# Exercise 3-1: Creating a soil property map

### Mapping objectives:

- Create a soil analysis point layer from tabular data in QGIS
- Create a continuous surface soil property map using Kriging Interpolation in SAGA GIS 6.2.0
- Design a grid sampling scheme

### Data folder: Dataset3



Open QGIS 3.4.11 with GRASS 7.6.1



QGIS Desktop 3.4.11 with GRASS 7.6.1

App

#### Part 1: Open a project

- 1. Create a new project in QGIS
  - a. Go to Manage Layers Toolbar, click Add vector layer to add F26\_Boundary\_UTM.shp into the project

ong term relea

Madeira

| đ                                  | Add vector layer        | ?            | ×   |
|------------------------------------|-------------------------|--------------|-----|
| Source type     File     Directory | O Database              | Protocol     |     |
| Encoding System                    | U Database              | 0110000      | •   |
| Source                             |                         |              |     |
| Dataset 5_Tutorial\Data\d          | lataset3\F26_Boundary_I | UTM.shp Brow | se  |
|                                    | Open (                  | Cancel H     | elp |

### Part 2: Create a soil analysis point layer from tabular data

- 1. Click Add Delimited Text Layer in Manage Layers Toolbar
- 2. Click Browse to select F26\_SoilAnalysis\_2014.txt and set other parameters as follows. Then click OK

| Constant Constant | Create a Layer                | from a Delim        | nited Text    | File           |                | ?          | <   |
|-------------------|-------------------------------|---------------------|---------------|----------------|----------------|------------|-----|
| ile Name 1/Ong    | oing_tasks/171214_QGIS_F26_Tu | /torial/Data/datase | t3/F26_SoilAn | alysis_2       | 014.txt B      | rowse      |     |
| ayer name F20     | SoilAnalysis_2014             |                     | E             | ncoding        | UTF-8          |            | -   |
| ile format        | CSV (comma separated v        | alues) 💿 Custor     | m delimiters  | 🔿 Regi         | ılar expressio | on delimit | er  |
|                   | Comma X Tab                   | Quote "             | e 🗌 (         | Colon<br>Escaj | Ser            | micolon    | ]   |
| ecord options     | Number of header lines to dis | card 0 🗘 🗙          | First record  | nas field      | names          |            |     |
| ield options      | Trim fields Discard e         | mpty fields 📃 D     | ecimal separa | tor is co      | mma            |            |     |
| eometry definit   | on 🖲 Point coordinates 🛛 🔘    | Well known text (   | wкт) 🔿 N      | o geome        | try (attribute | only tab   | le) |
|                   | X field Longitude 🔹           | Y field Latitude    | •             | DMS co         | ordinates      |            |     |
| yer settings      | Use spatial index             | Use subset i        | ndex          | W              | atch file      |            |     |
| SampleID          | Longitude Latitude Clay_%     | Silt_% Sand         | % SOM_%       | рн             | Lime_index     | P_ppm      | •   |
| 1                 | -73.939319 45.415785 23       | 41 36               | 63.3          | 6.9 6          | 59             | 78         |     |
| 2 2               | -73.939637 45.417081 13       | 25 62               | 7.8           | 5.9 6          | 54             | 140        | -   |
|                   |                               | 1                   |               |                |                |            |     |
| • •               |                               |                     |               |                |                |            |     |
|                   |                               |                     |               |                |                |            |     |
|                   |                               | J                   |               |                |                |            |     |

| Processing Toolbox                | 6. Change the type of field:   |
|-----------------------------------|--|
| 🎨 🔩 🕓 🖹 🦻 🔌                       | a. Type "refactor" in processing<br>Toolbox and open " <b>Refactor</b> |
| Q refactor                        | fields".   |
| <ul> <li>Recently used</li> </ul> | b. Select "F26_SoilAnalysis_2014                                       |
| 🔆 Refactor fields                 | shapefile.   |
| 🔻 🝳 Vector table                  | c. change all string type to   |
| 🌞 Refactor fields                 | "Double".  |
|                                   | d. click "Run"   |
|                                   |  |
|                                   |  |
|                                   |  |
|                                   |  |

