Georges Riverhealth Analysis

Analysis of the dataset using alternative tests

Mann-Kendall Tests

To statistically assess whether a variable of interest has an upward or downward monotonic trend, the Mann-Kendall test was performed. This is particularly useful when data may not be linear and would be particularly useful in this case as there is no clear linear trend. This is a non parametric test and does not involve any underlying assumptions about the data itself and can work for all distributions (your data may not comply with the assumption of normality). Due to the lack of data collection, many sites did not have a clear trend when linear regression was performed so the Mann-Kendall test is particularly useful in this scenario. The null hypothesis is that there exists no monotonic trend, the alternative hypothesis is that it exists, this can be positive, negative or non-null.

Shapiro-Wilk tests

We would conduct Shapiro-Wilk test for each variable at a site to corroborate assumptions of normality to enable us to perform the correlation tests. The two correlation tests, pearson and spearman correlation can only be conducted if the data is normal.

The null hypothesis for the Shapiro-Wilk test is that a variable is normally distributed in some population. If $p<0.05$, we reject the null hypothesis (data not normally distributed). We only procede with the correlation tests for each variable if our p value is greater than 0.05.

Pearson and Spearman tests

Note: Only conducted when data for a variable passes the Shapiro-Wilk test and other assumptions for these tests.

Pearson correlation coefficients tells us whether there is a linear relationship between the varaibles Spearman correlation coefficients tells us whether there is a monotonic relationship (relies on rank values, not raw data)

Scatterplot matrix and correlation matrix

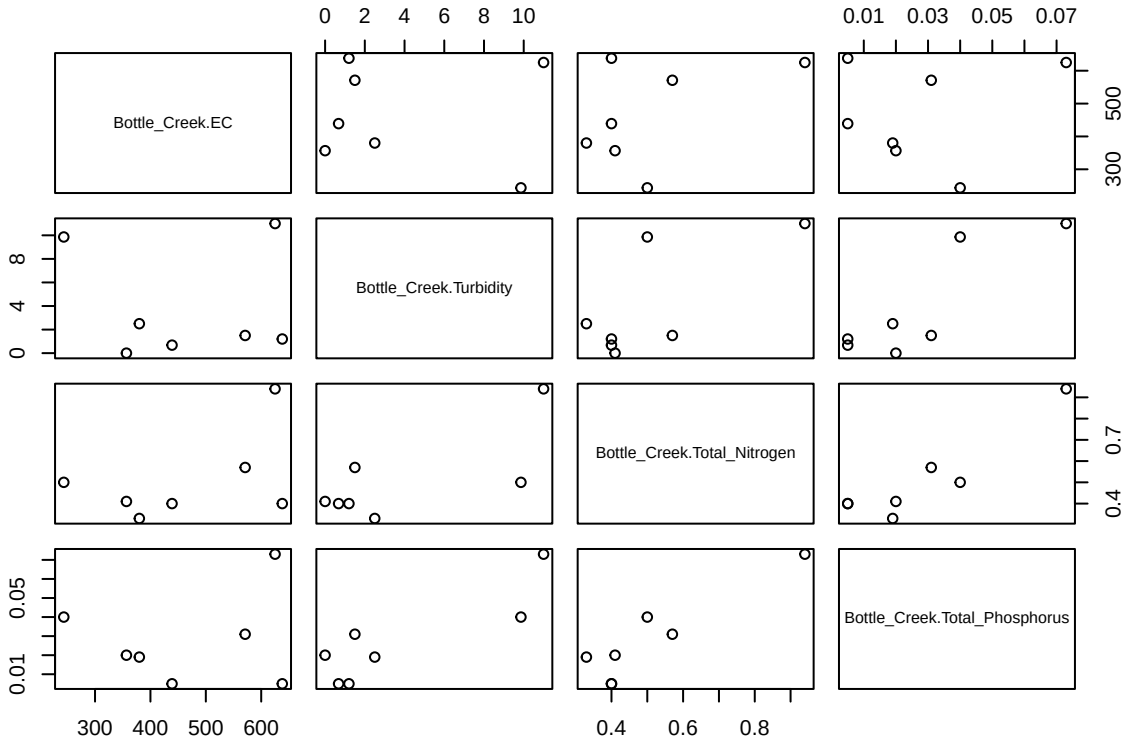
To see how each variable interacts with the other, and to get a better idea of the data to see if our tests would be suitable for the site, a scatterplot matrix and a correlation matrix was included to analyse dependence of a variable on the other.

Site 1 : Bottle Creek

```
library(readxl)
Bottle_Creek<-read_excel("C:/Users/HP/Downloads/Bottle_Creek.xlsx")
```

Scatterplot Matrix

```
bottlematrix<-data.frame(Bottle_Creek$EC,Bottle_Creek$Turbidity,Bottle_Creek$Total_Nitrogen,Bottle_Creek
pairs(bottlematrix)
```




```
cor(bottlematrix)
```

```
##                                Bottle_Creek.EC Bottle_Creek.Turbidity
## Bottle_Creek.EC                     1.00000000            -0.06764826
## Bottle_Creek.Turbidity             -0.06764826             1.00000000
## Bottle_Creek.Total_Nitrogen         0.46983218             0.72897198
## Bottle_Creek.Total_Phosphorus       0.14542413             0.86194999
##                                Bottle_Creek.Total_Nitrogen
## Bottle_Creek.EC                                  0.4698322
## Bottle_Creek.Turbidity                           0.7289720
## Bottle_Creek.Total_Nitrogen                      1.0000000
## Bottle_Creek.Total_Phosphorus                    0.9154205
##                                Bottle_Creek.Total_Phosphorus
```

```
## Bottle_Creek.EC                                  0.1454241
## Bottle_Creek.Turbidity                           0.8619500
## Bottle_Creek.Total_Nitrogen                      0.9154205
## Bottle_Creek.Total_Phosphorus                    1.0000000
```

