Master Environmental Sciences and Engineering

Applied Ecology

Data analysis

12/11/2024

Structure of the report

Page 1: Title, name of the students, group # and abstract (max. 200 words). The abstract should say (1) the research conducted, including the rationale, (2) methods, (3) key results, and (4) the main conclusion, including the key points of discussion. It should not contain citations.

Example of a 200 words abstract

Research

New Phytologist

Can we predict carbon stocks in tropical ecosystems from tree diversity? Comparing species and functional diversity in a plantation and a natural forest

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• Linking tree diversity to carbon storage can provide further motivation to conserve tropical forests and to design carbon-enriched plantations. Here, we examine the role of tree diversity and functional traits in determining carbon storage in a mixed-species plantation and in a natural tropical forest in Panama.

• We used species richness, functional trait diversity, species dominance and functional trait dominance to predict tree carbon storage across these two forests. Then we compared the species ranking based on wood density, maximum diameter, maximum height, and leaf mass per area (LMA) between sites to reveal how these values changed between different forests.

• Increased species richness, a higher proportion of nitrogen fixers and species with low LMA increased carbon storage in the mixed-species plantation, while a higher proportion of large trees and species with high LMA increased tree carbon storage in the natural forest. Furthermore, we found that tree species varied greatly in their absolute and relative values between study sites.

• Different results in different forests mean that we cannot easily predict carbon storage capacity in natural forests using data from experimental plantations. Managers should be cautious when applying functional traits measured in natural populations in the design of carbon-enriched plantations.

Structure of the report

Pages 2-7: Should follow the structure:

- Introduction (state of the art, objectives and hypotheses; use references) *about 1.5 pages*
- Methods (describe methods, sites and statistics briefly so that someone can reproduce the study; you can cite references to avoid describing methods in too much detail) *about 1.5 pages*
- Results (describe the results, including giving the significant differences) *about 1 page*
- Discussion (discuss the results as a whole, use references, explain the meaning of your findings for forest management purposes) *about 2 pages*
- Conclusions (state the main finding and suggest avenues for future work) *about 0.5 page*

--> Include the reference list and annexes after the 7 pages

Recap of measurements

- Potential biodiversity indice (IBP)
- DBH, tree height, species name
- Aboveground wood production (to be calculated now)
- Soil pH
- Plot LAI
- Dendro-microhabitats

Recap of report guidelines

- **Grading of the report (50% of the total grade with 50/50 ratio for the whole group and your individual contribution to the work):** You will be evaluated based on the description of the context (literature review), the presentation of the methods and results (methods and results are separated parts) and the discussion (use the literature to place the results in a wider context by explaining the consequences of the results).

- The report should not exceed 7 pages, excluding the references, and should not have more than 4 figures.

- In the report, students need to explain their individual contribution (group choice).

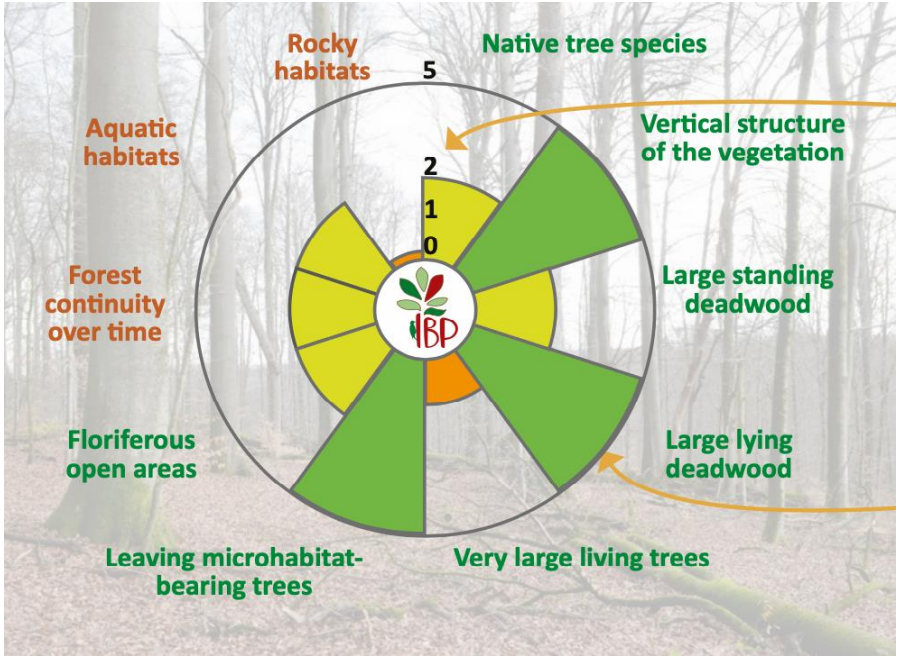
- Deadline: Latest the last day of the course (17/12/2024), you need to send your reports to the teachers

