BOKU UNIVERSITY

USAGE-NG
Up-skilling Agricultural Engineering Next Generation

Science for [life]

Geodata Collection and Analysis for Empowering Women in Turkana

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BOKU University

Co-funded by the European Union

Schedule

	September 25, 2025	September 26, 2025
9:00 – 10:15	Introduction to GIS	Data collection in the field
10:30 – 12:00	Visualisation of geodata	Editing data
Lunch break		
13:00 – 14:45	Data management and coordinate systems	Data analysis
15:00 – 17:00	Data acquisition	Map production

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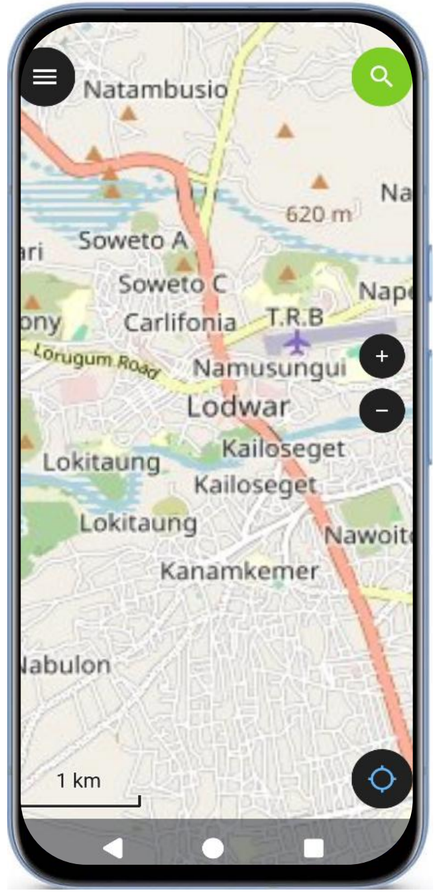
Day 2: QField for data acquistion in the field

Science for [life]

QGIS and QField

- **Objective:** Data collection in the field with a mobile device
- **Workflow**
  - Prepare a QGIS project and create a QField package
  - Copy the QField package to the mobile device
  - Collect data in the field
  - Copy the modified data back to the desktop computer
  - Synchronize the modified data with the original database or files

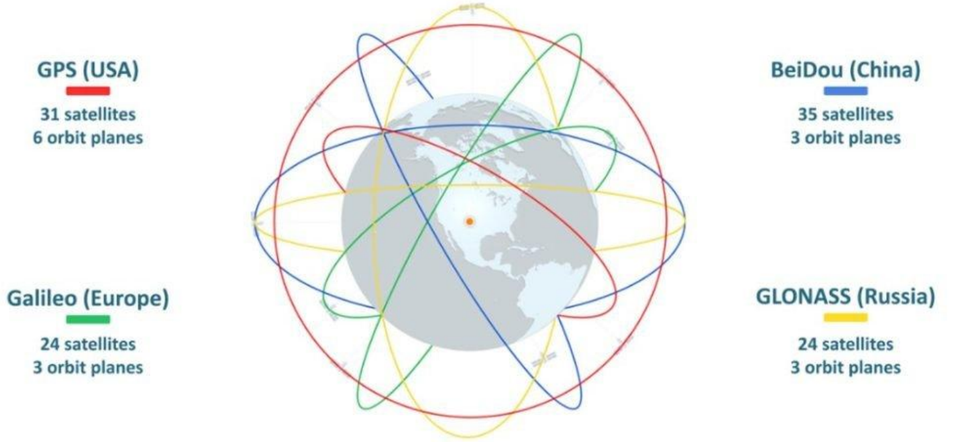


Positioning

- **Global Navigation Satellite Systems (GNSS)**

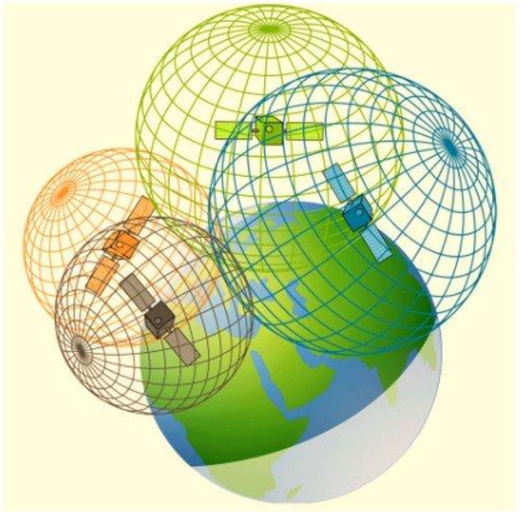
Idea:

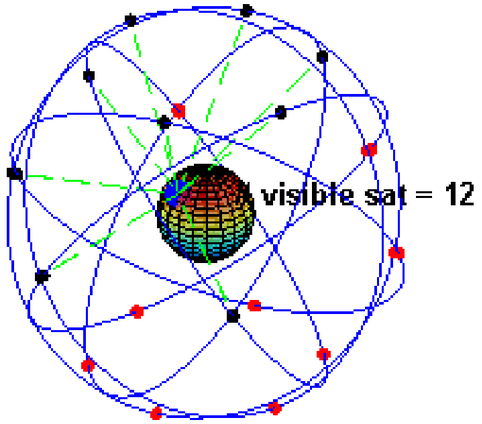
Satellites orbit the Earth on known orbits. The position of a point on Earth is calculated by measuring the distance to the satellites. The time it takes for the signal to travel from the satellite to a receiver is measured.



https://inertiallabs.com/gnss-and-satellite-navigation-explained/

By using information from at least four satellites, the receiver performs trilateration to calculate its precise latitude, longitude, altitude, and time, triangulating its position on Earth.



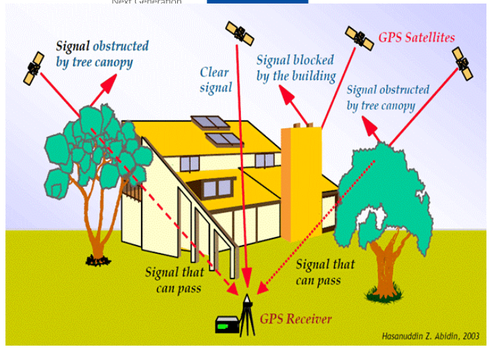


https://inertiallabs.com/gnss-and-satellite-navigation-explained/

Positioning

- **Limitations:**

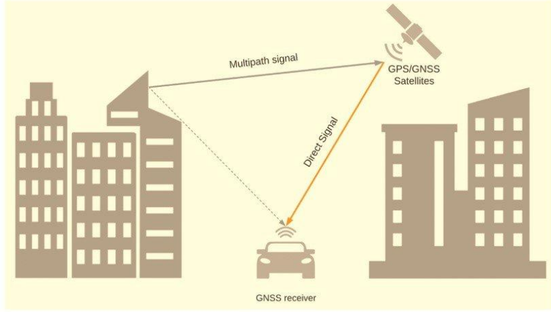
Factors limiting GNSS accuracy include signal obstruction (from buildings, trees), multipath interference (signals bouncing off surfaces), atmospheric conditions (ionospheric and tropospheric delays), poor satellite geometry (insufficient number or poor alignment of visible satellites), receiver quality, and potential intentional interference like jamming or spoofing.



https://www.researchgate.net/figure/Illustration-of-obstruction-eg-tress-canopy-building-and-interference-to-GNSS-signal_fig1_332943025

