

Gather soil and topography data

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```
# setup -----

library(tidyverse)

## -- Attaching core tidyverse packages ----- tidyverse 2.0.0 --
## v dplyr      1.1.4      v readr      2.1.6
## v forcats    1.0.1      v stringr   1.6.0
## v ggplot2    4.0.1      v tibble    3.3.0
## v lubridate  1.9.4      v tidyr     1.3.2
## v purrr      1.2.0
## -- Conflicts ----- tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()     masks stats::lag()
## i Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to become errors

library(soilDB)
library(aqp)

## This is aqp 2.2-1
##
## Attaching package: 'aqp'
##
## The following objects are masked from 'package:dplyr':
##
##      combine, slice

library(terra)

## terra 1.8.86
##
## Attaching package: 'terra'
##
## The following object is masked from 'package:tidyr':
##
##      extract

points <- read_csv("map/coords.csv") |>
  select(1:3) |>
  rename(id = site, lat = Latitude, lon = Longitude)
```

```
## Rows: 28 Columns: 4
## -- Column specification -----
## Delimiter: ","
## chr (2): site, category
## dbl (2): Latitude, Longitude
##
## i Use `spec()` to retrieve the full column specification for this data.
## i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```
# soil -----
```

Downloading SoilGrids data takes time, uncomment to run and save data.

```
# soil <- fetchSoilGrids(points, verbose = T)
#
# saveRDS(soil, "soilgrids.rds")

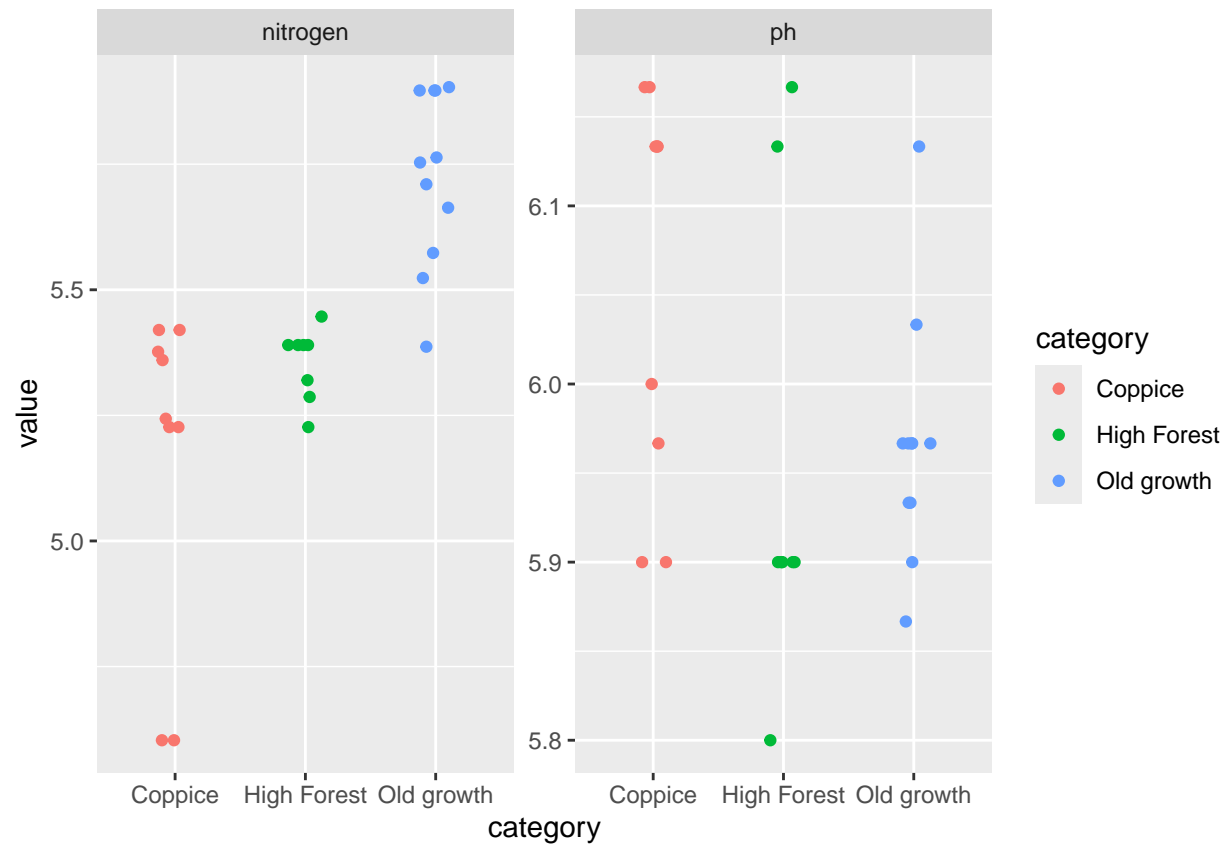
soil <- readRDS("soilgrids.rds")