Data replication

- All groups selected 1 plot of 10 x 10 m in each forest type (2 plots per group in total)
- **Today**: upload your data on Moodle so that all students can use them for the analyses (to increase sample size)
- Plots can be treated as replicates (n=10) for the measurements (e.g. LAI, pH, tree density)

Calculate the IBP score

- Each group has to calculate their IBP score of the monoculture and the mixed plot. The data does not need to be uploaded on Moodle as it should be the same for all groups.
- Use the excel sheet and follow the guidelines given on moodle for the calculation of the IBP



Please come talk to us if you have problems with the file

Structure your data before you upload!

1. Make columns for (1) the date, (2) your group number, (3) mixed vs. pure stand, (4) tree number or ID, (5) tree species (latin name, so all have the same names, don't mix "hêtre" with "fagus")
2. Every measurement in one excel column: (1) tree height, (2) DBH, etc.
3. The measurements that were done once per plot can just be repeated (e.g. LAI 4.07 for Pure stand in Group 1 can be entered for all the trees in the table, same goes for pH)

Structure your data before you upload!

Example Excel sheet:

Date	Group	Site	Tree_ ID	Species	Height	DBH	pH	LAI
9.10.2024	1	Pure	1	Picea abies	17.5	38	4.3	4.07
9.10.2024	1	Pure	2	Picea abies	24.5	45	4.3	4.07
9.10.2024	1	Pure	3	Castanea sativa	23.0	34	4.3	4.07
9.10.2024	1	Mixed	1	Fagus sylvatica	13.2	29	4.8	2.74
15.10.2024	1	Mixed	2	Abies alba	26.6	53	4.8	2.74
15.10.2024	1	Mixed	3	Picea abies	21.3	37	4.8	2.74

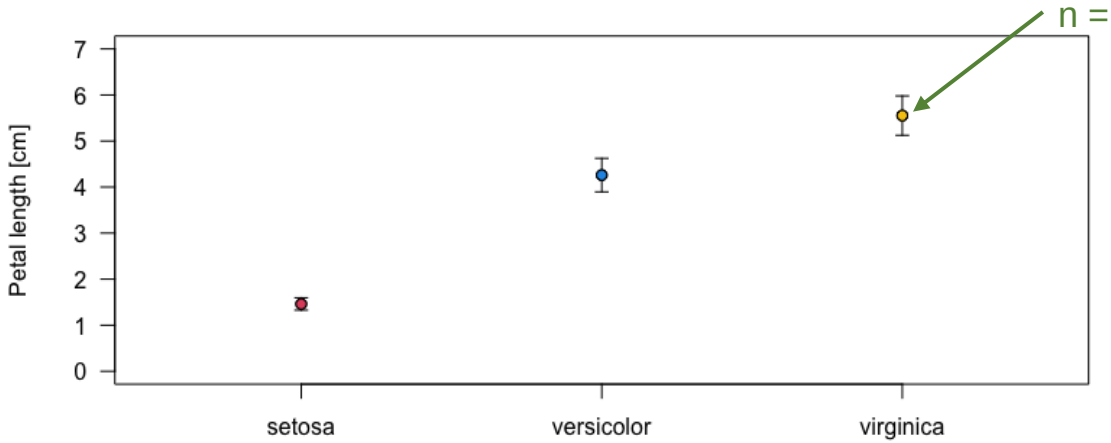
Save as excel file with your group name → Upload on Moodle

Calculate aboveground biomass

- After downloading the excel files of all group members, merge them into one file
- Now you can do calculations and analyses!
- Use the literature provided on moodle to find suitable formula to calculate aboveground biomass for all your tree species, and apply them

Descriptive statistics

Don't show all data points, but means and standard errors:



Iris versicolor

Iris setosa

Iris virginica

→ s.e. provides a "gut feeling" of differences, but is not a statistical test

Descriptive statistics

Don't show all data points, but means and standard errors:

For instance, to summarise by plot and site

Use the summarise function from the dplyr package with the following code:

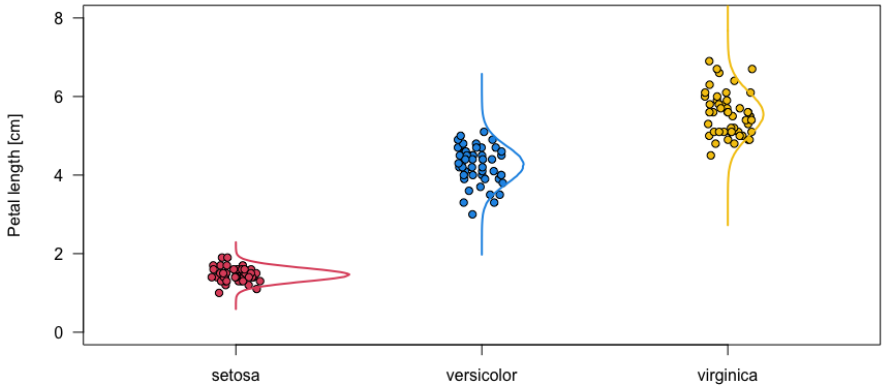
```
install.packages("dplyr")
library(dplyr)

my_data_agg <- my_data %>%
 group_by(Plot, Site) %>%
 summarise(n = n(),
        height_m = mean(height, na.rm=T),
        height_se = se(height, na.rm=T)/sqrt(n),
                DBH_m = mean(DBH, na.rm=T),
        DBH_se = se(DBH, na.rm=T)/sqrt(n))
```

This is an example with R, but you can use any language/software for doing the stats

Group comparisons

Use ANOVA to compare two or more groups (e.g. mixture vs. monoculture or tree species)

```
> mymodel <- aov(Petal.Length ~ Species, data=iris)
> summary(model)

             Df  Sum Sq  Mean Sq  F value   Pr(>F)
Species       2  437.1   218.55     1180   <2e-16 ***
Residuals   147   27.2     0.19
```



The probability that the measured difference between the species is observed by chance is very small.

So, the species probably differ. But all of them? We don't know with this anova.

Group comparisons

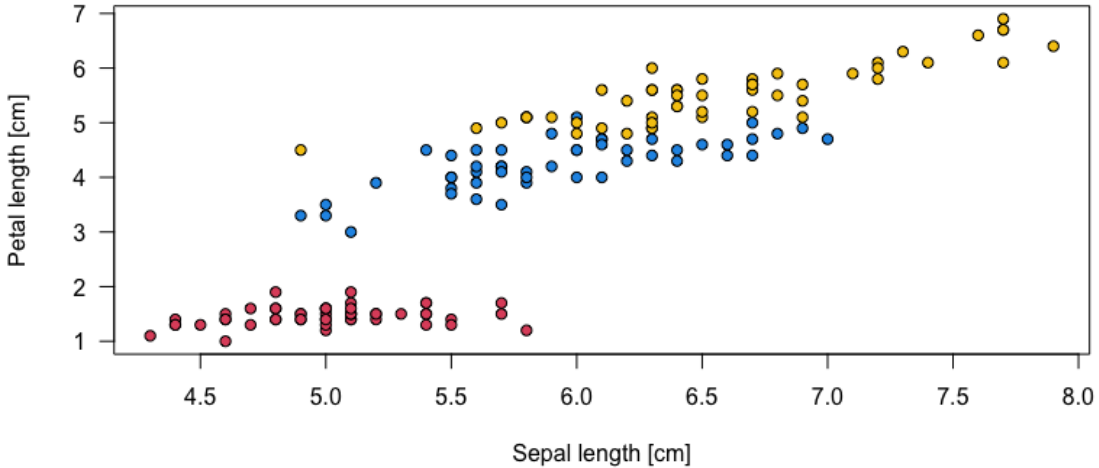
Testing the differences between forest types by considering the effect of the plots as random effects

```
# Open data file
data <- read.csv("your_data_file.csv")

# Fit a linear mixed-effects model
model <- lmer(TreeBiomass ~ ForestType + Species + (1 | Plot), data = data)

# View the summary of the model
summary(model)

# Test the effect of ForestType
anova(model)
```

