Module 2

Measuring Environmental Change

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1 Overview

```
#| '!! shinylive warning !!': |
#|   shinylive does not work in self-contained HTML documents.
#|   Please set `embed-resources: false` in your metadata.
#| standalone: true
#| viewerHeight: 500
library(shiny)


# Function to generate block maxima
generate_max <- function(N, n, rdist, param, a, b, seed=pi){
  set.seed(seed)
  Mn <- numeric(N)
  for(i in 1:N){
    sample <- rdist(n, param[1], param[2])
    Mn[i] <- (max(sample) - b) / a
  }
  return(Mn)
}

# UI
iu <- fluidPage(
  titlePanel("Block Maxima Simulation"),
  sidebarLayout(
    sidebarPanel(
      selectInput("dist", "Choose Distribution:", choices = c("Uniform(0,1)" = "uniform", "E
      sliderInput("n", "Observations per Block (n):", min = 5, max = 100, value = 5, step =
      sliderInput("N", "Number of Blocks (N):", min = 10000, max = 50000, value = 50000, ste
    ),
    mainPanel(
      plotOutput("histogram")
    )
  )
)

# Server
server <- function(input, output) {
  output$histogram <- renderPlot({
    if (input$dist == "uniform") {
      a <- 1 / input$n
      b <- 1
      Mn <- generate_max(input$N, input$n, runif, c(0,1), a, b)
      true_gev <- function(x) evd::dgev(x, loc = -1, scale = 1, shape = -1)
    } else {
      a <- 1
```

```
    b <- log(input$n)
    Mn <- generate_max(input$N, input$n, rgamma, c(1,1), a, b)
    true_gev <- function(x) evd::dgev(x, loc = 0, scale = 1, shape = 0)
  }

  hist(Mn, breaks = "FD", col = "lightblue", prob = TRUE, main = "Histogram of Block Maxim
  curve(true_gev, col = "red", lwd = 2, add = TRUE)
 })
}

# Run App
shinyApp(ui = iu, server = server)
```

This module provides the foundational principles and practical skills for processing, evaluating, and interpreting environmental and ecological data. It begins by contextualizing the role of statistics in environmental science, using contemporary news and research to illustrate how quantitative evidence informs public discourse and policy. The core of the module focuses on characterizing and managing the inherent uncertainty, variability, and common issues found in environmental and ecological data — such as censored data, outliers, and missing values—found in empirical datasets. We will also revise some core statistical concepts and look further into how environmental data is sourced, from different sampling strategies to monitoring network design.

2 Course Structure

This course provides an appreciation of the application of statistical methods and concepts to problems in *Environmental and Ecological Sciences*.

The course consists of 3 modules divided into weeks - this is primarily to help you find the relevant material easily.

Module	Week	Topic
Environmental Monitoring & Data processing	1	Introduction to Environmental Statistics
	2	Understanding our Data
	3	Sampling and Monitoring Networks
Measuring Environmental Change	4	Assessing Change Over Time
	5	Temporal Correlation and Changepoints
	6	Modelling Environmental Extremes
Spatial Ecology and Conservation Modelling	7	Introduction to Spatial Ecology
	8	Species Distribution Modelling
	9	Methods for Complex Ecological Data

2.1   Lectures

There will be two - 1 hr lectures per week

- **Tuesday 12** noon (Wolfson Medical School:253 Seminar 1-Yudo)

- **Wednesday 9am** (Maths and Stats:116 Lecture Theatre).

> **i** Note
>
> *Lectures will be recorded if the room's technology allows them to be.*

2.2   Tutorials

In addition, there will be **four** tutorials for this course. There are two tutorial groups - please check on MyCampus which one you are in.

3   Tutorial Group 1 - Monday 10am

Tutorial groups:

- STATS 4009 - TU01 (23738)

- STATS 5031 - TU01 (24174)

Venue:

Adam Smith: 281

Tutorial dates:

1. 26-Jan-2026

2. 09-Feb-2026

3. 23-Feb-2026

4. 09-Mar-2026

4   Tutorial Group 2- Wednesday 12 noon

Tutorial groups:

- STATS 4009 - TU02 (23739)

- STATS 5031 - TU02 (24175)

Venue:

Joseph Black Building:C407 Agricultm

Tutorial dates:

1. 28 -Jan-2026

2. 11-Feb-2026

3. 25-Feb-2026

4. 11-Mar-2026

> **!** Important
>
> *You are expected to have attempted the exercise sheets before the tutorial - they will be available in advance.*

4.1 Labs

There will be three labs taking place in Boyd Orr Building:418 Lab from **15:00-17:00pm** on the following dates (clicking on the date will direct you to the lab material):

1. Lab session 1 - Jan 30th
2. Feb 27th
3. March 13th

5 Assessments

Assessment in this course includes continuous assessment and a final exam. The exam will take place in April/May.

- *Level H* students will have a **Group Report** worth 25% and a final exam worth 75%.
- *Level M* students will have a **Group Report** worth 25%, a **critique** worth 10% and a final exam worth 65%.