- **Accuracies**

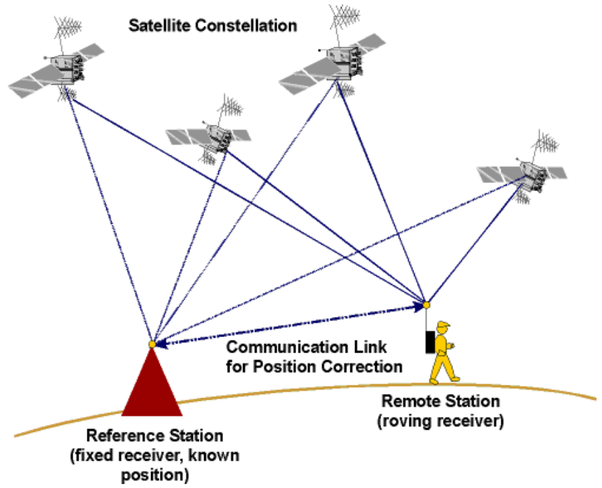
Standard GNSS receivers in mobile phones have accuracies of 2-10 meters outdoors under ideal conditions. Factors like the number of visible satellite systems, signal strength, and the device's internal sensors, such as its Inertial Measurement Unit (IMU), influence accuracy. More advanced techniques like Precise Point Positioning (PPP) and the use of raw GNSS data are improving smartphone accuracy, sometimes to the centimeter level for static measurements.



https://inertiallabs.com/gnss-and-satellite-navigation-explained/

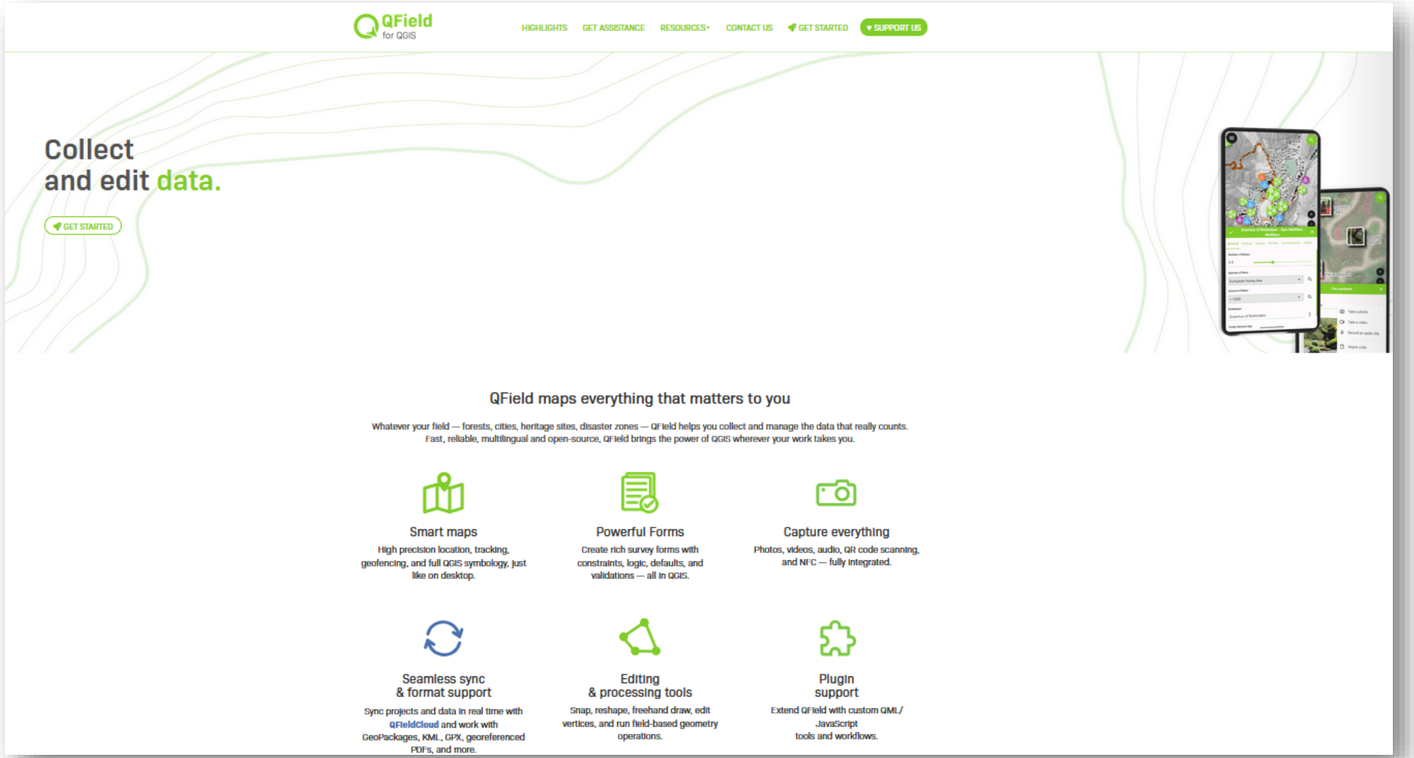
- **Enhancement:**

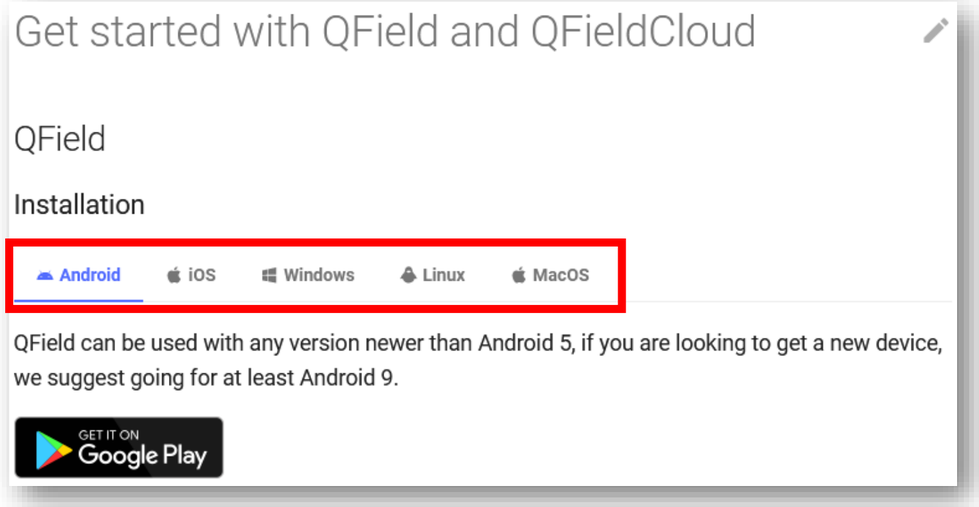
Differential GNSS: working with correction signals.