Electrical Conductivity

```
library("trend")
shapiro.test(Bottle_Creek$EC)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  Bottle_Creek$EC
## W = 0.92549, p-value = 0.5132
```

```
cor.test(Bottle_Creek$EC, Bottle_Creek$Turbidity,method='pearson')
```

```
##
##  Pearson's product-moment correlation
##
## data:  Bottle_Creek$EC and Bottle_Creek$Turbidity
## t = -0.15161, df = 5, p-value = 0.8854
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  -0.7809237  0.7222010
## sample estimates:
##         cor
## -0.06764826
```

```
cor.test(Bottle_Creek$EC, Bottle_Creek$Turbidity,method='spearman')
```

```
##
##  Spearman's rank correlation rho
##
## data:  Bottle_Creek$EC and Bottle_Creek$Turbidity
## S = 52, p-value = 0.9063
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##        rho
## 0.07142857
```

```
cor.test(Bottle_Creek$EC, Bottle_Creek$Total_Nitrogen,method='pearson')
```

```
##
##  Pearson's product-moment correlation
##
## data:  Bottle_Creek$EC and Bottle_Creek$Total_Nitrogen
## t = 1.1901, df = 5, p-value = 0.2874
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
```

```
##  -0.4383019  0.9032947
## sample estimates:
##       cor
## 0.4698322
```

```
cor.test(Bottle_Creek$EC, Bottle_Creek$Total_Nitrogen,method='spearman')
```

```
## Warning in cor.test.default(Bottle_Creek$EC, Bottle_Creek$Total_Nitrogen, :
## Cannot compute exact p-value with ties
```

```
##
##  Spearman's rank correlation rho
##
## data:  Bottle_Creek$EC and Bottle_Creek$Total_Nitrogen
## S = 48.937, p-value = 0.7876
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##       rho
## 0.1261312
```

```
cor.test(Bottle_Creek$EC, Bottle_Creek$Total_Phosphorus,method='pearson')
```

```
##
##  Pearson's product-moment correlation
##
## data:  Bottle_Creek$EC and Bottle_Creek$Total_Phosphorus
## t = 0.32867, df = 5, p-value = 0.7557
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  -0.6823613  0.8097989
## sample estimates:
##       cor
## 0.1454241
```

```
cor.test(Bottle_Creek$EC, Bottle_Creek$Total_Phosphorus,method='spearman')
```

```
## Warning in cor.test.default(Bottle_Creek$EC, Bottle_Creek$Total_Phosphorus, :
## Cannot compute exact p-value with ties
```

```
##
##  Spearman's rank correlation rho
##
## data:  Bottle_Creek$EC and Bottle_Creek$Total_Phosphorus
## S = 67.1, p-value = 0.6701
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##       rho
## -0.1982062
```

```
mk.test(Bottle_Creek$EC)
```

```
##
##  Mann-Kendall trend test
##
## data:  Bottle_Creek$EC
## z = 0.30038, n = 7, p-value = 0.7639
## alternative hypothesis: true S is not equal to 0
## sample estimates:
##          S       varS        tau
##  3.0000000 44.3333333  0.1428571
```

Turbidity

```
shapiro.test(Bottle_Creek$Turbidity)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  Bottle_Creek$Turbidity
## W = 0.76236, p-value = 0.01705
```

```
mk.test(Bottle_Creek$Turbidity)
```

```
##
##  Mann-Kendall trend test
##
## data:  Bottle_Creek$Turbidity
## z = 0, n = 7, p-value = 1
## alternative hypothesis: true S is not equal to 0
## sample estimates:
##           S        varS         tau
## -1.00000000 44.33333333 -0.04761905
```

Total Nitrogen

```
shapiro.test(Bottle_Creek$Total_Nitrogen)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  Bottle_Creek$Total_Nitrogen
## W = 0.77865, p-value = 0.02503
```

```
mk.test(Bottle_Creek$Total_Nitrogen)
```

```
##
##  Mann-Kendall trend test
##
## data:  Bottle_Creek$Total_Nitrogen
```

```
## z = 0, n = 7, p-value = 1
## alternative hypothesis: true S is not equal to 0
## sample estimates:
##        S     varS      tau
##  0.00000 43.33333  0.00000
```

Total Phosphorus

```
shapiro.test(Bottle_Creek$Total_Phosphorus)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  Bottle_Creek$Total_Phosphorus
## W = 0.88435, p-value = 0.2465
```

```
cor.test(Bottle_Creek$Total_Phosphorus, Bottle_Creek$EC,method='pearson')
```

```
##
##  Pearson's product-moment correlation
##
## data:  Bottle_Creek$Total_Phosphorus and Bottle_Creek$EC
## t = 0.32867, df = 5, p-value = 0.7557
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  -0.6823613  0.8097989
## sample estimates:
##       cor
## 0.1454241
```

```
cor.test(Bottle_Creek$Total_Phosphorus, Bottle_Creek$EC,method='spearman')
```

```
## Warning in cor.test.default(Bottle_Creek$Total_Phosphorus, Bottle_Creek$EC, :
## Cannot compute exact p-value with ties
```

```
##
##  Spearman's rank correlation rho
##
## data:  Bottle_Creek$Total_Phosphorus and Bottle_Creek$EC
## S = 67.1, p-value = 0.6701
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##        rho
## -0.1982062
```

```
cor.test(Bottle_Creek$Total_Phosphorus, Bottle_Creek$Turbidity,method='pearson')
```

```
##
##  Pearson's product-moment correlation
##
```

```
## data:  Bottle_Creek$Total_Phosphorus and Bottle_Creek$Turbidity
## t = 3.8016, df = 5, p-value = 0.01261
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  0.3103203 0.9793279
## sample estimates:
##     cor
## 0.86195
```

```
cor.test(Bottle_Creek$Total_Phosphorus, Bottle_Creek$Turbidity,method='spearman')
```

```
## Warning in cor.test.default(Bottle_Creek$Total_Phosphorus,
## Bottle_Creek$Turbidity, : Cannot compute exact p-value with ties
```

```
##
##  Spearman's rank correlation rho
##
## data:  Bottle_Creek$Total_Phosphorus and Bottle_Creek$Turbidity
## S = 16.647, p-value = 0.07824
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##       rho
## 0.7027312
```

```
cor.test(Bottle_Creek$Total_Phosphorus, Bottle_Creek$Total_Nitrogen,method='pearson')
```

```
##
##  Pearson's product-moment correlation
##
## data:  Bottle_Creek$Total_Phosphorus and Bottle_Creek$Total_Nitrogen
## t = 5.0856, df = 5, p-value = 0.003816
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  0.5226788 0.9876366
## sample estimates:
##       cor
## 0.9154205
```

```
cor.test(Bottle_Creek$Total_Phosphorus, Bottle_Creek$Total_Nitrogen,method='spearman')
```

```
## Warning in cor.test.default(Bottle_Creek$Total_Phosphorus,
## Bottle_Creek$Total_Nitrogen, : Cannot compute exact p-value with ties
```