summary <- horizons(soil) |>
  select(label, id, nitrogenmean, phh2omean) |>
  filter(label %in% c("0-5", "5-15", "15-30")) |>
  group_by(id) |>
  summarise(nitrogen = mean(nitrogenmean), ph = mean(phh2omean))

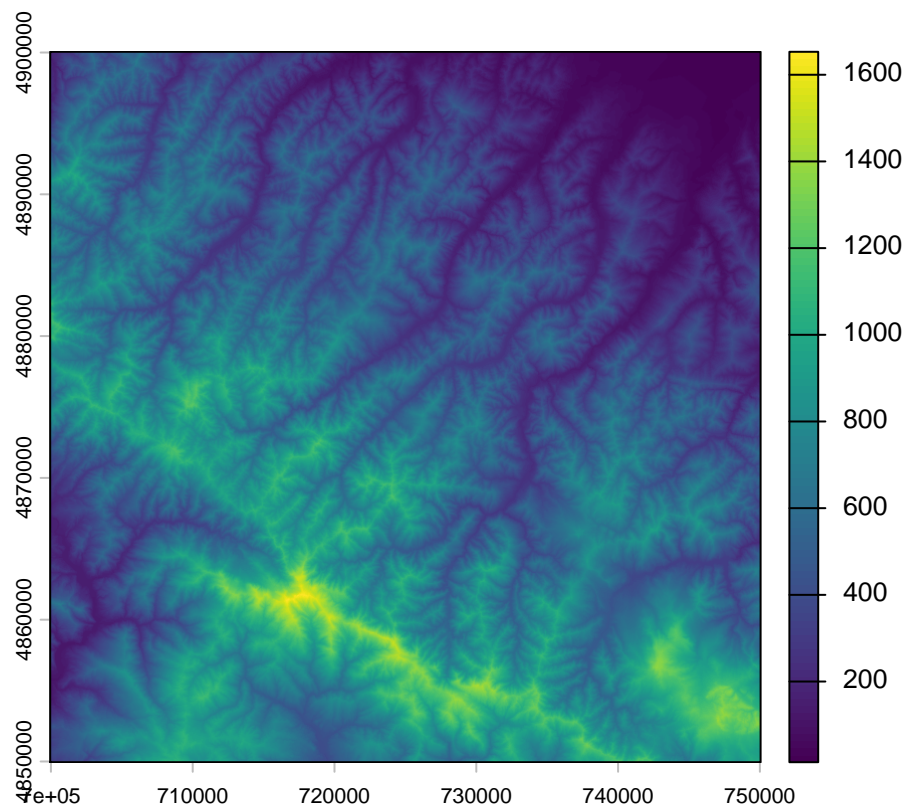
sites <- read_csv("data/classification.csv") |>
  left_join(summary, by = join_by(site == id)) |>
  drop_na()
```

```
## Rows: 32 Columns: 2
## -- Column specification -----
## Delimiter: ","
## chr (2): site, category
##
## i Use `spec()` to retrieve the full column specification for this data.
## i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