QField

http://qfield.org

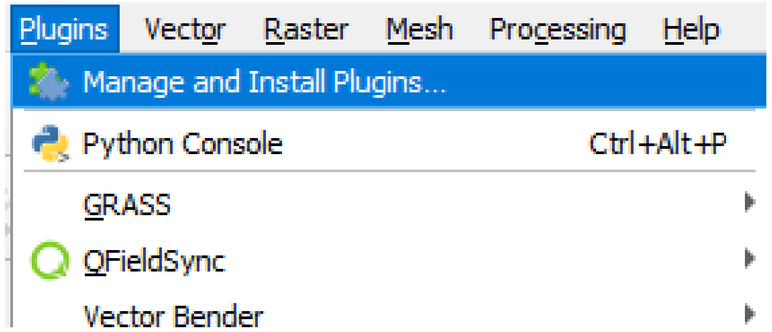


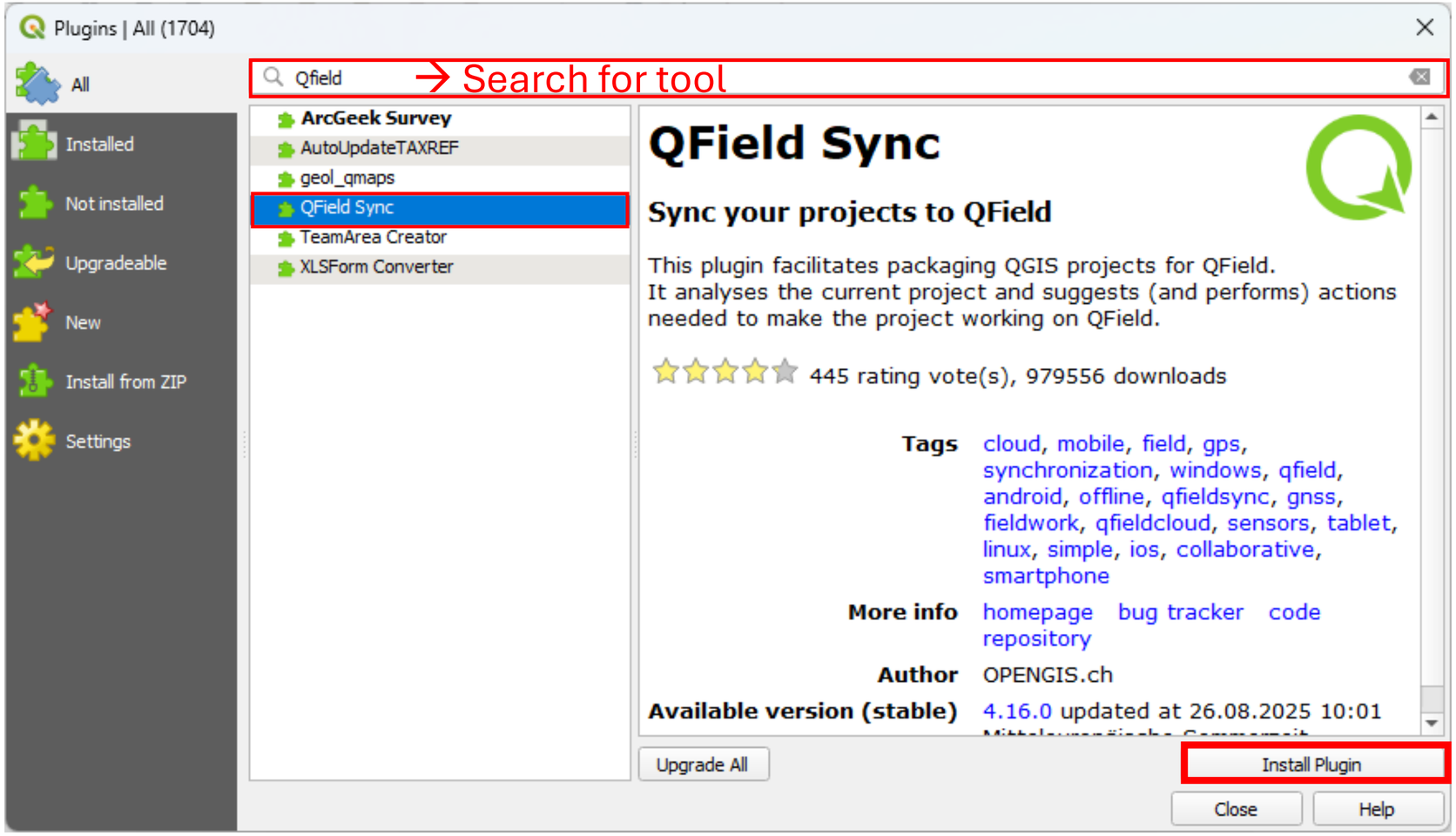


https://vimeo.com/695452246?embedded=true&source=vimeo_logo&owner=36168865

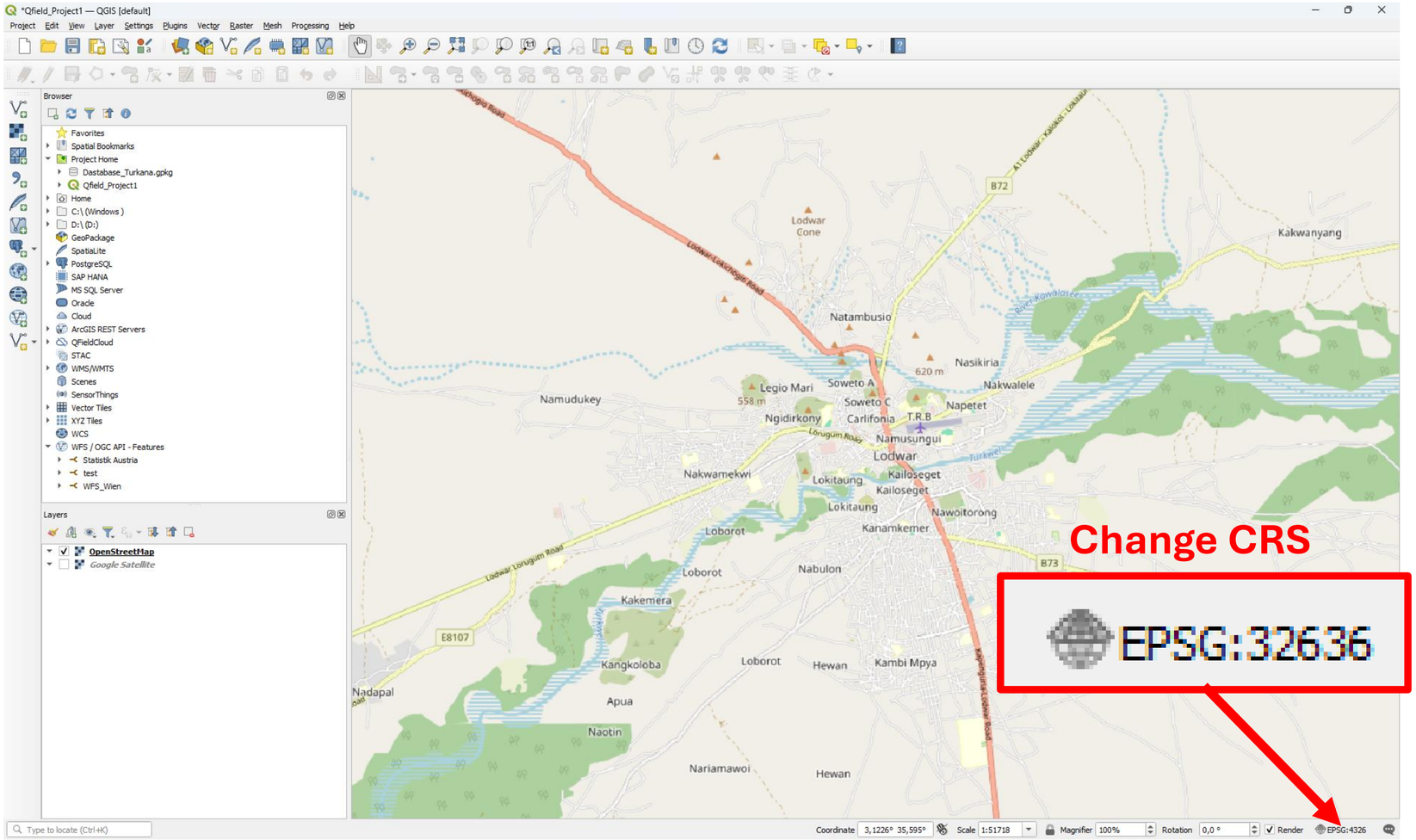
QGIS

- **Plugin required**





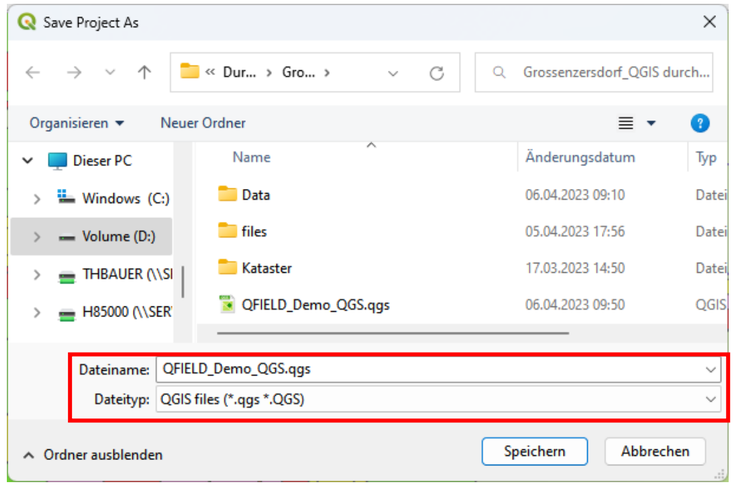
QGIS



Content (example):