This is an example with R, but you can use any language/software for doing the stats

Correlation of measurements

You can show relationships between measurements to look into potentially drivers of specific patterns



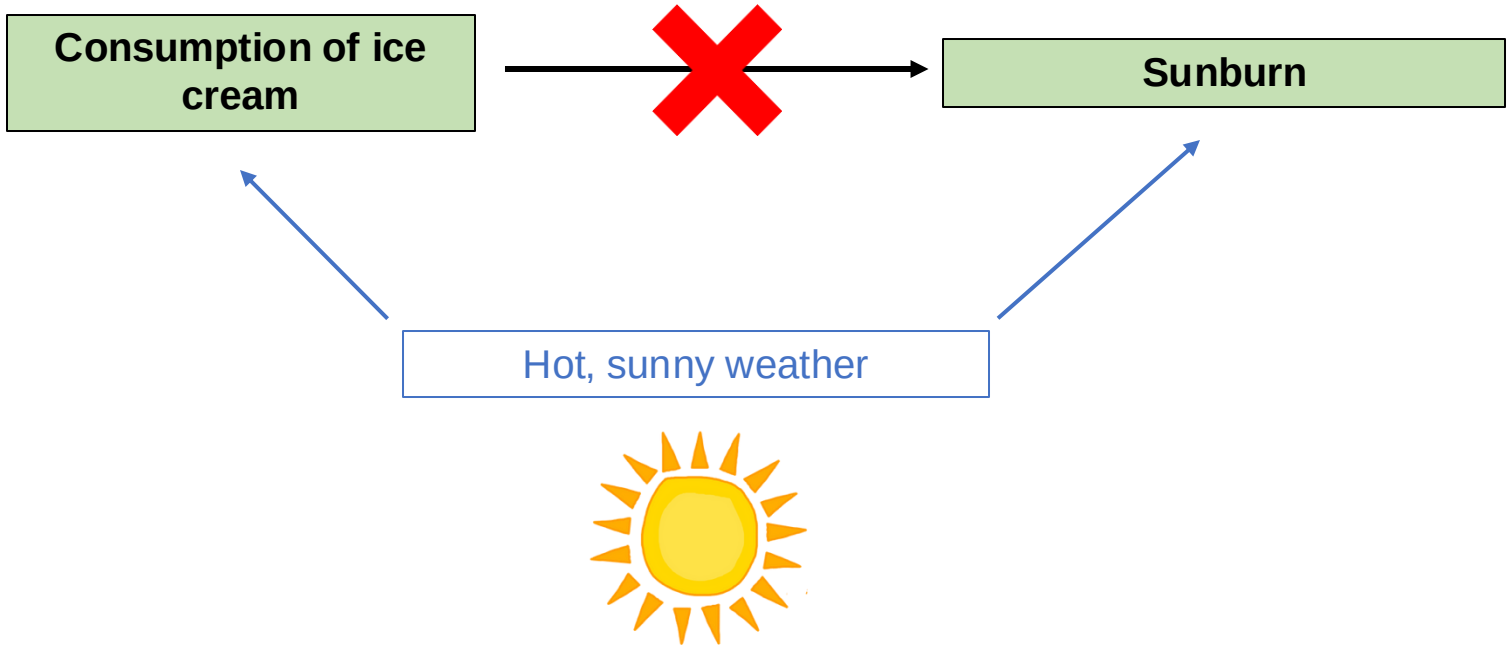

```
> cor(my_data$my_measurements1,
  my_data$my_measurements2)

[1] 0.8717538

> cor.test(my_data$my_measurements1,
  my_data$my_measurements2,
  method = "pearson")

t = 21.646, df = 148, p-value < 2.2e-16
```

→ no causality inferred! Both measurements might be related to something else (fertilisation, species, etc.)