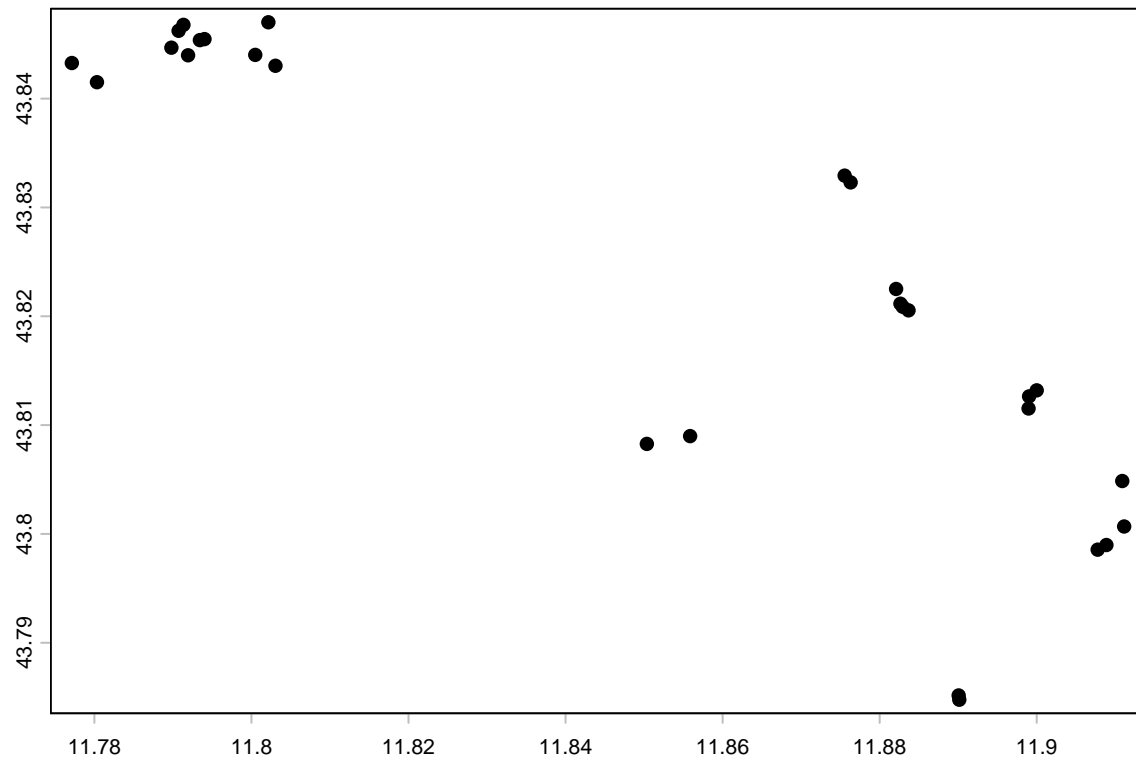
```
sites |>
  pivot_longer(c(nitrogen, ph), names_to = "variable", values_to = "value") |>
  ggplot(aes(x = category, y = value, color = category))+
  #geom_boxplot()+
  geom_point(position = 'jitterdodge')+
  facet_wrap(~variable, scales = 'free_y')
```