- XYZ-Tiles: Google, OpenStreetMap
- Area of investigation
- Point, line, polygon data

Save as .qgs

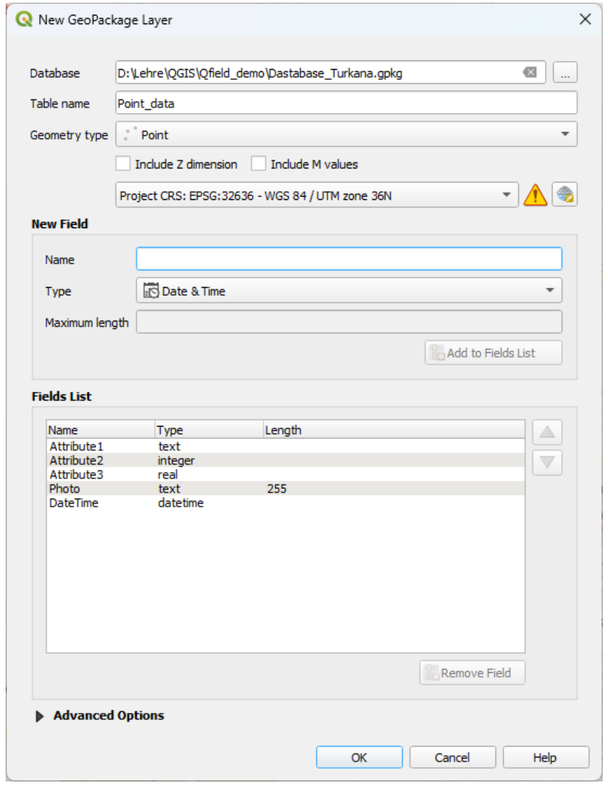


→ Save all files to one folder

QGIS

- **Definition of a layer for data acquisition in the field**

→ New Shape-File or GeoPackage