| Pa         | arame<br>ut lay   | eters<br>/er                | Log   |                  |   |        |           |       | Refac                                    | tor                | fields   |
|------------|-------------------|-----------------------------|---|------------------|---|--------|-----------|-------|--|--------------------|--|
|            | F26               | 5_Soil                      | Analysis_2014_U<br>features only                | TM [EPSG: 32618] |   |        | •         | 9     | the structu<br>table of a<br>can be more | vector<br>dified i | the attribute<br>layer, Fields<br>n their type<br>a fields |
| -iei       | ds ma             | appini                      | G<br>Field name                                 | Tune             |   | Length | Precision | - 📖   | lype<br>Double                           |                    |  |
| 0          | -                 | 3                           | SampleID  | Double           | - | 254    | 0         |       | Double                                   | ¥                  | ayer is<br>contains a                                      |
| 1          | *                 | 3                           | Longitude                                       | Double           | * | 254    | 0         |       | Double                                   | *                  | table,<br>provided   |
| 2          | -                 | 3                           | Latitude  | Double           | - | 254    | 0         |       | Double                                   | ¥                  |  |
| 3          | *                 | 3                           | Clay_%  | Double           | - | 254    | 0         |       | Double                                   | . *                |  |
| 4          | -                 | 3                           | Silt_%  | Double           | - | 254    | 0         |       | Double                                   | *                  |  |
| 5          | •                 | 3                           | Sand_%  | Double           | * | 254    | 0         |       | Double                                   | *                  |  |
| 6          | *                 | 3                           | SOM_%   | Double           | - | 254    | 0         | 6     |  |                    |  |
| .oa<br>tef | id fiel<br>factor | ds fro<br>red               | om layer [ * Clip                               | ped              |   |        | ▼ Load F  | ields |  |                    |  |
| [Cr<br>√]  | Oper              | temp                        | oorary layer]<br>out file after runni           | ing algorithm    |   |        |           |       |  |                    |  |
|            |                   |                             |   |                  | C | )%     |           | 11.   |  | -1î                | Cancel   |
| lun        | as B              | atch I                      | Process   |                  |   |        | R         | un    | Close                                    |                    | Help   |
| /          | •                 | <u>Refa</u><br>F26_<br>F26_ | <u>ctored</u><br>Yield_Soybeans<br>Boundary_UTM | 5_2014<br>1      |   |        |           |       |  |                    |  |

- 3. In Layer Panel, right click *Refactoraed*, then click Save As
- 4. In Save vector layer
  - a. Format = ESRI Shapefile
  - b. File name = F26\_SoilAnalysis\_2014\_UTM.shp
  - c. CRS = Project CRS (EPSG:32618 WGS 84 / UTM zone 18 N) Click OK
- 5. Right click F26\_SoilAnalysis\_2014 and Refactoraed then click Remove

### Part 3: Create an interpolated soil property raster layer using SAGA GIS software

1. Launch SAGA GIS 6.2.0



- 2. Import F26\_Boundary\_UTM.shp and F26\_SoilAnalysis\_2014\_UTM.shp into SAGA
  - a. In Data Source > File system, navigate to the project folder and double click on F26\_Boundary\_UTM.shp and F26\_SoilAnalysis\_2014\_UTM.shp to add these two layers to Data > Tree