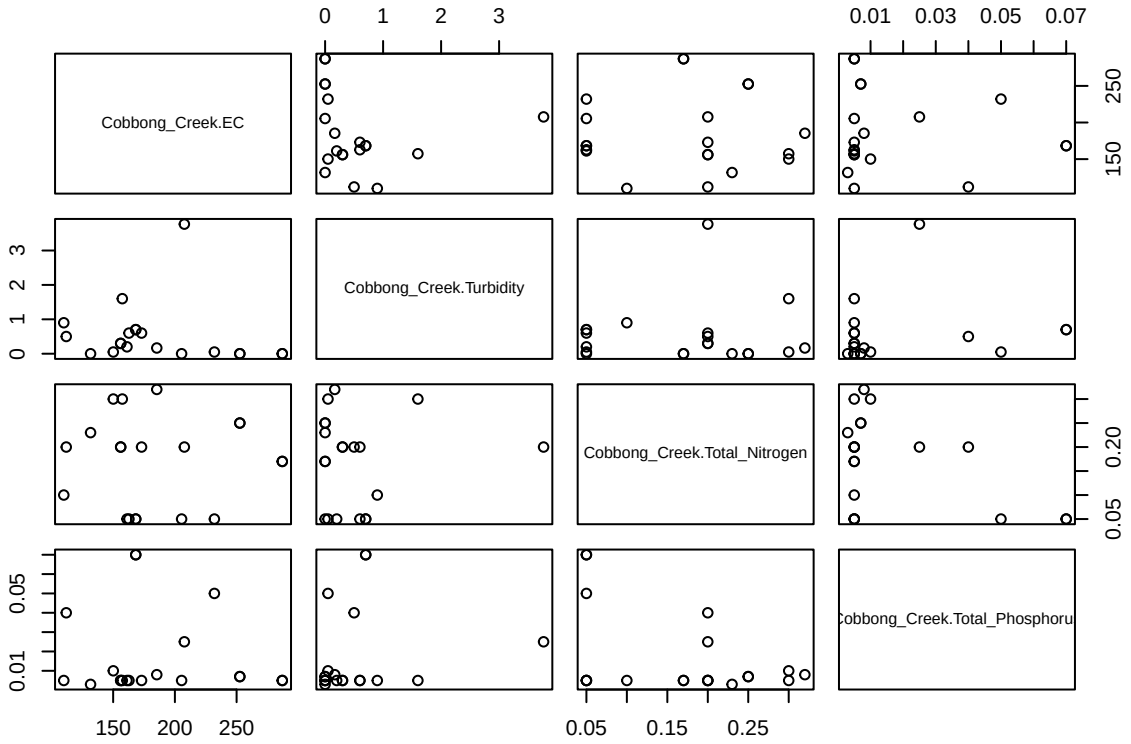
```
##
##  Spearman's rank correlation rho
##
## data:  Bottle_Creek$Total_Phosphorus and Bottle_Creek$Total_Nitrogen
## S = 8.1455, p-value = 0.01431
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##       rho
## 0.8545455
```

```
mk.test(Bottle_Creek$Total_Phosphorus)
```

```
##
##  Mann-Kendall trend test
##
## data:  Bottle_Creek$Total_Phosphorus
## z = -0.15191, n = 7, p-value = 0.8793
## alternative hypothesis: true S is not equal to 0
## sample estimates:
##           S        varS         tau
## -2.00000000 43.33333333 -0.09759001
```

Site 2 : Cobbong Creek

```
Cobbong_Creek<-read_excel("C:/Users/HP/Downloads/Cobbong_Creek.xlsx")
cobbonhmatrix<-data.frame(Cobbong_Creek$EC,Cobbong_Creek$Turbidity,Cobbong_Creek$Total_Nitrogen,Cobbong
cobbonhmatrix<-na.omit(cobbonhmatrix)
pairs(cobbonhmatrix)
```




```
cor(cobbonhmatrix)
```

```
##                                Cobbong_Creek.EC Cobbong_Creek.Turbidity
```

```
## Cobbong_Creek.EC                     1.00000000             -0.15812241
## Cobbong_Creek.Turbidity             -0.15812241              1.00000000
## Cobbong_Creek.Total_Nitrogen         0.02803754              0.04874828
## Cobbong_Creek.Total_Phosphorus      -0.09785710              0.16921188
##                                Cobbong_Creek.Total_Nitrogen
## Cobbong_Creek.EC                                 0.02803754
## Cobbong_Creek.Turbidity                          0.04874828
## Cobbong_Creek.Total_Nitrogen                     1.00000000
## Cobbong_Creek.Total_Phosphorus                  -0.45377507
##                                Cobbong_Creek.Total_Phosphorus
## Cobbong_Creek.EC                                  -0.0978571
## Cobbong_Creek.Turbidity                            0.1692119
## Cobbong_Creek.Total_Nitrogen                      -0.4537751
## Cobbong_Creek.Total_Phosphorus                     1.0000000
```

Electrical Conductivity

```
mk.test(na.omit(Cobbong_Creek$EC))
```

```
##
##  Mann-Kendall trend test
##
## data:  na.omit(Cobbong_Creek$EC)
## z = 0.21177, n = 21, p-value = 0.8323
## alternative hypothesis: true S is not equal to 0
## sample estimates:
##            S         varS          tau
## 8.000000e+00 1.092667e+03 3.846332e-02
```

```
shapiro.test((Cobbong_Creek$EC))
```

```
##
##  Shapiro-Wilk normality test
##
## data:  (Cobbong_Creek$EC)
## W = 0.95373, p-value = 0.3998
```