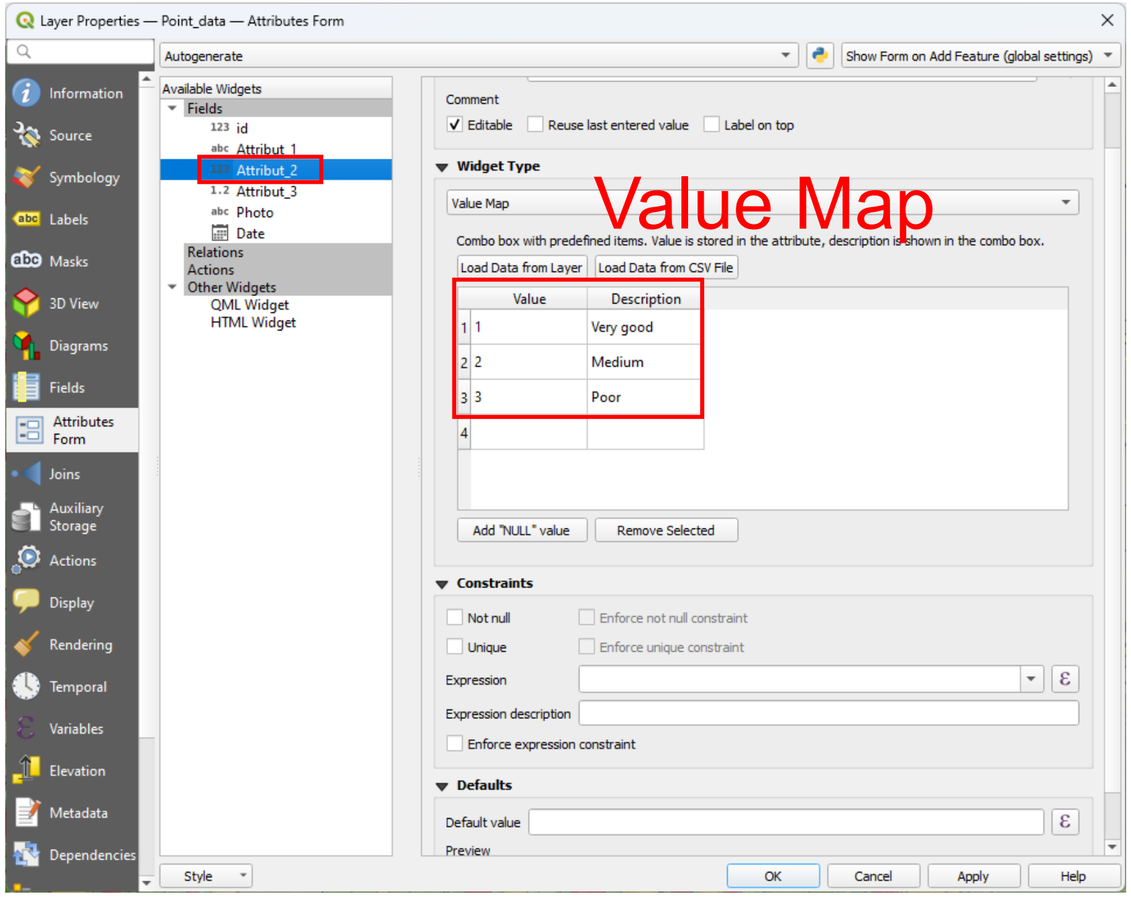


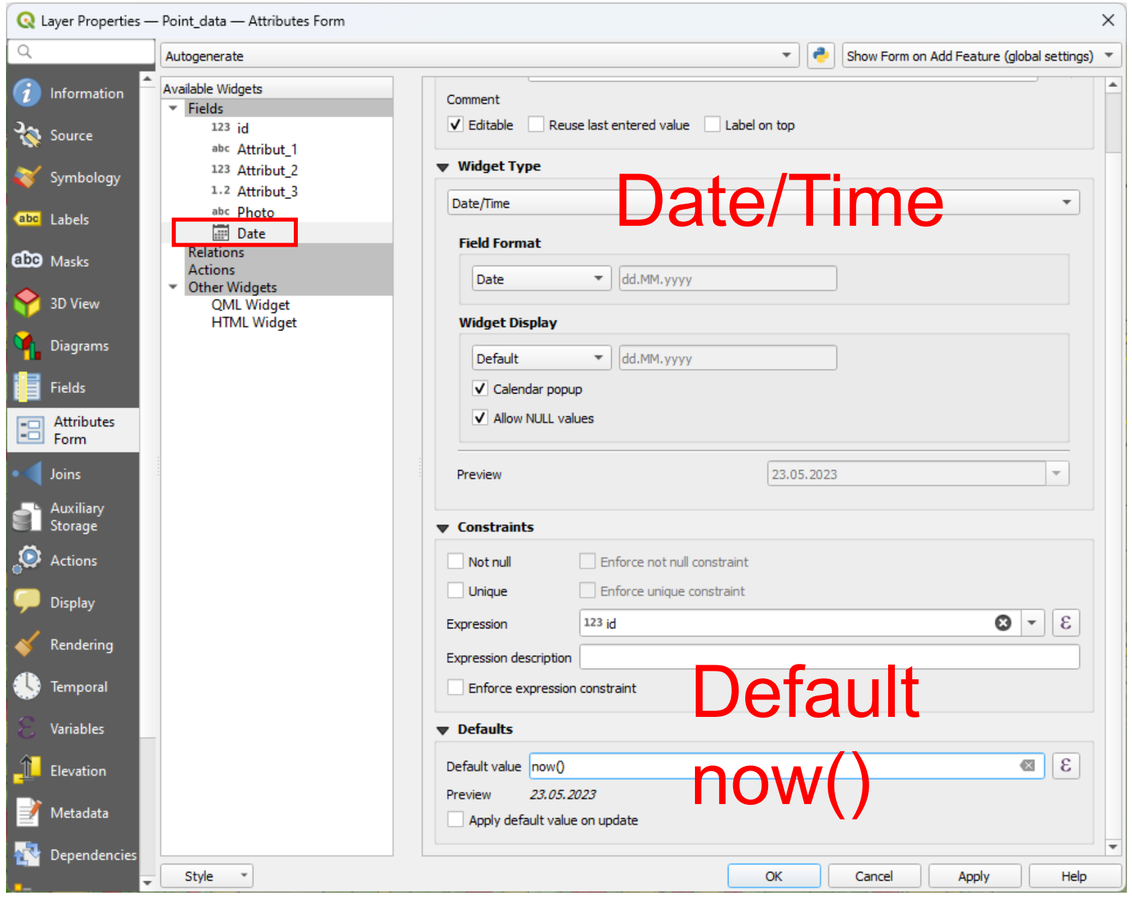
Example:
Attributes can be saved as Text, Integer, Decimal or Date

Photo: String (text) with length ~200 to store even the full path

QGIS

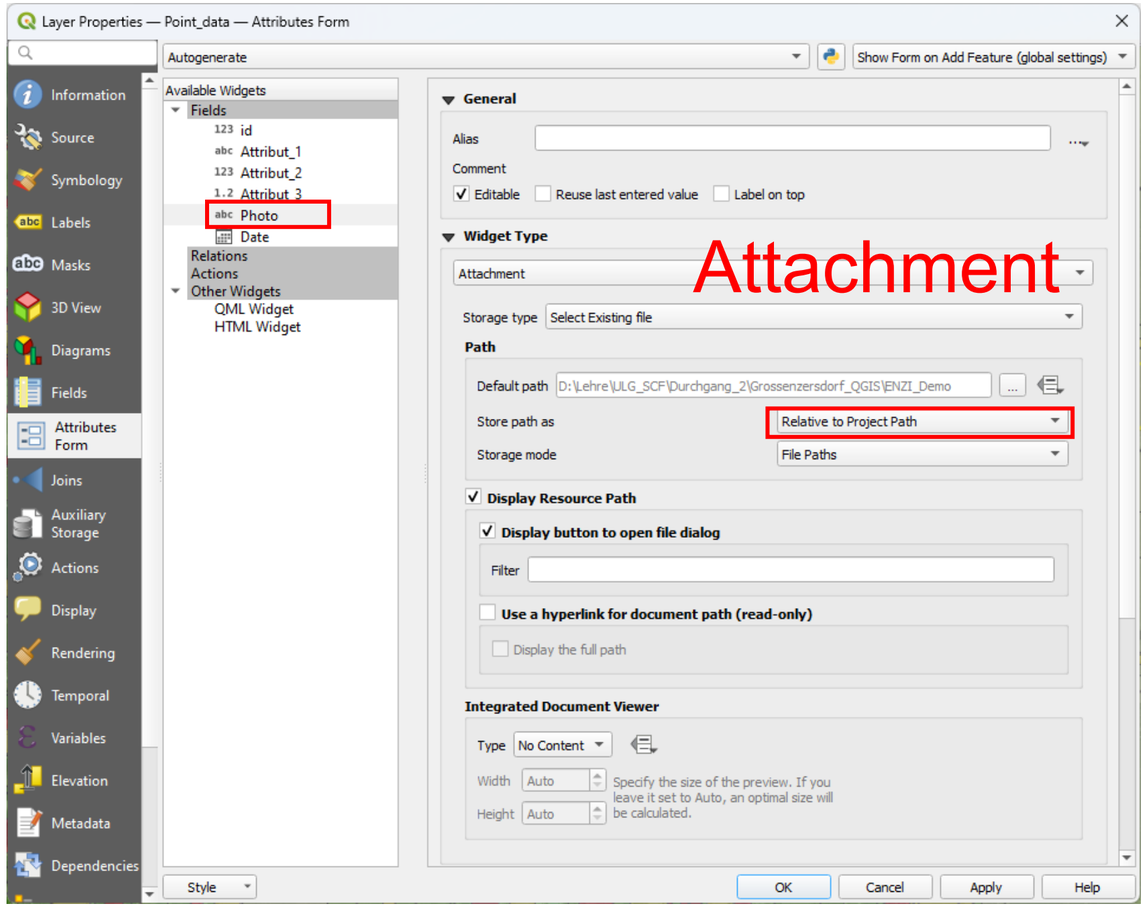
- **Attribute Forms:** Pre-definition of values





