

# HANDOUTS 1

## Time Series with R course outline

### Day 1

#### Introduction to R Basics

##### Installing and using R software

- Availability of R – open source software
- Installing R and support packages
- The R windows
- Loading and using R libraries

##### Using Data with R

- Data formats that can be used by R
- Reading data into R from txt files and Excel
- Using data: vectors, data elements
- Logical variables and factors
- Handling missing values in R

##### Lunch 1 hour

##### Basics of using Rcmdr (R commander)

- Drawing graphs, scatterplots, boxplots, probability plots
- Saving a graph to the hard drive
- Transforming variables
- Computing descriptive Statistics
- Computing hypothesis tests: parametric and non-parametric
- Computing linear regression models with diagnostics

##### Using the R console window

- Plots: density plot
- Tests: Kendall correlation
- Writing and using scripts (i.e. macros/programs) in R
- Scripts for time series and regression
- RcmdrPlugin.epack for Time Series

## HANDOUTS 2

### Time Series with R Day 2 Time Series Methods

#### Serial Correlation and Information Content

- Correlation Review
- Serial correlation vs autocorrelation
- Effective sample size
- Effects of autocorrelation on hypothesis tests
- Exercise

#### Regression, Trends, Seasonality review

- How to build a good regression model
- Residuals analysis
- Trend analysis with sin and cos terms
- Exercise

Lunch 1 hour

#### Time series analysis

- Objectives, Graphics
- Tests of randomness
- Overall tests vs. specific lags
- Parametric test of temporal correlation
- Normality test
- Autocorrelation function, ACF
- Partial autocorrelation function, PACF
- ACF and PACF when some data are missing

#### Time series models

- Stationarity
- Autoregressive (AR) models
- Moving average (MA) models
- ARMA models
- ARIMA models
- ACF, PACF to guide choice of models
- Model estimation
- Exercise: water quality measurements

## HANDOUTS 3

# Time Series with R

## Day 3

### Time Series Methods, cont.

Regression Analysis in the presence of correlated residuals  
Durbin -Watson test and simplified procedures  
Generalized Least Squares (GLS) models in R  
Iterative GLS in R  
Performing complex regression with correlated residuals  
Exercise

Bootstrap Methods  
Bootstrap concepts.  
Bootstrapping uncorrelated data. Example: the UCL95  
Value of bootstrapping for time series data  
Bootstrapping methods for serially correlated data  
Exercise: bootstrap estimate of water quality

Outlier identification  
Review of Normality assumption and dangers with uncorrelated data  
How outlier tests work, and their limitations  
Outlier tests in time series

Seasonal and regional Kendall tests  
How these tests work: blocking  
Seasonal Kendall  
Regional Kendall test for entire study areas  
Incorporating both seasonal and regional patterns  
Adjustments for serial correlation

Applications of analysis and modeling to attendees' data  
Putting attendees' data in to R  
Evaluating ACFs, PACFs of users' data  
Determining a best fit model  
Group discussion