Correlation of measurements

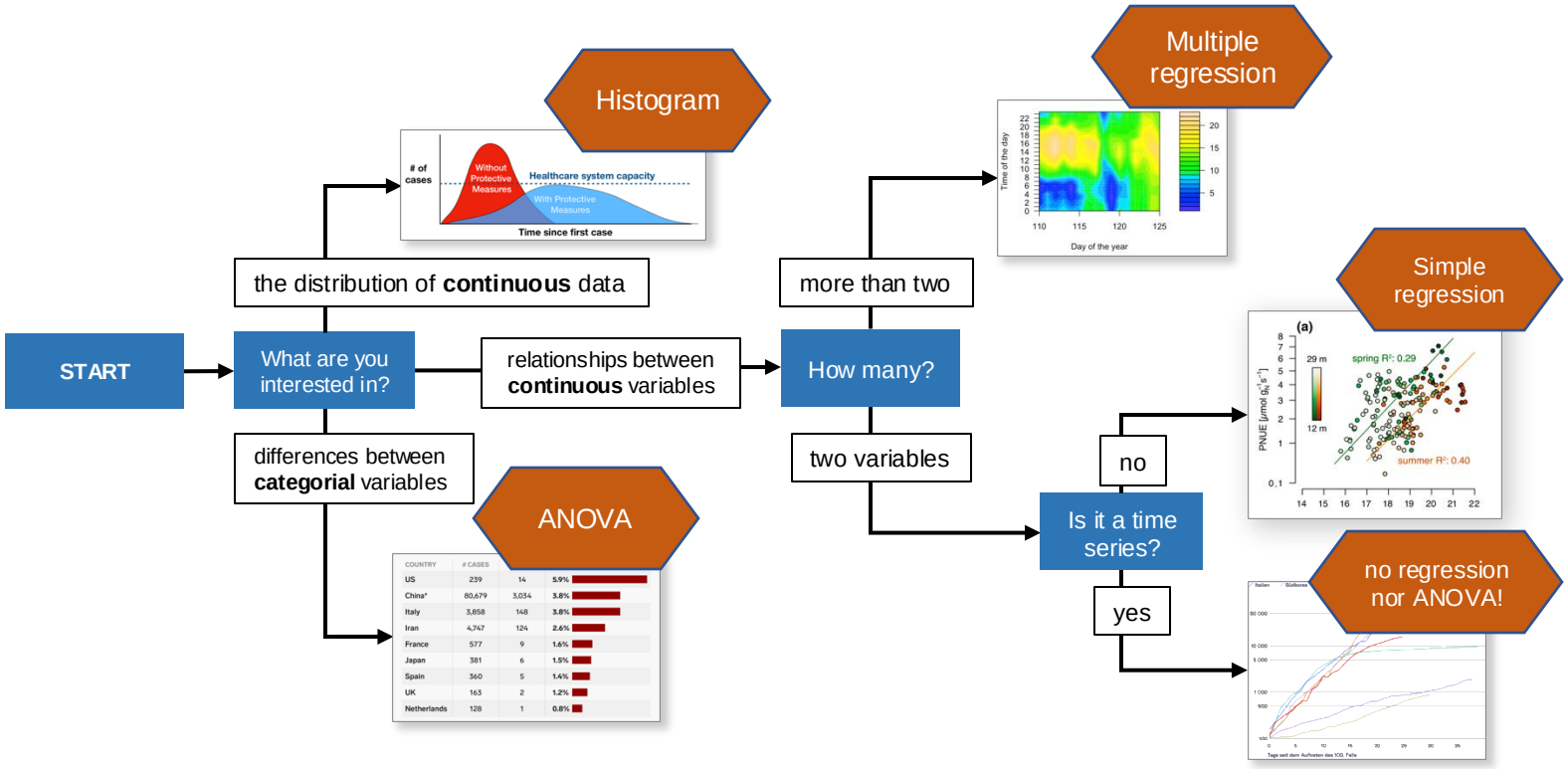
Confounding effect

No direct causal link between predictor and response!



What figure to chose?

