

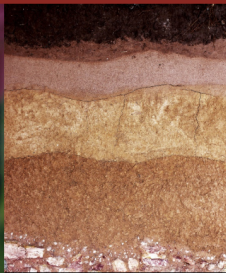
DSM 2025

Workshop: Evaluating Digital Soil Maps by their patterns

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Workshop objectives

1. Become familiar with the concept of “**spatial patterns**”
2. Become familiar with statistical methods to **describe** spatial patterns
3. Become familiar with concepts of **aggregation** and **segmentation**
4. Become familiar with **R packages** for pattern description, comparison and aggregation
5. *Optional* Become familiar with the geopat2 Unix program for pattern-based segmentation
6. Consider what it means for a DSM product to represent “**true**” **spatial patterns** of soil properties and map units at different cartographic and categorical scales.

Workshop structure

1. Brief **presentation** of the problem and some approaches to addressing it
2. Tutorial **setup**: packages, directories, input maps
3. Exercise and discussion: Characterizing the **pattern of single maps: continuous**
4. Exercise and discussion: Characterizing the **pattern of single maps: classified**
5. Exercise and discussion: **Aggregation** by the supercells package
6. *Optional* Exercise and discussion: **Pattern-based segmentation** with the geopat Unix program
7. Discussion! the relation to **'reality'**

Preparation

Prior to the workshop:

1. Make sure R and R Markdown are installed and functioning properly.
2. Install the required packages; you can do this by sourcing the script `InstallWorkshopPackages_2025.R`
3. Decide on a data source (see next).
 - If you decide to use your own data, prepare the GeoTIFF as explained next
 - If you decide to use the example SoilGrids tile, it will be provided at the workshop.
4. *Optional* For segmentation, Install GeoPAT from <https://github.com/Nowosad/geopat2>

Data sources

- Option 1 Preferred** Bring your own gridded map of soil properties, in an area where you are familiar with the “true” soil landscape pattern
- Pick an area with contrasting patterns of values, not necessarily of the range of values
 - Size $\approx 480 \times 480$ pixels, covering about $1^\circ \times 1^\circ$
 - Format as a multi-layer GeoTIFF.
- Option 2** Prepare a multi-layer $1^\circ \times 1^\circ$ GeoTIFF of your area of interest, from SoilGrids v2.0 (see next slide)
- Option 3** Use the prepared multi-layer $1^\circ \times 1^\circ$ GeoTIFF of an area in Tamil Nadu, from SoilGrids v2.0 (supplied at the workshop)

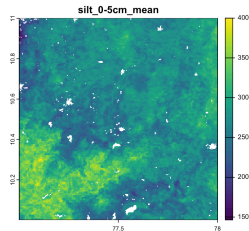
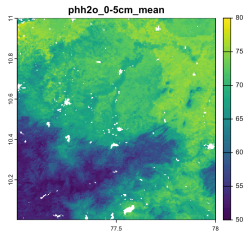
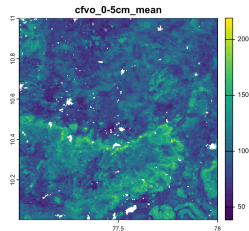
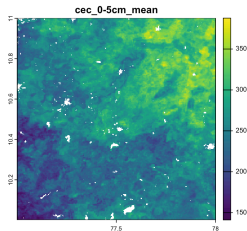
Option 2: Preparing a GeoTIFF from SoilGrids I

1. **Load** the R Markdown source `SoilGrids250_MakeRasterStack.Rmd` into RStudio
2. In Section “Directories” **specify** the **target directory** on your system for the GeoTIFF; **save** the modified source
3. **Load** the R script `GetTiles.R` into RStudio
4. **Modify** the variables specifying lower-right corner latitude and longitude to specify your **area of interest**; **save** the modified source
5. **Select** the properties and depth slices which will make up your raster stack
 - one property, all depth slices; or all properties, one depth slice; or selected properties, all depth slices
6. **Select** the appropriate code block and **run** it.
 - This will create the GeoTIFFs, one per property/depth.

Option 2: Preparing a GeoTIFF from SoilGrids II

7. **Load** the R Markdown source `SoilGrids250_MakeRasterStack.Rmd` into RStudio.
8. In Section “Directories” **specify** the **target directory** on your system for the GeoTIFF; **save** the modified source
9. **Render or “Run all”**
 - This will create the raster stack as a multi-layer GeoTIFF.