Turbidity

```
mk.test(na.omit(Cobbong_Creek$Turbidity))
```

```
##
##  Mann-Kendall trend test
##
## data:  na.omit(Cobbong_Creek$Turbidity)
## z = -0.13204, n = 20, p-value = 0.8949
## alternative hypothesis: true S is not equal to 0
## sample estimates:
##            S         varS          tau
##  -5.00000000 917.66666667  -0.02773928
```

```r
shapiro.test(Cobbong_Creek$Turbidity)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  Cobbong_Creek$Turbidity
## W = 0.61477, p-value = 4.205e-06
```

```r
cor.test(Cobbong_Creek$Turbidity, Cobbong_Creek$EC,method='pearson')
```

```
##
##  Pearson's product-moment correlation
##
## data:  Cobbong_Creek$Turbidity and Cobbong_Creek$EC
## t = -0.6794, df = 18, p-value = 0.5055
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  -0.5613632  0.3057956
## sample estimates:
##        cor
## -0.1581224
```

```r
cor.test(Cobbong_Creek$Turbidity, Cobbong_Creek$EC,method='spearman')
```

```
## Warning in cor.test.default(Cobbong_Creek$Turbidity, Cobbong_Creek$EC, method =
## "spearman"): Cannot compute exact p-value with ties
```

```
##
##  Spearman's rank correlation rho
##
## data:  Cobbong_Creek$Turbidity and Cobbong_Creek$EC
## S = 1909.4, p-value = 0.05486
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##        rho
## -0.4356523
```

```r
cor.test(Cobbong_Creek$Turbidity, Cobbong_Creek$Total_Nitrogen,method='pearson')
```

```
##
##  Pearson's product-moment correlation
##
## data:  Cobbong_Creek$Turbidity and Cobbong_Creek$Total_Nitrogen
## t = 0.20707, df = 18, p-value = 0.8383
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  -0.4024543  0.4808951
## sample estimates:
##        cor
## 0.04874828
```

```
cor.test(Cobbong_Creek$Turbidity, Cobbong_Creek$Total_Nitrogen,method='spearman')
```

```
## Warning in cor.test.default(Cobbong_Creek$Turbidity,
## Cobbong_Creek$Total_Nitrogen, : Cannot compute exact p-value with ties
```

```
##
##  Spearman's rank correlation rho
##
## data:  Cobbong_Creek$Turbidity and Cobbong_Creek$Total_Nitrogen
## S = 1528.2, p-value = 0.5306
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##        rho
## -0.1490482
```

```
cor.test(Cobbong_Creek$Turbidity, Cobbong_Creek$Total_Phosphorus,method='pearson')
```

```
##
##  Pearson's product-moment correlation
##
## data:  Cobbong_Creek$Turbidity and Cobbong_Creek$Total_Phosphorus
## t = 0.72841, df = 18, p-value = 0.4757
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  -0.2954307  0.5691173
## sample estimates:
##       cor
## 0.1692119
```

```
cor.test(Cobbong_Creek$Turbidity, Cobbong_Creek$Total_Phosphorus,method='spearman')
```

```
## Warning in cor.test.default(Cobbong_Creek$Turbidity,
## Cobbong_Creek$Total_Phosphorus, : Cannot compute exact p-value with ties
```

```
##
##  Spearman's rank correlation rho
##
## data:  Cobbong_Creek$Turbidity and Cobbong_Creek$Total_Phosphorus
## S = 991.89, p-value = 0.2794
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##       rho
## 0.2542173
```

Total Nitrogen

```
mk.test(na.omit(Cobbong_Creek$Total_Nitrogen))
```

```
##
##  Mann-Kendall trend test
```

```
##
## data:  na.omit(Cobbong_Creek$Total_Nitrogen)
## z = 1.4626, n = 21, p-value = 0.1436
## alternative hypothesis: true S is not equal to 0
## sample estimates:
##            S         varS          tau
##   48.0000000 1032.6666667    0.2496751
```

```
shapiro.test(Cobbong_Creek$Total_Nitrogen)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  Cobbong_Creek$Total_Nitrogen
## W = 0.86977, p-value = 0.00949
```

Total Phosphorus

```
mk.test(na.omit(Cobbong_Creek$Total_Phosphorus))
```

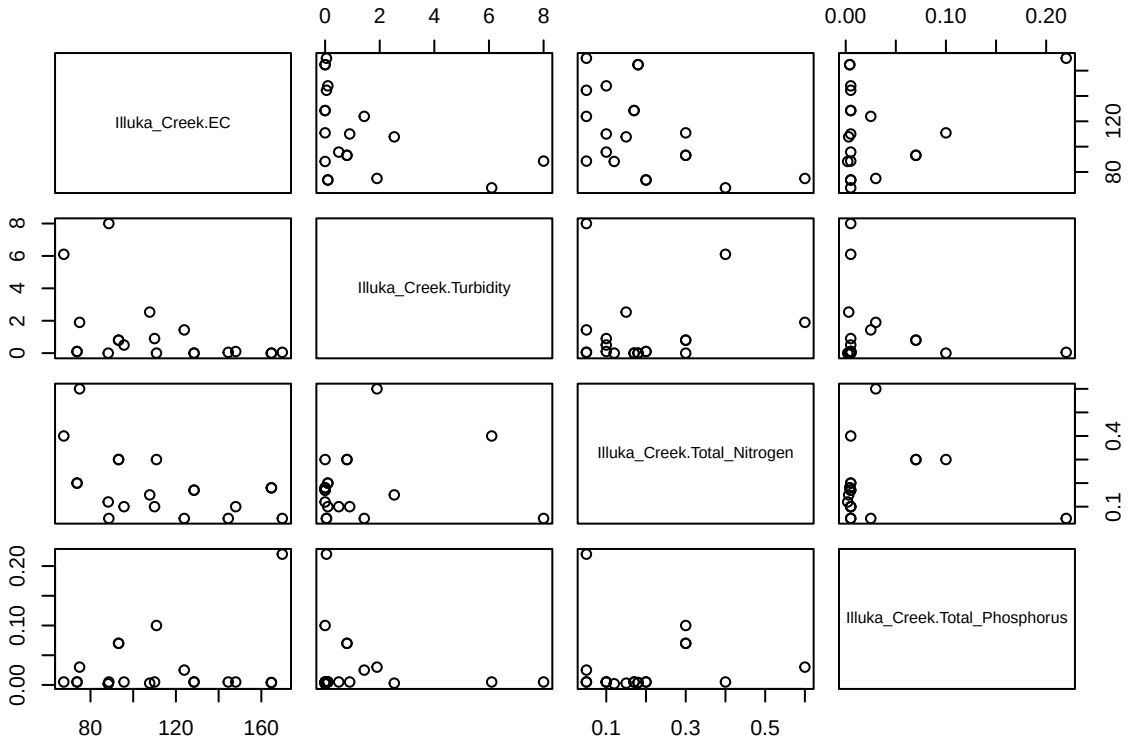
```
##
##  Mann-Kendall trend test
##
## data:  na.omit(Cobbong_Creek$Total_Phosphorus)
## z = -0.73899, n = 21, p-value = 0.4599
## alternative hypothesis: true S is not equal to 0
## sample estimates:
##         S      varS       tau
## -24.00000 968.66667  -0.13012
```

```
shapiro.test(Cobbong_Creek$Total_Phosphorus)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  Cobbong_Creek$Total_Phosphorus
## W = 0.65336, p-value = 7.621e-06
```