QGIS

- **Attribute Forms:** Pre-definition of values



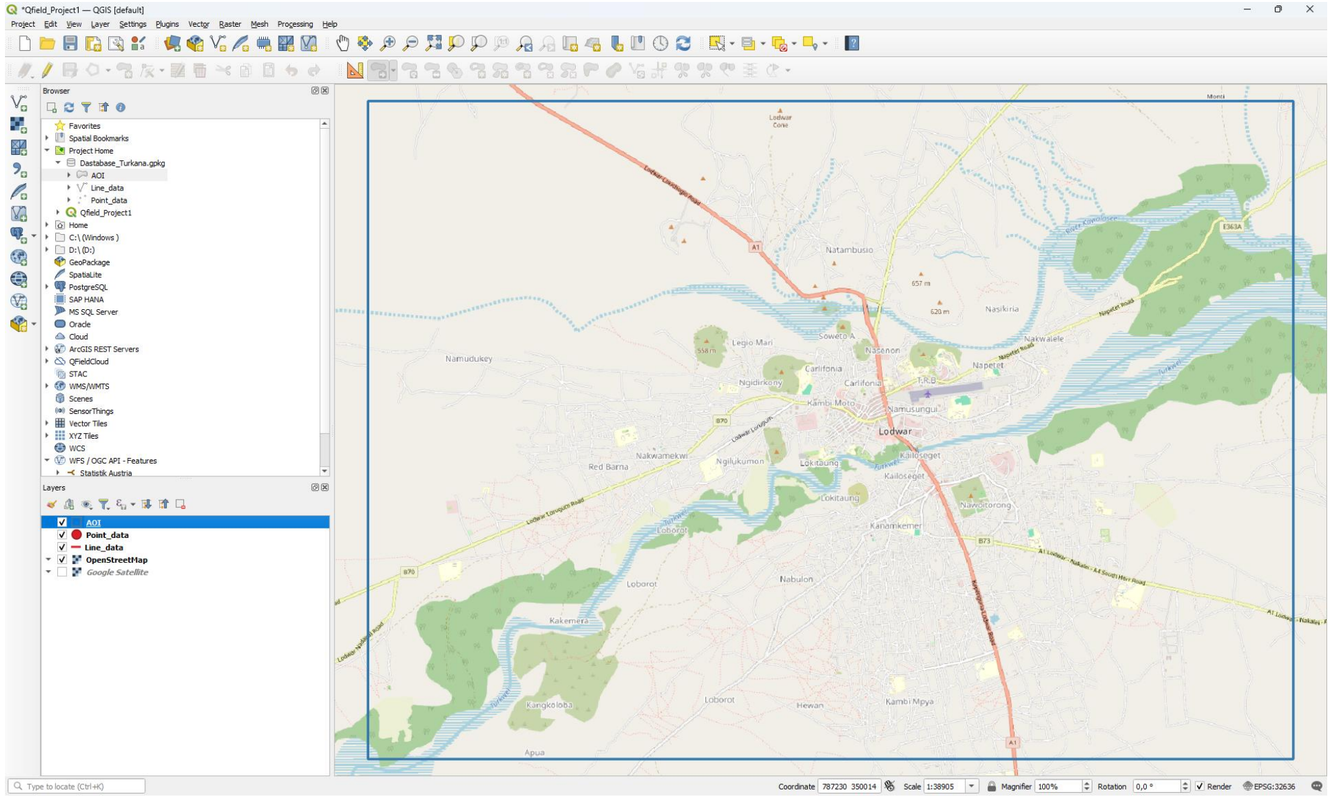
Attachment

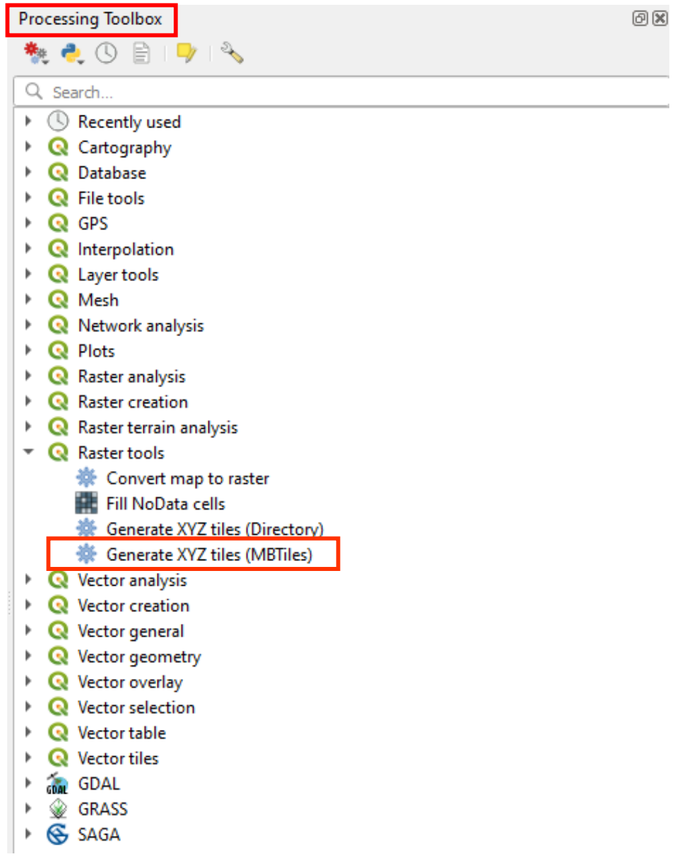
Photo in the field: save as „Attachment“ (Field type: text)

QGIS

- **Basemaps in QField:** online (XYZ-Tiles,WMTS) or offline (various raster formats)

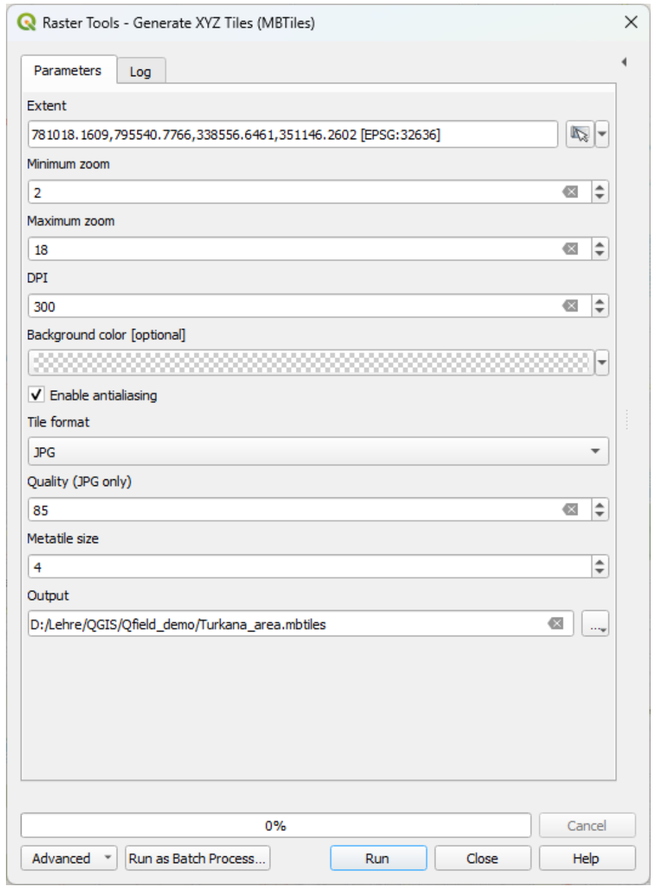
Offline: create MBTiles from WM(T)S





QGIS

- **MBTiles:** all visible layers will be converted

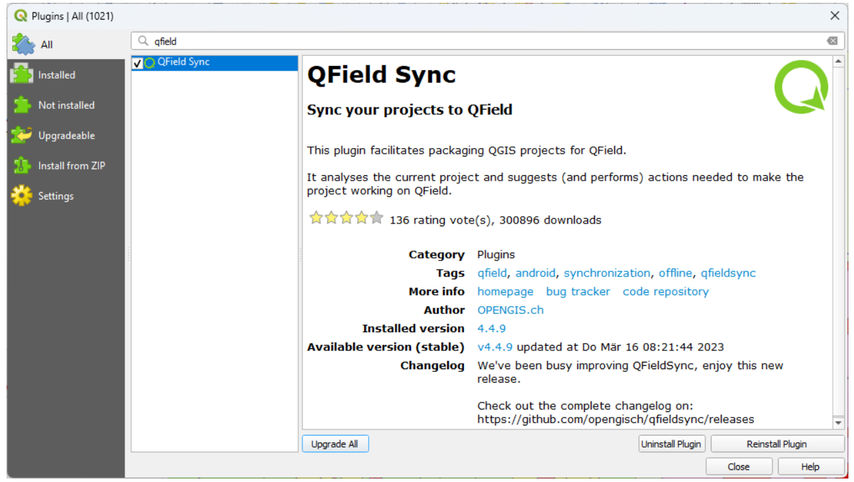


Extent: use option „Draw on Map Canvas“
Minimum zoom: 2
Maximum zoom: 18
DPI: 300
Tile format: JPG
Quality: 85
Output file: name.mbtiles

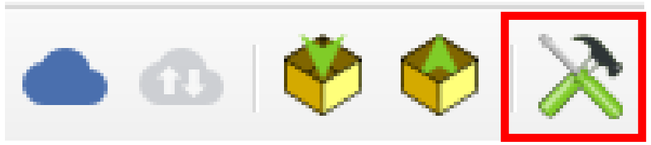
Qfield: in case of problems with MBTiles
→ Save MBTiles as TIFF
→ Load TIFF to main project