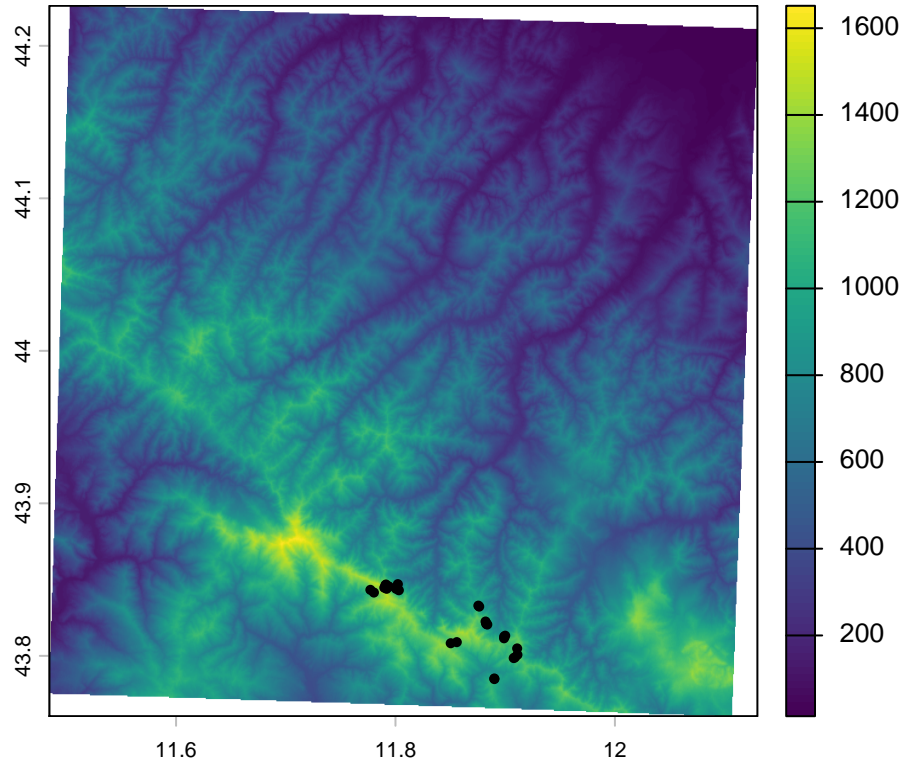
```
# topography -----
dtm_casentino <- rast("map/DTM/w48570_s10/w48570_s10.tif")
plot(dtm_casentino)
```



```
v <- vect(points, crs = "WGS84")  
plot(v)
```



```
WGS84 <- "+init=EPSG:4326"  
dtm_casentino<- terra::project(dtm_casentino, WGS84) #reprojecting to epsg:4326#  
plot(dtm_casentino)  
points(v)
```



```
slope <- terrain(dtm_casentino, v = "slope", unit = "degrees")
aspect <- terrain(dtm_casentino, v = "aspect", unit = "degrees")

altitude <- extract(dtm_casentino, v, ID=F, bind=T) |>
  values() |>
  rename(site = 1, altitude = 2)

slope <- extract(slope, v, ID=F, bind=T) |>
  values() |>
  rename(site = 1, slope = 2)

aspect <- extract(aspect, v, ID=F, bind=T) |>
  values() |>
  rename(site = 1, aspect = 2)

sites <- sites |>
  left_join(altitude) |>
  left_join(slope) |>
  left_join(aspect)

## Joining with `by = join_by(site)`
## Joining with `by = join_by(site)`
## Joining with `by = join_by(site)`
```

```
print(sites, n = 50)
```

```
## # A tibble: 28 x 7
##   site category    nitrogen    ph altitude slope aspect
##   <chr> <chr>         <dbl> <dbl>    <dbl> <dbl> <dbl>
## 1 T1    Coppice         4.60  6.17     991.   18.0  302.
## 2 T2    Coppice         4.60  6.17    1001.   21.5  305.
## 3 T3    High Forest      5.29  6.17    1208.   14.7  283.
## 4 T4    High Forest      5.32  6.13    1269.   20.0   47.3
## 5 T5    Old growth       5.66  6.03    1212.   29.9  212.
## 6 T6    Old growth       5.52  6.13    1178.   36.4  203.
## 7 T7    Old growth       5.75  5.9     1393.   26.0  105.
## 8 T8    Old growth       5.71  5.97    1416.   26.3   96.5
## 9 T9    Old growth       5.76  5.97    1463.   35.4   74.4
## 10 T10   Coppice          5.42  6.13    1172.   24.9  187.
## 11 T11   Coppice          5.42  6.13    1195.   23.8  190.
## 12 T12   Old growth       5.90  5.97    1378.   30.4   79.1
## 13 T13   Old growth       5.90  5.97    1288.   25.1  117.
## 14 T14   Old growth       5.90  5.97    1272.   25.5  105.
## 15 T18   High Forest      5.39  5.9     1033.   14.2  115.
## 16 T19   High Forest      5.39  5.9     1040.   13.0  105.
## 17 T20   High Forest      5.39  5.9     1015.   14.4  124.
## 18 T21   High Forest      5.23  5.9     1049.   24.0  344.
## 19 T22   Coppice          5.23  5.9     1002.   23.9  359.
## 20 T23   Coppice          5.23  5.9     1006.   22.9  272.
## 21 T24   Coppice          5.38  6       1231.   22.5   47.9
## 22 T25   High Forest      5.45  5.8     1184.   17.4  227.
## 23 T26   Coppice          5.36  5.97    1068.   10.6  292.
## 24 T27   Coppice          5.24  6.13    1078.   34.4  120.
## 25 T28   High Forest      5.39  5.9     1045.   16.3  121.
## 26 T29   Old growth       5.90  5.93     962.   22.5  116.
## 27 T30   Old growth       5.57  5.93     983.   24.7  157.
## 28 T31   Old growth       5.39  5.87     923.   27.9   42.3
```

```
write_csv(sites, "other results/sitetype.csv")
```

```
# summary -----
```

```
library(circular)
```

```
##
## Attaching package: 'circular'
##
## The following objects are masked from 'package:stats':
##
##   sd, var
```

```
summary <- sites |>
  mutate(aspect = as.circular(aspect, units = "degrees", type = "angles",
                              template = "none", modulo = "2pi", zero = 0,
                              rotation = "clock")) |>
  group_by(category) |>
```

```

    summarise(across(c(nitrogen:slope), list(mean = mean, sd = sd)),
              aspect_mean = mean.circular(aspect),
              aspect_sd = sd.circular(aspect))

glimpse(summary)

## Rows: 3
## Columns: 11
## $ category      <chr> "Coppice", "High Forest", "Old growth"
## $ nitrogen_mean <dbl> 5.164444, 5.355000, 5.724242
## $ nitrogen_sd   <dbl> 0.32740563, 0.07138094, 0.17454125
## $ ph_mean       <dbl> 6.055556, 5.950000, 5.966667
## $ ph_sd         <dbl> 0.11303883, 0.12848321, 0.06992059
## $ altitude_mean <dbl> 1082.593, 1105.436, 1224.417
## $ altitude_sd   <dbl> 93.69086, 98.44995, 192.73518
## $ slope_mean    <dbl> 22.48391, 16.75765, 28.19986
## $ slope_sd      <dbl> 6.274834, 3.659278, 4.428776
## $ aspect_mean   <circular> 287.3575, 104.0401, 113.7978
## $ aspect_sd     <dbl> 1.6280338, 1.5571589, 0.8854249

write_csv(summary, "other_results/sitesummary.csv")

# session info -----

sessionInfo()

## R version 4.5.2 (2025-10-31)
## Platform: x86_64-redhat-linux-gnu
## Running under: Nobara Linux 43 (KDE Plasma Desktop Edition)
##
## Matrix products: default
## BLAS/LAPACK: FlexiBLAS OPENBLAS-OPENMP; LAPACK version 3.12.1
##
## locale:
##  [1] LC_CTYPE=it_IT.UTF-8      LC_NUMERIC=C
##  [3] LC_TIME=it_IT.utf8       LC_COLLATE=it_IT.UTF-8
##  [5] LC_MONETARY=it_IT.utf8   LC_MESSAGES=it_IT.UTF-8
##  [7] LC_PAPER=it_IT.utf8      LC_NAME=C
##  [9] LC_ADDRESS=C             LC_TELEPHONE=C
## [11] LC_MEASUREMENT=it_IT.utf8 LC_IDENTIFICATION=C
##
## time zone: Europe/Rome
## tzcode source: system (glibc)
##
## attached base packages:
## [1] stats      graphics  grDevices  datasets  utils      methods    base
##
## other attached packages:
##  [1] circular_0.5-2 terra_1.8-86  aqp_2.2-1    soilDB_2.8.13
##  [5] lubridate_1.9.4 forcats_1.0.1 stringr_1.6.0 dplyr_1.1.4
##  [9] purrr_1.2.0   readr_2.1.6  tidyr_1.3.2  tibble_3.3.0
## [13] ggplot2_4.0.1 tidyverse_2.0.0
##