Site 3 : Illuka_Creek

```
Illuka_Creek<-read_excel("C:/Users/HP/Downloads/Illuka_Creek.xlsx")
Illukamatrix<-data.frame(Illuka_Creek$EC,Illuka_Creek$Turbidity,Illuka_Creek$Total_Nitrogen,Illuka_Creek
Illukamatrix<-na.omit(Illukamatrix)
pairs(Illukamatrix)
```




```
cor(Illukamatrix)
```

```
##                                Illuka_Creek.EC Illuka_Creek.Turbidity
## Illuka_Creek.EC                      1.0000000             -0.4283918
## Illuka_Creek.Turbidity              -0.4283918              1.0000000
## Illuka_Creek.Total_Nitrogen         -0.4927228              0.1246703
## Illuka_Creek.Total_Phosphorus        0.2709471             -0.1716663
##                                Illuka_Creek.Total_Nitrogen
## Illuka_Creek.EC                                -0.49272281
## Illuka_Creek.Turbidity                          0.12467032
## Illuka_Creek.Total_Nitrogen                     1.00000000
## Illuka_Creek.Total_Phosphorus                   0.02260687
##                                Illuka_Creek.Total_Phosphorus
## Illuka_Creek.EC                                   0.27094709
## Illuka_Creek.Turbidity                           -0.17166627
## Illuka_Creek.Total_Nitrogen                       0.02260687
## Illuka_Creek.Total_Phosphorus                     1.00000000
```

Electrical Conductivity

```
mk.test(na.omit(Illuka_Creek$EC))
```

```
##
##  Mann-Kendall trend test
##
```

```
## data:  na.omit(Illuka_Creek$EC)
## z = 0.81681, n = 21, p-value = 0.414
## alternative hypothesis: true S is not equal to 0
## sample estimates:
##            S         varS          tau
##   28.0000000 1092.6666667    0.1346216
```

```
shapiro.test(Illuka_Creek$EC)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  Illuka_Creek$EC
## W = 0.93264, p-value = 0.1555
```

Turbidity

```
mk.test(na.omit(Illuka_Creek$Turbidity))
```

```
##
##  Mann-Kendall trend test
##
## data:  na.omit(Illuka_Creek$Turbidity)
## z = 0, n = 20, p-value = 1
## alternative hypothesis: true S is not equal to 0
## sample estimates:
##    S varS  tau
##    0  916    0
```

```
shapiro.test((Illuka_Creek$Turbidity))
```

```
##
##  Shapiro-Wilk normality test
##
## data:  (Illuka_Creek$Turbidity)
## W = 0.6033, p-value = 3.186e-06
```

Total Nitrogen

```
mk.test(na.omit(Illuka_Creek$Total_Nitrogen))
```

```
##
##  Mann-Kendall trend test
##
## data:  na.omit(Illuka_Creek$Total_Nitrogen)
## z = -0.73109, n = 21, p-value = 0.4647
## alternative hypothesis: true S is not equal to 0
## sample estimates:
##            S         varS          tau
##  -25.0000000 1077.6666667   -0.1235416
```

```
shapiro.test(Illuka_Creek$Total_Nitrogen)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  Illuka_Creek$Total_Nitrogen
## W = 0.55811, p-value = 7.325e-07
```

Total Phosphorus

```
mk.test(na.omit(Illuka_Creek$Total_Phosphorus))
```

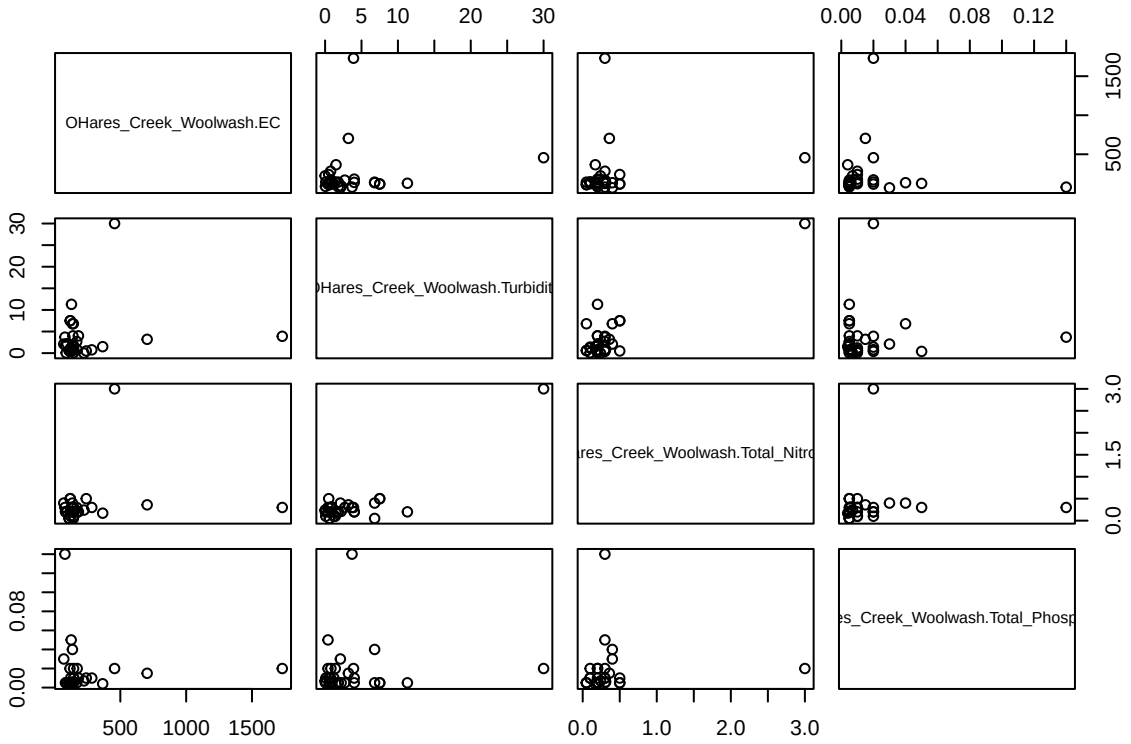
```
##
##  Mann-Kendall trend test
##
## data:  na.omit(Illuka_Creek$Total_Phosphorus)
## z = -2.7953, n = 21, p-value = 0.005185
## alternative hypothesis: true S is not equal to 0
## sample estimates:
##           S        varS         tau
## -88.0000000 968.6666667  -0.4771067
```

```
shapiro.test((Illuka_Creek$Total_Phosphorus))
```

```
##
##  Shapiro-Wilk normality test
##
## data:  (Illuka_Creek$Total_Phosphorus)
## W = 0.55927, p-value = 7.521e-07
```