QGIS

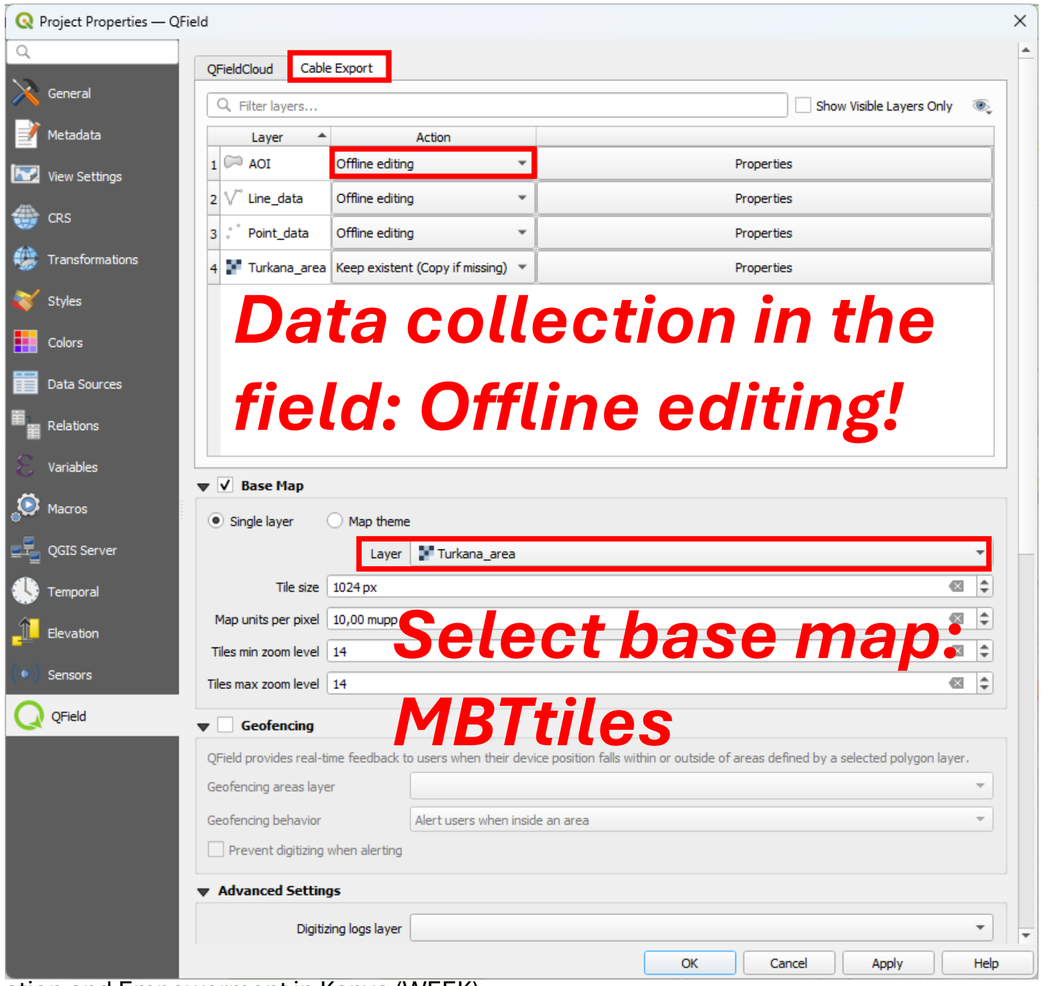
- **Synchronisation** of data with mobile device (Plugin)



Toolbar:



QFieldCloud: registration required
Cable Export: via USB



QGIS

- **Package for QField:** all data will be copied to a new directory → first remove unwanted layers from the QGIS-project

Recommendation: think about a useful folder structure for import and export!

Folder on PC:

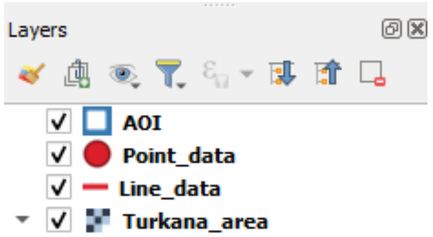
Qfield_Export

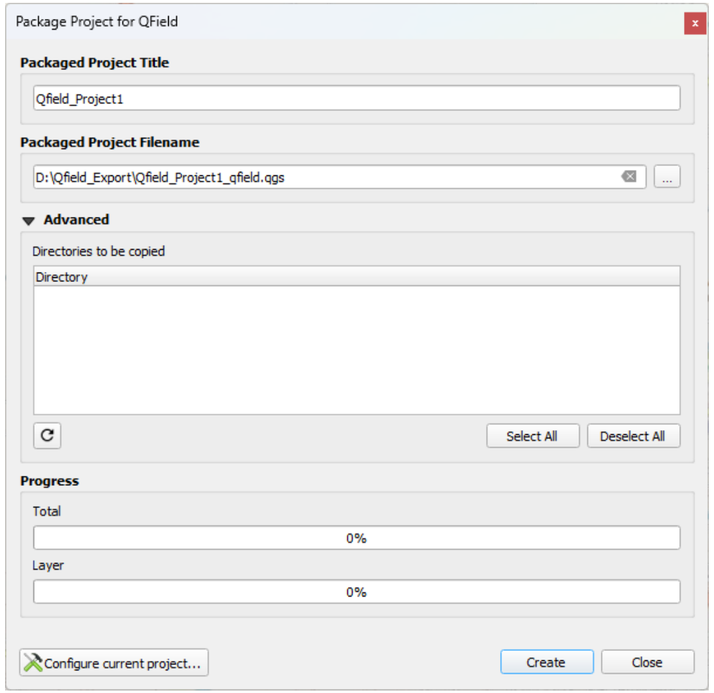
Qfield_Import

Folder on mobile:

Export_from_mobile

Import_to_mobile





Copy the resulting folder to the mobile device!

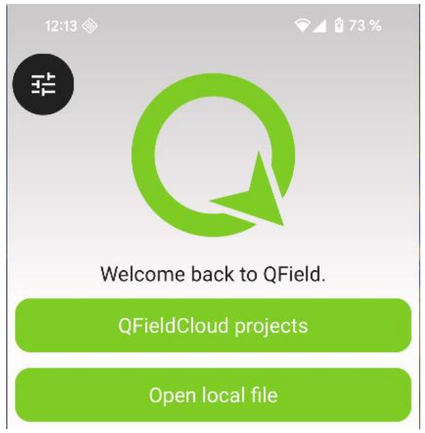
→ Check if „offline-editing“ data are copied properly

→ In case of missing data, copy manually!

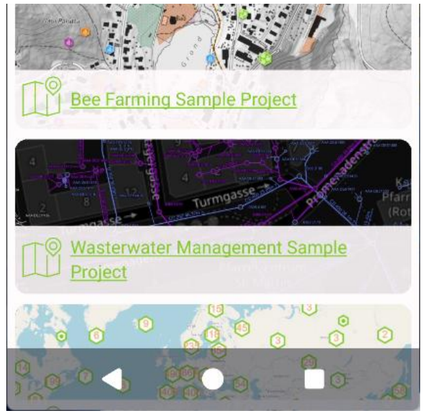
→ QGIS Document .qgs is an „offline-project“

