -0.03012  0.00107  0.02865  0.15215
##
## Coefficients:
##                      Estimate Std. Error t value Pr(>|t|)
## (Intercept)           0.28732    0.01101   26.09  < 2e-16 ***
## AverageMonthlyPrecip  0.05111    0.01744    2.93  0.00392 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.05901 on 150 degrees of freedom
## Multiple R-squared:  0.05413,    Adjusted R-squared:  0.04783
## F-statistic: 8.585 on 1 and 150 DF,  p-value: 0.00392
```

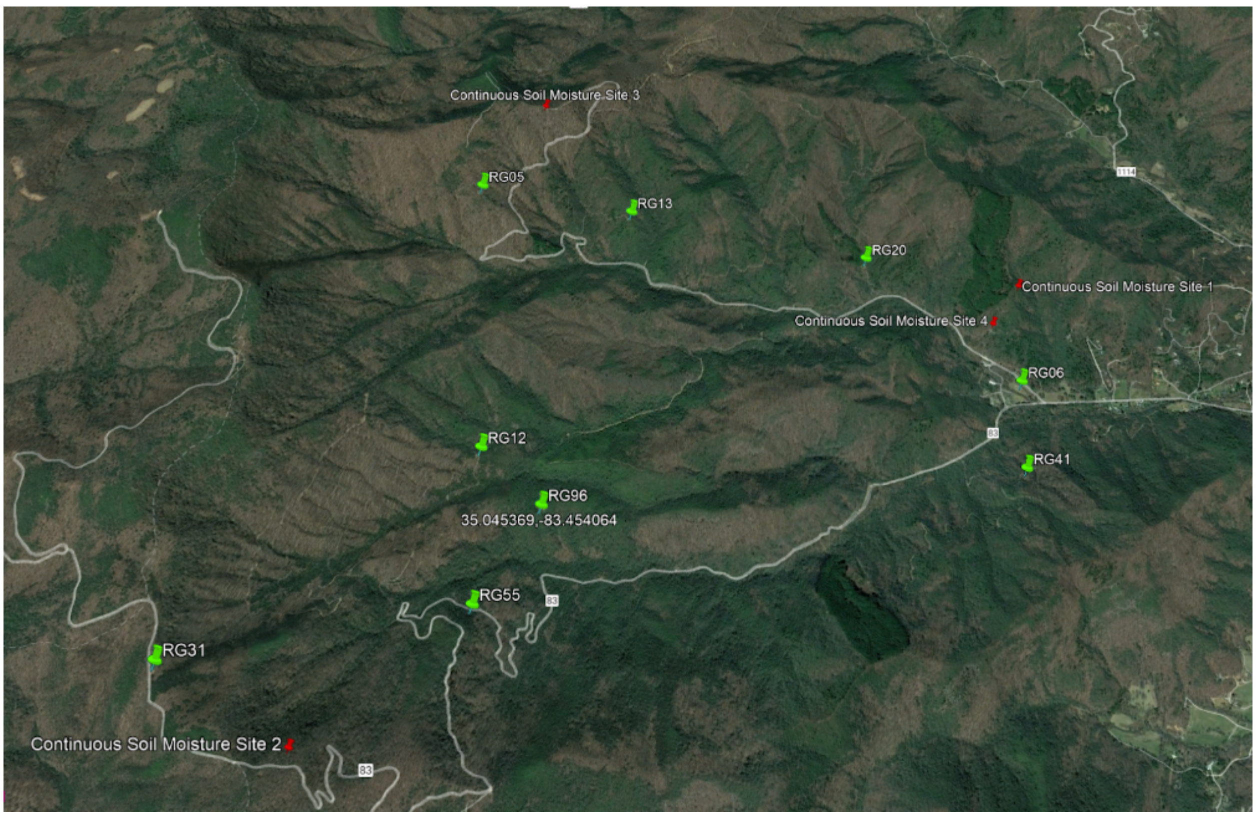


Figure 1: Soil moisture research sites and rain gauge locations within Coweeta Basin, North Carolina.