Site 4 : OHares Creek Woolwash

```
OHares_Creek_Woolwash<-read_excel("C:/Users/HP/Downloads/OHares_Creek_Woolwash.xlsx")
Oharesmatrix<-data.frame(OHares_Creek_Woolwash$EC,OHares_Creek_Woolwash$Turbidity,OHares_Creek_Woolwash$
Oharesmatrix<-na.omit(Oharesmatrix)
pairs(Oharesmatrix)
```




```
cor(Oharesmatrix)
```

```
##                                        OHares_Creek_Woolwash.EC
## OHares_Creek_Woolwash.EC                             1.00000000
## OHares_Creek_Woolwash.Turbidity                      0.14812806
## OHares_Creek_Woolwash.Total_Nitrogen                 0.16694759
## OHares_Creek_Woolwash.Total_Phosphorus              -0.02557661
##                                        OHares_Creek_Woolwash.Turbidity
## OHares_Creek_Woolwash.EC                                    0.14812806
## OHares_Creek_Woolwash.Turbidity                             1.00000000
## OHares_Creek_Woolwash.Total_Nitrogen                        0.87970647
## OHares_Creek_Woolwash.Total_Phosphorus                      0.03855484
##                                        OHares_Creek_Woolwash.Total_Nitrogen
## OHares_Creek_Woolwash.EC                                         0.16694759
## OHares_Creek_Woolwash.Turbidity                                  0.87970647
## OHares_Creek_Woolwash.Total_Nitrogen                             1.00000000
## OHares_Creek_Woolwash.Total_Phosphorus                           0.06812084
##                                        OHares_Creek_Woolwash.Total_Phosphorus
## OHares_Creek_Woolwash.EC                                           -0.02557661
## OHares_Creek_Woolwash.Turbidity                                     0.03855484
## OHares_Creek_Woolwash.Total_Nitrogen                                0.06812084
## OHares_Creek_Woolwash.Total_Phosphorus                              1.00000000
```

Electrical Conductivity

```
mk.test(na.omit(OHares_Creek_Woolwash$EC))
```

```
##
##  Mann-Kendall trend test
##
## data:  na.omit(OHares_Creek_Woolwash$EC)
## z = 2.8672, n = 33, p-value = 0.004142
## alternative hypothesis: true S is not equal to 0
## sample estimates:
##            S         varS          tau
##  186.0000000 4163.3333333    0.3529418
```

```
shapiro.test(OHares_Creek_Woolwash$EC)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  OHares_Creek_Woolwash$EC
## W = 0.43169, p-value = 3.465e-10
```

Turbidity

```
mk.test(na.omit(OHares_Creek_Woolwash$Turbidity))
```

```
##
##  Mann-Kendall trend test
##
## data:  na.omit(OHares_Creek_Woolwash$Turbidity)
## z = -0.20413, n = 31, p-value = 0.8382
## alternative hypothesis: true S is not equal to 0
## sample estimates:
##             S          varS           tau
##  -13.00000000 3455.66666667   -0.02813912
```

```
shapiro.test(OHares_Creek_Woolwash$Turbidity)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  OHares_Creek_Woolwash$Turbidity
## W = 0.56795, p-value = 2.142e-08
```

Total Nitrogen

```
mk.test(na.omit(OHares_Creek_Woolwash$Total_Nitrogen))
```

```
##
##  Mann-Kendall trend test
##
## data:  na.omit(OHares_Creek_Woolwash$Total_Nitrogen)
```

```
## z = 0.11068, n = 33, p-value = 0.9119
## alternative hypothesis: true S is not equal to 0
## sample estimates:
##            S         varS          tau
## 8.000000e+00 4.000000e+03 1.626823e-02
```

```
shapiro.test(OHares_Creek_Woolwash$Total_Nitrogen)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  OHares_Creek_Woolwash$Total_Nitrogen
## W = 0.37642, p-value = 1.004e-10
```

Total Phosphorus

```
mk.test(na.omit(OHares_Creek_Woolwash$Total_Phosphorus))
```

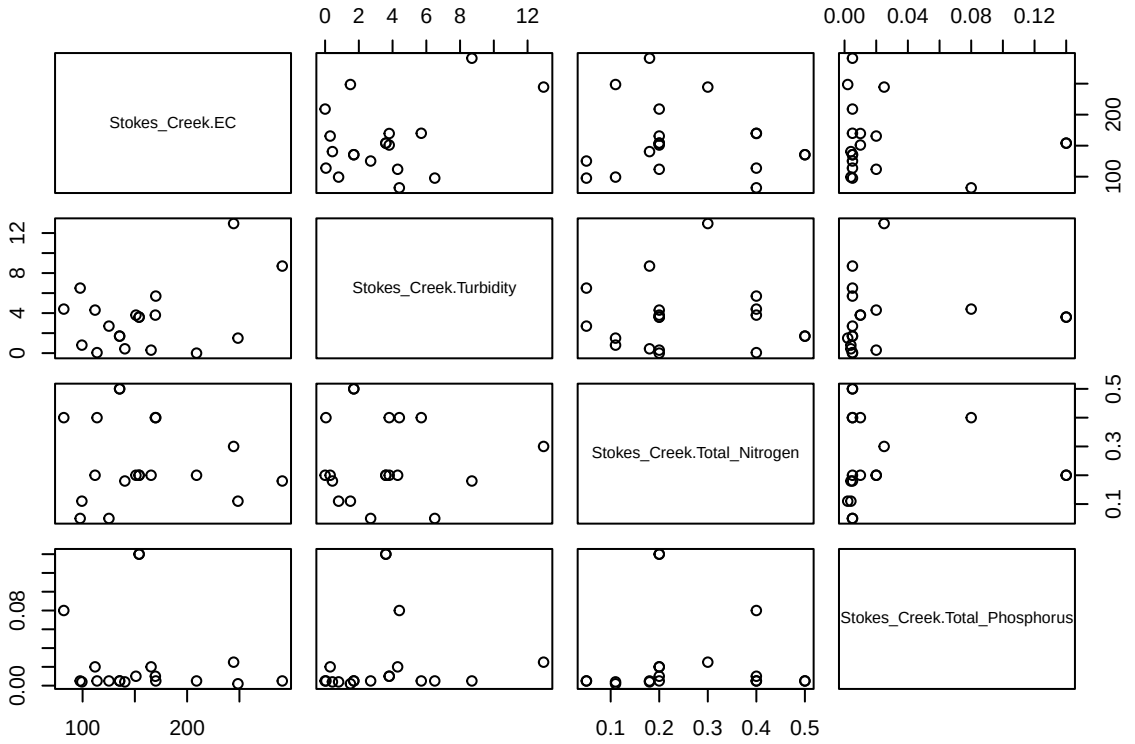
```
##
##  Mann-Kendall trend test
##
## data:  na.omit(OHares_Creek_Woolwash$Total_Phosphorus)
## z = 1.0093, n = 33, p-value = 0.3128
## alternative hypothesis: true S is not equal to 0
## sample estimates:
##           S        varS         tau
##   64.000000 3896.000000    0.134005
```

```
shapiro.test(OHares_Creek_Woolwash$Total_Phosphorus)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  OHares_Creek_Woolwash$Total_Phosphorus
## W = 0.49694, p-value = 1.669e-09
```