| SAGA                              |   |     |
|-----------------------------------|---|-----|
| File Geoprocessing Window ?       |   |     |
| : 🗳 🖬 🖽 🖬 🖬 🖬 🚳 🦘 🛛 १             |   |     |
| Manager X                         |   |     |
| 🍢 Tools 🔁 Data 🕼 Maps             |   |     |
| 🔚 Tree 📑 Thumbnails               |   |     |
| 🔁 Data                            |   |     |
| 📋 🔁 Shapes                        |   |     |
|                                   |   |     |
|                                   |   |     |
| □···· > Polygon                   |   |     |
| çı arrıza bounday, arm            |   |     |
|                                   |   |     |
| Data Sources X                    |   |     |
| 🔚 File System 📸 ODBC 📸 PostgreSQL |   |     |
| temp 🔺                            |   |     |
|                                   |   |     |
|                                   | Messages  | z I |
| E26 SoilAnalysis_2014.txt         | General Secution General  |     |
| E26 SoilAnalysis 2014 UTM shr     | i2019.01.25/14-15-191 Load tool chain: tools/toolchains/tta_TravelTime.vml_ok/au  | 7   |
|                                   | [2018-01-25/14:58:34] Load shapes: Dt\Google Drive\Research\Ongoing_tasks\180123  |     |
|                                   | _QGIS_F26_Tutorial\Data\dataset3\F26_Boundary_UTM.shpokay<br>   <b>2018-01-25/14:58:361</b> Load shapes: D:\Goode Drive\Besearch\Opgoing_tasks\180123 | i I |
| Recognized Files 🔹                | QGIS_F26_Tutorial\Data\dataset3\F26_SoiAnalysis_2014_UTM.shpokay  |     |
| ready                             |   |     |

3. In Main Manu, go to Geoprocessing > Grid > Grid System > Create Grid System

| Load Tool Library         | - 1                |               |            |                        |
|---------------------------|--------------------|---------------|------------|------------------------|
| Find and Run Tool         | 1                  | ×             |            |                        |
| Climate                   | •                  |               |            |                        |
| Database                  |                    |               |            |                        |
| File                      |                    |               |            |                        |
| Garden                    | $\rightarrow \bot$ |               |            |                        |
| Grid                      | •                  | Analysis      |            |                        |
| Imagery                   | •                  | Calculus      |            |                        |
| Projection                | •                  | Distances     | - )÷.      |                        |
| Shapes                    | •                  | Filter        | - >        |                        |
| Simulation                | •                  | Gaps          | - <b>+</b> |                        |
| Spatial and Geostatistics | •                  | Grid System   | •          | Aggregate              |
| TIN                       |                    | Gridding      | +          | Clip Grids             |
| Table                     |                    | Values        | +          | Clip Grids [interactiv |
| Terris Analysis           | 1                  | Vigualization | <b>_</b>   | Create Grid Surtem     |

4. In Create Grid System:

Use default values, with the following exceptions:

- a. Cellsize = 5
- b. Extent Definition = one or more shapes layers
- c. Adjust = extent to cell size
- d. Data Objects > Shapes > Sahpes Layers = 1 object (*F26\_Boundary\_UTM*), click Okay

| Create Grid System          |                             | x        |   |
|-----------------------------|-----------------------------|----------|---|
| Options                     |                             | Okay     |   |
| Initialization Value        | 0                           |          |   |
| Cellsize                    | 5                           | Cancel   |   |
| Extent Definition           | one or more shapes layers   |          |   |
| Adjust                      | extent to cell size         |          |   |
| Use Offset                  |                             | Load     |   |
| Data Objects                |                             |          |   |
| Shapes                      |                             | Jave     |   |
| >> Shapes Layers            | 1 object (F26_Boundary_UTM) | Defaults |   |
|                             |                             |          |   |
|                             |                             |          |   |
| >> Shapes Lavers            |                             | Info >>  |   |
| ~ ~ ~ ~ ~                   |                             |          |   |
|                             |                             |          | Manager                                       |
|                             |                             |          | 🍬 Tools 🗎 Data 🕞 Maps                         |
|                             | Shape(s)                    | ×        | 🖫 Tree 💾 Thumbnails                           |
|                             |                             |          | 🚘 Data  |
| 01. F26_SoilAnalysis_2014_U | TN >> D1. F26_Boundary_UTM  | Okay     | 🖨 🖷 Grids                                     |
|                             |                             |          | ☐ Щ 5; 81x 87y; 582902.606307x 5029571.127338 |
|                             | >                           | Cancel   | 01. Dummy Grid                                |
|                             |                             |          | 🗎 🔁 Shapes                                    |
|                             | <                           |          | Point   |
|                             |                             |          | 01. F26_SoilAnalysis_2014_UTM                 |
|                             | <<                          |          | Polygon                                       |
|                             |                             |          | 01. F26_Boundary_UTM                          |
|                             |                             |          |   |
|                             |                             |          |   |
|                             | Down                        |          |   |
|                             |                             |          |   |