→ https://r-graph-gallery.com



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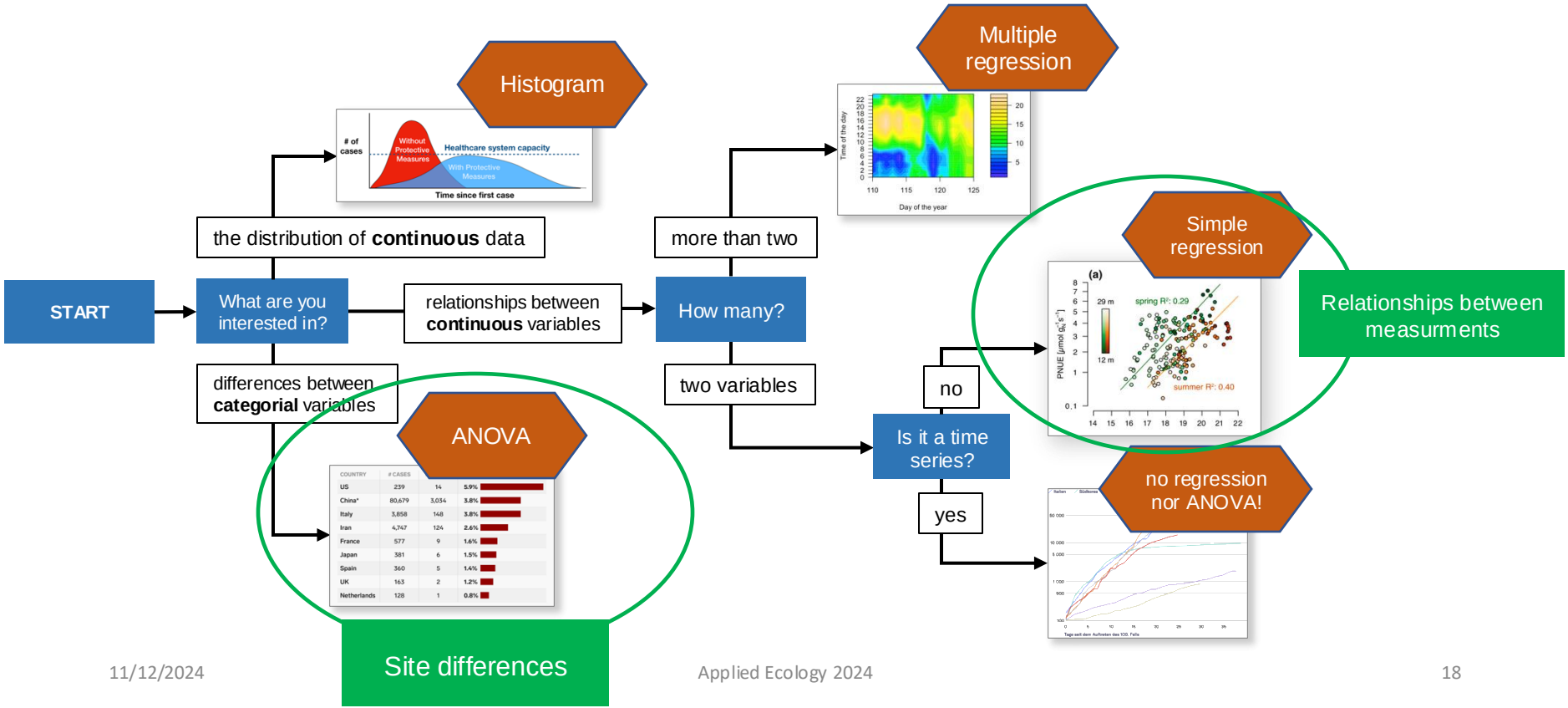

Schedule of the lectures

Date	Time	Topic	Week	Location
10/9/24	8-12h	Introduction	1	CHB 330
17/09/2024	8-12h	Presentation of cases 1, 2 and 3	2	CHB 330
24/9/2024	8-12h	Presentation of cases 4, 5, and 6	3	CHB 330
1/10/24	8-12h	Excursion to Lausanne	4	Lausanne
8/10/24	8-12h	Field work #1	5	Field
15/10/2024	8-12h	Field work #2	6	Field
22/10/2024	**HOLIDAYS**			
29/10/2024	8-12h	Lab work #1	7	GR B2 423
5/11/24	8-12h	Excursion to Suchy	8	CHB 330
12/11/24	8h30-10h 10-12h	Presentation by Massimiliano Probo (1h30) Data Analyses I	9	CHB 330
19/11/2024	8h30-10h 10-12h	Excursion EPFL Energy plateform (1.5 h) Data Analyses II	10	CHB 330
26/11/2024	8h30-10h 10-12h	Excursion EPFL Energy plateform (1.5 h) Work on Presentation & report I	11	CHB 330
3/12/24	8-12h	Work on Presentation & report II	12	CHB 330
10/12/24	8-12h	Student presentations I	13	CHB 330
17/12/2024	8-12h	Student presentations II	14	CHB 330

Excursion 3 + data analyses

Students will be separated into two groups to visit the thermal power plant (**Groups 1-5 on 19/11**).

We will meet at 8:30 near the pumping stations next to the lake.