Site 5 : Stokes Creek

```
Stokes_Creek<-read_excel("C:/Users/HP/Downloads/Stokes_Creek.xlsx")
Stokesmatrix<-data.frame(Stokes_Creek$EC,Stokes_Creek$Turbidity,Stokes_Creek$Total_Nitrogen,Stokes_Creek
Stokesmatrix<-na.omit(Stokesmatrix)
pairs(Stokesmatrix)
```




```
cor(Stokesmatrix)
```

```
##                                Stokes_Creek.EC Stokes_Creek.Turbidity
## Stokes_Creek.EC                      1.0000000             0.40695699
## Stokes_Creek.Turbidity               0.4069570             1.00000000
## Stokes_Creek.Total_Nitrogen         -0.1074804            -0.01150915
## Stokes_Creek.Total_Phosphorus       -0.1301810             0.10099889
##                                Stokes_Creek.Total_Nitrogen
## Stokes_Creek.EC                                -0.10748038
## Stokes_Creek.Turbidity                         -0.01150915
## Stokes_Creek.Total_Nitrogen                     1.00000000
## Stokes_Creek.Total_Phosphorus                  -0.02014390
##                                Stokes_Creek.Total_Phosphorus
## Stokes_Creek.EC                                   -0.1301810
## Stokes_Creek.Turbidity                             0.1009989
## Stokes_Creek.Total_Nitrogen                       -0.0201439
## Stokes_Creek.Total_Phosphorus                      1.0000000
```

Electrical Conductivity

```
mk.test(na.omit(Stokes_Creek$EC))
```

```
##
##  Mann-Kendall trend test
##
```

```
## data:  na.omit(Stokes_Creek$EC)
## z = 1.6564, n = 20, p-value = 0.09764
## alternative hypothesis: true S is not equal to 0
## sample estimates:
##           S        varS         tau
##  52.0000000 948.0000000   0.2751361
```

```
shapiro.test(Stokes_Creek$EC)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  Stokes_Creek$EC
## W = 0.92734, p-value = 0.1372
```

Turbidity

```
mk.test(na.omit(Stokes_Creek$Turbidity))
```

```
##
##  Mann-Kendall trend test
##
## data:  na.omit(Stokes_Creek$Turbidity)
## z = -0.10515, n = 19, p-value = 0.9163
## alternative hypothesis: true S is not equal to 0
## sample estimates:
##            S         varS          tau
##  -4.00000000 814.00000000  -0.02359974
```

```
shapiro.test(Stokes_Creek$Turbidity)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  Stokes_Creek$Turbidity
## W = 0.86992, p-value = 0.0144
```

Total Nitrogen

```
mk.test(na.omit(Stokes_Creek$Total_Nitrogen))
```

```
##
##  Mann-Kendall trend test
##
## data:  na.omit(Stokes_Creek$Total_Nitrogen)
## z = -0.19901, n = 20, p-value = 0.8423
## alternative hypothesis: true S is not equal to 0
## sample estimates:
##            S         varS          tau
##  -7.00000000 909.00000000  -0.03953477
```

```r
shapiro.test(Stokes_Creek$Total_Nitrogen)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  Stokes_Creek$Total_Nitrogen
## W = 0.91132, p-value = 0.06754
```

```r
cor.test(Stokes_Creek$Total_Nitrogen, Stokes_Creek$EC,method='pearson')
```

```
##
##  Pearson's product-moment correlation
##
## data:  Stokes_Creek$Total_Nitrogen and Stokes_Creek$EC
## t = -0.19655, df = 18, p-value = 0.8464
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  -0.4789887  0.4045281
## sample estimates:
##         cor
## -0.04627682
```

```r
cor.test(Stokes_Creek$Total_Nitrogen, Stokes_Creek$EC,method='spearman')
```

```
## Warning in cor.test.default(Stokes_Creek$Total_Nitrogen, Stokes_Creek$EC, :
## Cannot compute exact p-value with ties
```

```
##
##  Spearman's rank correlation rho
##
## data:  Stokes_Creek$Total_Nitrogen and Stokes_Creek$EC
## S = 1219.9, p-value = 0.7285
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##       rho
## 0.08280378
```

```r
cor.test(Stokes_Creek$Total_Nitrogen, Stokes_Creek$Turbidity,method='pearson')
```

```
##
##  Pearson's product-moment correlation
##
## data:  Stokes_Creek$Total_Nitrogen and Stokes_Creek$Turbidity
## t = -0.047457, df = 17, p-value = 0.9627
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  -0.4632965  0.4450265
## sample estimates:
##         cor
## -0.01150915
```

```
cor.test(Stokes_Creek$Total_Nitrogen, Stokes_Creek$Turbidity,method='spearman')
```

```
## Warning in cor.test.default(Stokes_Creek$Total_Nitrogen,
## Stokes_Creek$Turbidity, : Cannot compute exact p-value with ties
```

```
##
##  Spearman's rank correlation rho
##
## data:  Stokes_Creek$Total_Nitrogen and Stokes_Creek$Turbidity
## S = 1104.2, p-value = 0.8984
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##        rho
## 0.03142501
```

```
cor.test(Stokes_Creek$Total_Nitrogen, Stokes_Creek$Total_Phosphorus,method='pearson')
```

```
##
##  Pearson's product-moment correlation
##
## data:  Stokes_Creek$Total_Nitrogen and Stokes_Creek$Total_Phosphorus
## t = -0.085944, df = 18, p-value = 0.9325
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  -0.4586631  0.4260865
## sample estimates:
##         cor
## -0.02025302
```

```
cor.test(Stokes_Creek$Total_Nitrogen, Stokes_Creek$Total_Phosphorus,method='spearman')
```

```
## Warning in cor.test.default(Stokes_Creek$Total_Nitrogen,
## Stokes_Creek$Total_Phosphorus, : Cannot compute exact p-value with ties
```

```
##
##  Spearman's rank correlation rho
##
## data:  Stokes_Creek$Total_Nitrogen and Stokes_Creek$Total_Phosphorus
## S = 806.79, p-value = 0.08616
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##       rho
## 0.3933881
```

Total Phosphorus

```
mk.test(na.omit(Stokes_Creek$Total_Phosphorus))
```

```
##
##  Mann-Kendall trend test
```