5. Go to Manager > Tools > Spatial and Geostatistics - Kriging > Ordinary Kriging. Double click on this tool to open the dialog window



6. In Ordinary Kriging:

Use the default values, except for the following:

- a. Data Objects
   Shapes >> Points = 01. F26\_SoilAnalysis\_2014\_UTM
   Attribute = pH
- Dptions > Target Grid system = grid or grid system
   Grid system= 5; 81x87y; 582902.606307x5029571.127338y
   << Prediction = <create>

## c. Search Options Search Range = global Number of Points = all points within search distance

### Click Okay

In Grids > Grid System, use the drop down arrow to select

| Ordinary Kriging                     |  | X        |
|--------------------------------------|--|----------|
| 🗆 Data Objects                       |  | Okay     |
| Shapes                               |  | Gildy    |
| ∃ >> Points                          | 01. F26_SoilAnalysis_2014_UTM              | Cancel   |
| Attribute                            | pH   |          |
| Options                              |  |          |
| 😑 Target Grid System                 | grid or grid system                        | Load     |
| Grid System                          | 5; 81x 87y; 582902.606307x 5029571.127338y | Save     |
| << Prediction                        | <create></create>                          | Jave     |
| < Quality Measure                    | <not set=""></not>                         | Defaults |
| 🕀 Kriging                            |  |          |
| Type of Quality Measure              | Standard Deviation                         |          |
| Logarithmic Transformation           |  | Info >>  |
| Block Kriging                        |  |          |
| Cross Validation                     | none                                       |          |
| Search Options                       |  |          |
| Search Range                         | global                                     |          |
| Number of Points                     | all points within search distance 🔹        |          |
|                                      |  |          |
| Number of Delete                     |  |          |
|                                      |  |          |
|                                      |  |          |
| Available Choices:                   |  |          |
| [0] maximum number of nearest points |  |          |
| utitali oomis wiinin search distance |  |          |

7. In Variogram:

Use default values, except ...

Under the variogram plot, replace the variables with values:

n (nugget) = 0.06; s (sill) = 0.25; r (range) = 210

So, the spherical model of pH = 0.06 + (0.25 - 0.06)\* if else(x > 210, 1, 1.5 \* x / 210 - 0.5 \* x^3 / 210^3) [Press Enter key]

Click Ok







- 9. Right click 02. F26\_SoilAnalysis\_2014\_UTM.pH [Ordinary Kriging] to save the file as pH.sgrd
- 10. Repeat steps 5 8 to interpolate soil property of K\_ppm, P/Al\_ratio, SOM\_%, and Lime\_index, and then save them as *K\_sgrd*, *P\_Al.sgrd*, *SOM.sgrd* and *lime\_index.sgrd* respectively

| Attribute  | Spherical model   | Function Fitting Range |
|------------|---|------------------------|
| K_ppm      | 0 + (2600 - 0) * ifelse(x > 150, 1, 1.5 * x / 150 - 0.5 * x^3 / 150^3)    | 60                     |
| P/AI       | 0 + (340 - 0) * ifelse(x > 160, 1, 1.5 * x / 160 - 0.5 * x^3 / 160^3)     | 80                     |
| Lime_index | 2.5 + (6.8 - 2.5) * ifelse(x > 200, 1, 1.5 * x / 200 - 0.5 * x^3 / 200^3) | 100                    |
| SOM_%      | 0 + (520 – 0) * ifelse(x > 150, 1, 1.5 * x / 150 – 0.5 * x^3 / 150^3)     | 100                    |