GeoTIFF example



Tutorial document

Source `PatternAnalysisWorkshopTutorial_DSM2025.qmd`

- A Quarto¹ source notebook – similar to R Markdown²

Compiled HTML and PDF versions, using the Tamil Nadu example

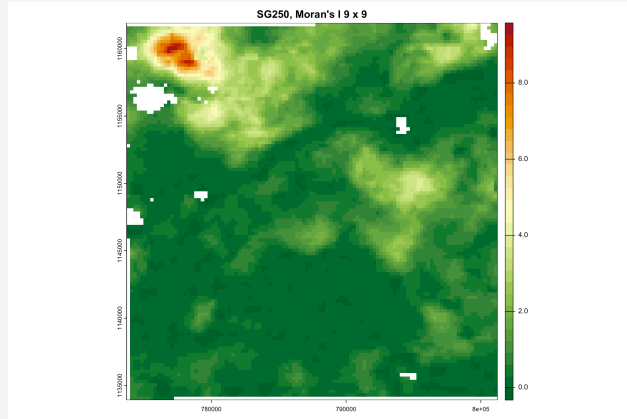
¹<https://quarto.org/>

²<https://rmarkdown.rstudio.com/>

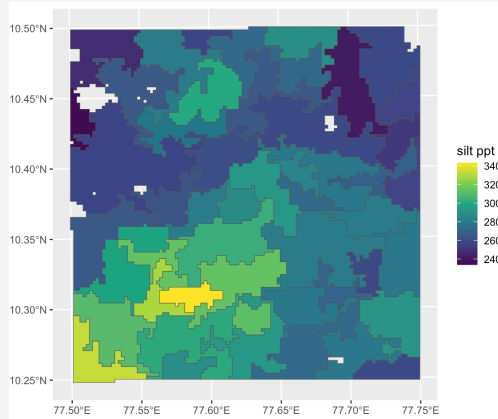
Working through the “Pattern Analysis” tutorial

1. Open the **tutorial source** in RStudio..
2. Open one of the **compiled documents** in a web browser (HTML) or PDF viewer (PDF), for reference.
3. Modify the source at heading `DSM product to evaluate` to specify the path and map files on your system.
4. Work through the source document by **running code chunks in sequence**, examining/interpreting the output.
 - Toolbar dropdown menu Run: either Run Current Chunk or Run Next Chunk
 - or, in the source code, click the “down” arrow at the right of the chunk header.
5. Feel free to **expand/adapt!**
6. Stopping points for **discussion** after each topic

Moving window local spatial autocorrelation example



Supercells example



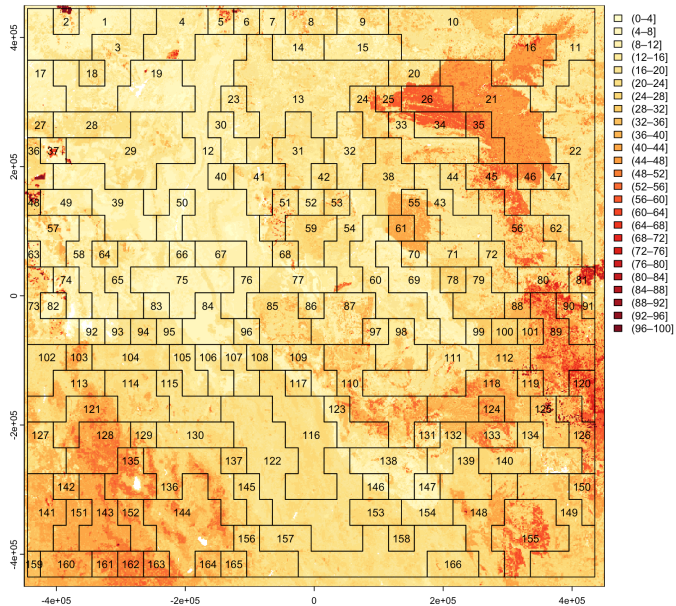
Discussion points (after “Patterns” tutorial)

- Which landscape-level metrics, seem most useful in characterizing the map? In determining if the map is “realistic”?
- How successful was aggregation in finding relatively homogeneous landscape units? Which parameters were optimal and why?
- How to communicate pattern analysis and supercells results to map users?
- Do we really know the “true” soil pattern at various scales?

Optional: Segmentation

- There will likely not be enough time for this, but just in case ...and you can practice at home.
- At coarser scales, homogeneity of properties may not be possible or even desirable. This has led to the concept of **landscape segments**, defined by the **co-occurrence pattern of contrasting grid cells** of some pre-defined size.
- The **GeoPAT** suite is a set of **stand-alone Unix programs**
- These can be invoked in **sequence** to obtain a **segmentation** and an **evaluation of its quality**.
- We hope that the segments divide the soil landscape into units with homogeneous **internal patterns**.

Shift: 20000 m



Optional: Segmentation

1. The GeoPAT Unix executables must be installed on your system.
2. Load Quarto source `SegmentingSoilMaps.qmd` into RStudio.
3. Adjust the path to the GeoPAT program (line 113) for your system.
4. Adjust the path to the input files (line 126)
5. Render this file, or Run All. This will write a set of functions to `SegmentingSoilMaps_Functions.RData`
6. Download some area of the Global Soil Organic Carbon map, see script `PrepareGSOC.R` – adjust to your area.
7. Load Quarto document `SegmentingSoilMaps_CaseStudy_GSOC.qmd`.
8. Adjust the paths and areas and render or Run All



Discussion points (after “Segmentation”)

- Which grid size best segmented the landscape into groups of patterns?
- Do you recognized areas with known internal landscape patterns?
- How to communicate segmentation analysis results to map users?