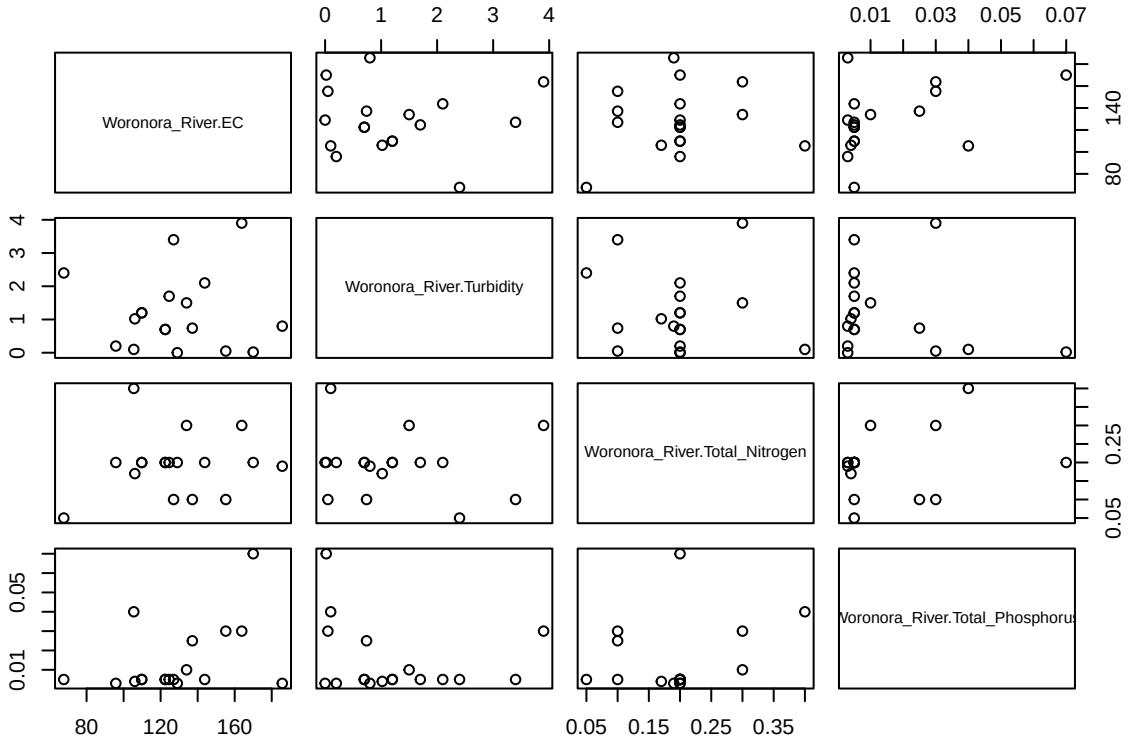
```
##
## data:  na.omit(Stokes_Creek$Total_Phosphorus)
## z = -0.87663, n = 20, p-value = 0.3807
## alternative hypothesis: true S is not equal to 0
## sample estimates:
##           S        varS         tau
## -27.0000000 879.6666667  -0.1563281
```

```
shapiro.test(Stokes_Creek$Total_Phosphorus)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  Stokes_Creek$Total_Phosphorus
## W = 0.56821, p-value = 1.403e-06
```

Site 6 : Woronora River

```
Woronora_River<-read_excel("C:/Users/HP/Downloads/Woronora_River.xlsx")
Woronoramatrix<-data.frame(Woronora_River$EC,Woronora_River$Turbidity,Woronora_River$Total_Nitrogen,Woro
Woronoramatrix<-na.omit(Woronoramatrix)
pairs(Woronoramatrix)
```



```
cor(Woronoramatrix)
```

```
##                                 Woronora_River.EC Woronora_River.Turbidity
## Woronora_River.EC                       1.00000000              -0.01173576
## Woronora_River.Turbidity               -0.01173576               1.00000000
## Woronora_River.Total_Nitrogen           0.13392420              -0.09447410
## Woronora_River.Total_Phosphorus         0.41450955              -0.22854905
##                                 Woronora_River.Total_Nitrogen
## Woronora_River.EC                                   0.1339242
## Woronora_River.Turbidity                           -0.0944741
## Woronora_River.Total_Nitrogen                       1.0000000
## Woronora_River.Total_Phosphorus                     0.2546467
##                                 Woronora_River.Total_Phosphorus
## Woronora_River.EC                                     0.4145095
## Woronora_River.Turbidity                             -0.2285491
## Woronora_River.Total_Nitrogen                         0.2546467
## Woronora_River.Total_Phosphorus                       1.0000000
```

Electrical Conductivity

```
mk.test(na.omit(Woronora_River$EC))
```

```
##
##  Mann-Kendall trend test
##
## data:  na.omit(Woronora_River$EC)
## z = -0.6612, n = 42, p-value = 0.5085
## alternative hypothesis: true S is not equal to 0
## sample estimates:
##             S          varS           tau
##  -62.00000000 8511.33333333   -0.07213507
```

```
shapiro.test(Woronora_River$EC)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  Woronora_River$EC
## W = 0.97191, p-value = 0.382
```

Turbidity

```
mk.test(na.omit(Woronora_River$Turbidity))
```

```
##
##  Mann-Kendall trend test
##
## data:  na.omit(Woronora_River$Turbidity)
## z = -0.91037, n = 18, p-value = 0.3626
## alternative hypothesis: true S is not equal to 0
## sample estimates:
##           S        varS         tau
## -25.0000000 695.0000000  -0.1644772
```

```
shapiro.test(Woronora_River$Turbidity)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  Woronora_River$Turbidity
## W = 0.88543, p-value = 0.03225
```

Total Nitrogen

```
mk.test(na.omit(Woronora_River$Total_Nitrogen))
```

```
##
##  Mann-Kendall trend test
##
## data:  na.omit(Woronora_River$Total_Nitrogen)
## z = -0.12472, n = 42, p-value = 0.9007
## alternative hypothesis: true S is not equal to 0
## sample estimates:
##             S          varS           tau
##  -12.00000000 7778.66666667   -0.01584684
```

```
shapiro.test(Woronora_River$Total_Nitrogen)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  Woronora_River$Total_Nitrogen
## W = 0.33396, p-value = 1.45e-12
```

Total Phosphorus

```
mk.test(na.omit(Woronora_River$Total_Phosphorus))
```

```
##
##  Mann-Kendall trend test
##
## data:  na.omit(Woronora_River$Total_Phosphorus)
## z = -1.7483, n = 42, p-value = 0.0804
## alternative hypothesis: true S is not equal to 0
## sample estimates:
##            S         varS          tau
## -148.0000000 7069.3333333   -0.2062574
```

```
shapiro.test(Woronora_River$Total_Phosphorus)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  Woronora_River$Total_Phosphorus
## W = 0.17925, p-value = 5.711e-14
```