1. Back to QGIS interface, double click *pH.sdat* in Browser Panel to add this layer into Layers Panel



- 2. In Menu Bar, go to Raster > Extraction > Clipper ...
  - a. Input file (rater) = *pH*
  - b. Output file = *pH\_c*
  - c. Clipping mode = Mask layer Mask layer = *F26\_Boundary\_UTM* Keep resolution of input raster
  - a. Load into canvas when finished

Click OK

| ¢.   | لم<br>Clipper  | ? ×           |
|--|--|---------------|
| Input file (raster)  | pH 💌   | Select        |
| Output file  | 6_Tutorial/Data/dataset3/pH_c.tif  | Select        |
| No data value  | 0  |               |
| Clipping mode  |  |               |
| O Extent   | Mask layer   |               |
| Mask laver F26   | Boundary UTM   | Select        |
| Keep resolut   | ion of input raster Set output fi  | le resolution |
| gdalwarp -q -cutlin<br>Drive/Research/On<br>/dataset3/F26_Bou<br>"D:/Google<br>Drive/Research/On | e "D:/Google<br>going_tasks/171214_QGIS_F26_Tuto<br>ndary_UTM.shp" -tr 5.0 5.0 -of GTiff<br>going_tasks/171214_QGIS_F26_Tuto | rial/Data     |
|  | OK Close   | Help          |

- 3. In Layers Panel, right click *pH* layer and click Remove
- 4. In Layers Panel, right click *pH\_c* layer and click Properties
  - a. In Style:

b.

| Render type =<br>Singleband pseudocolor  | 🔏 Layer Properties - pH   St  | yle  |                                  |  |                |    |                       | ?       | X |
|--|---|--|----------------------------------|--|----------------|----|-----------------------|---------|---|
| Singleband pseudocolor<br>Load min/max values<br>Interpolation = Liner<br>Color = Blues;<br>Check Invert<br>Mode = Equal interval;<br>Classes = 10<br>Click Classify<br>Click OK | Cayer Properties - pH   Sty     General     Style     Transparency     Pyramids     Histogram     Metadata     Legend | yle<br>■ Band rendering<br>Render type Singleband pseudocolor ■<br>Band Band 1 (Gray)<br>Min 6.09687 Max 7.37401<br>▶ Load min/max values<br>Interpolation Linear<br>Color Blues ■ Edit X Invert<br>Label unit<br>suffix                             |                                  |  |                |    |                       |         |   |
|  |   | Yalue         Origin:           Value         6.097           6.239         6.381           6.523         6.664           6.948         7.09           7.232         7.374           Mode         Equal in           Style <ul> <li>Style</li> </ul> | Estimated cum<br>Color<br>terval | Label<br>6.097<br>6.239<br>6.381<br>6.523<br>6.664<br>6.806<br>6.948<br>7.09<br>7.232<br>7.374 | f full extent. | ОК | Class<br>Cancel Apply | es 10 🜩 |   |



- 5. Rename each layer for a better layout
  - a. Right click *pH\_c* to rename this layer as *Soil pH*
  - b. Right click **F26\_Boundary\_UTM** to rename this layer as **Boundary**
  - c. Right click F26\_SoilAnalysis\_2014\_UTM to rename this layer as Soil Sampling

| X   |   | Soil Sampling |
|-----|---|---------------|
| X   |   | Boundary      |
| ⊟ 🗙 | 2 | Soil pH       |
|     |   | 5.815         |
|     |   | 6.251         |
|     |   | 6.409         |
|     |   | 6.538         |
|     |   | 6.689         |
|     |   | 6.826         |
|     |   | 6.955         |
|     |   | 7.094         |
|     |   | 7.281         |
| l   |   | 7.51          |

### Part 5: Create a soil pH layout map

1. In Main Menu, click Project > New Print Composer, and name this layout as Soil pH. Click OK

| Create unique p<br>(title generated | orint composer title<br>if left empty) |
|-------------------------------------|--|
| Soil pH                             | -                                      |
| 01                                  | Connect                                |

2. Click Add new map and draw a rectangular area in the layout



Scale = 2500

