Step 2.1 Deriving slope from DEM

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2025-10-31

Contents

1 Objectives

This script aims to **compute a slope raster (in degrees) from a Digital Elevation Model**, which can then be used as a predictor in habitat modeling workflows.

Slope is a potentially important explanatory variable for habitat distribution, for several reasons:

- **Microclimate influence**: Steeper slopes can have different exposure to sunlight and water, affecting temperature, humidity, and other environmental factors.
- **Water drainage**: Areas with higher slopes often have more efficient drainage, influencing water availability for vegetation.
- **Habitat specificity**: Some habitats are closely associated with particular slope conditions. For instance, certain plant or animal species may prefer gentle or steep slopes depending on their ecological requirements.
- **Interaction with other variables**: Slope may interact with other environmental variables to shape habitat distribution. For example, slope and elevation together can have compounded effects on species patterns.

2 Script explanation

2.1 Clean environment and graphics

```
rm(list = ls()) # Clear all objects from the R environment to start fresh
graphics.off()   # Close all graphics devices (if any plots are open)
```

2.2 Load required packages

```
library(terra) # For raster manipulation and terrain analysis
```

2.3 Define global variables

Note: A global variable is a variable defined outside of any function. This means the variable is accessible from any part of the code, including inside functions. A global variable retains its value throughout the execution of the R script unless it is explicitly modified in the code.

It is important to define at a minimum:

- the `"District"`: the archipelago of interest (e.g. “CRO” for Crozet archipelago)
- the `"Island"`: the island within the archipelago of interest (e.g. “POS” for Possession island)
- the `"Satellite2"`: the name of satellite providing digital elevation model (DEM)
- the `"Year2"`: the acquisition year of the DEM
- the `"Res2"`: the resolution of DEM

```
District='CRO' # 3-letter code for archipelago (e.g. Crozet)
Island='POS'   # 3-letter code for island (e.g. Possession)
Satellite2="SRTM" # Satellite name of DEM
Year2="2012" # Acquisition year of DEM
Res2="30m"  # Spatial resolution of DEM
```

2.4 Set working directory

You must define a general root directory (`"localHOME"`) that serves as the base path for your input and output data. This directory should point to the local environment where:

- input DEM imagery is located under `"data/raster/Precut_image`
- output slope imagery will be saved under `"data/raster/Precut_image`

```
# Base local path (customize to your local environment)
#localHOME = paste0("your_local_path/")
localHOME=paste0("/home/genouest/cnrs_umr6553/despel/CARTOVEGE/")

# Path to open input dem raster
open_precut_raster_path=paste0(localHOME,"data/raster/Precut_image")

# Path to save slope raster
save_precut_raster_path=paste0(localHOME,"data/raster/Precut_image")
```

2.5 Load Digital Elevation Model (DEM)

```
print("Loading pre-cut DEM raster")
dtm <- rast(paste0(open_precut_raster_path,"/",
                   District,"_",Island,"_",Satellite2, "_",Year2,"_",Res2, "_dtm_precut.tif"))
```

2.6 Derive slope from DEM values

The 'terrain()" function is used to calculate slope from a Digital Elevation Model:

- `v = "slope"` specifies that the variable to compute.
- `unit = "degrees"` defines the output unit for the slope values. By default, the slope is expressed in degrees, but this can be changed depending on your preference—common options include "degrees" or "percent".
- `neighbors = 8` here indicates that the slope should be calculated based on 8 surrounding pixels (the full neighborhood around each cell). This parameter can be adjusted depending on the desired sensitivity and context of analysis.

  You can specify how many neighboring cells to use when computing slope or aspect using the neighbors parameter:

  - **8** (queen case): Includes all 8 neighboring cells around the target pixel — both adjacent and diagonal. This configuration is known as the queen case, similar to the queen's movement in chess, which allows movement in all directions. It provides a more comprehensive estimation by considering the full neighborhood.
  - **4** (rook case): Includes only the 4 directly adjacent cells (up, down, left, right), excluding diagonals. This is referred to as the rook case, akin to the rook's movement in chess. It offers a more simplified analysis, which may be preferable in some contexts to reduce computational noise.

```
# Compute slope in degrees (default output is % slope if not specified)
print("Slope computing")
slope <- terrain(dtm, v = "slope",unit="degrees", neighbors=8)


# save slope raster
slope_file <- paste0(save_precut_raster_path,"/",
                     District,"_",Island,"_",Satellite2, "_",Year2,"_",Res2, "_slope_precut.tif")
writeRaster(slope, filename = slope_file)
```

This script computes the terrain slope (in degrees) from a pre-cut DEM raster and saves the resulting slope map as a GeoTIFF.