```



```
## loaded via a namespace (and not attached):
## [1] utf8_1.2.6      generics_0.1.4  stringi_1.8.7   lattice_0.22-7
## [5] hms_1.1.4       digest_0.6.39  magrittr_2.0.4  evaluate_1.0.5
## [9] grid_4.5.2      timechange_0.3.0 RColorBrewer_1.1-3 mvtnorm_1.3-3
## [13] fastmap_1.2.0   ape_5.8-1      DBI_1.2.3       scales_1.4.0
## [17] CoprManager_0.5.7 codetools_0.2-20 cli_3.6.5       crayon_1.5.3
## [21] rlang_1.1.6     bit64_4.6.0-1  withr_3.0.2     yaml_2.3.12
## [25] tools_4.5.2     parallel_4.5.2 tzdb_0.5.0      colorspace_2.1-2
## [29] boot_1.3-32     curl_7.0.0     vctrs_0.6.5     R6_2.6.1
## [33] lifecycle_1.0.4 bit_4.6.0      vroom_1.6.7     cluster_2.1.8.1
## [37] pkgconfig_2.0.3 pillar_1.11.1  gtable_0.3.6    glue_1.8.0
## [41] data.table_1.18.0 Rcpp_1.1.0     xfun_0.55       tidyselect_1.2.1
## [45] rstudioapi_0.17.1 knitr_1.50     farver_2.1.2    htmltools_0.5.9
## [49] nlme_3.1-168    labeling_0.4.3 rmarkdown_2.30  compiler_4.5.2
## [53] S7_0.2.1
```