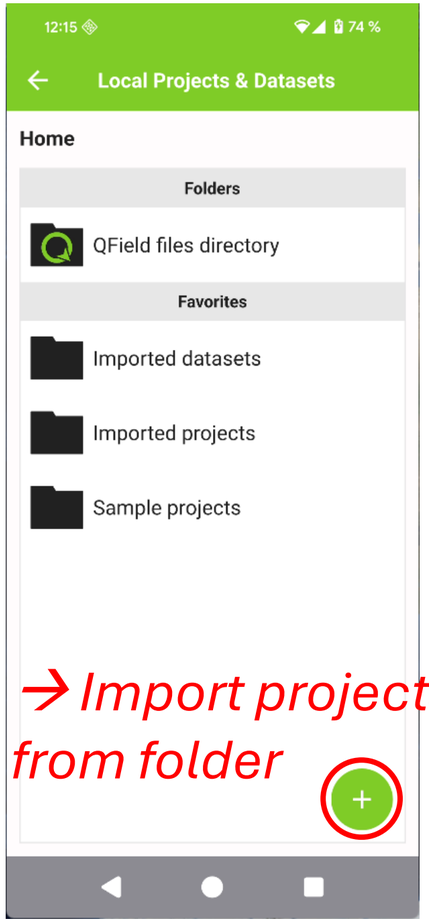
QField

- **Start QField on your mobile and load project**

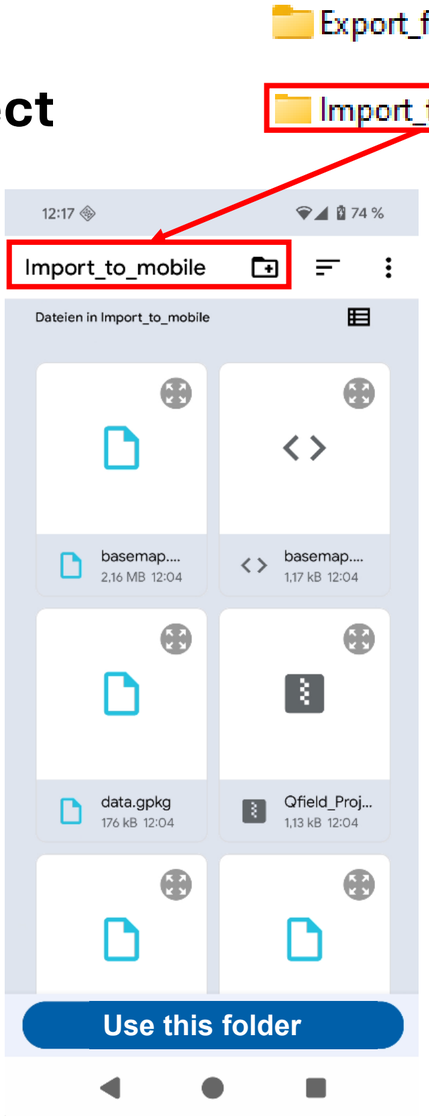


→ *Open local file*





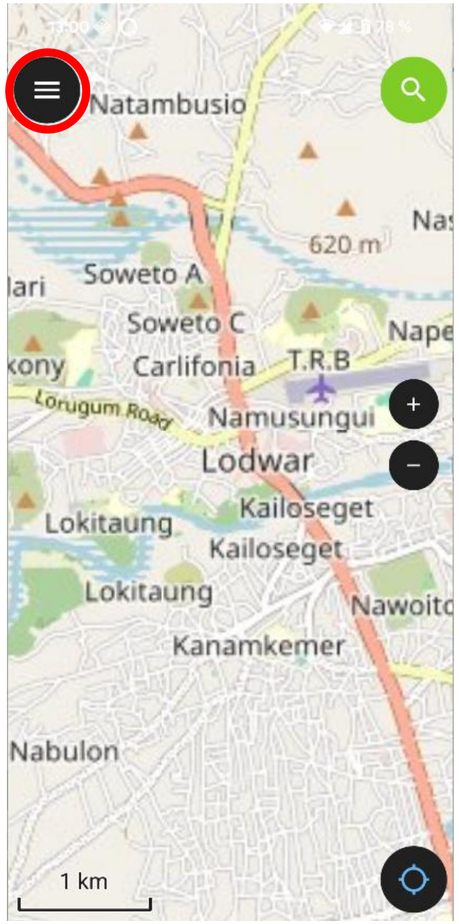
→ *Import projects from folder*

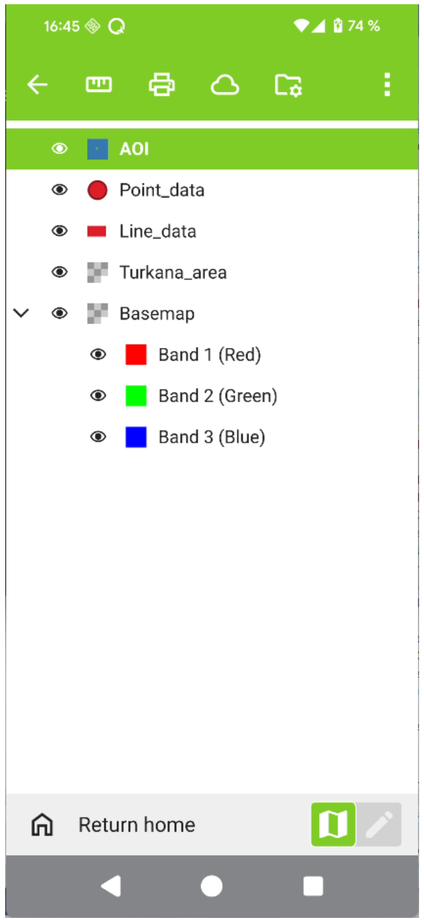


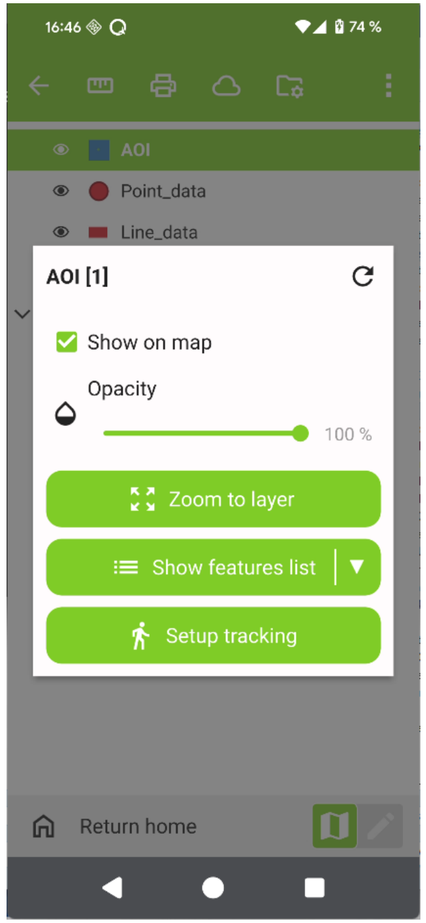
→ Start Qfield-Project

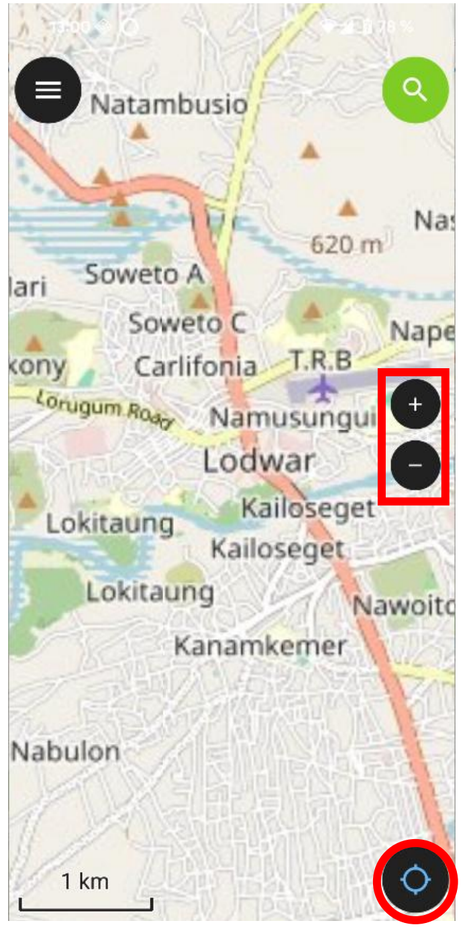
QField

- **Layer visibility, activation of positioning service**







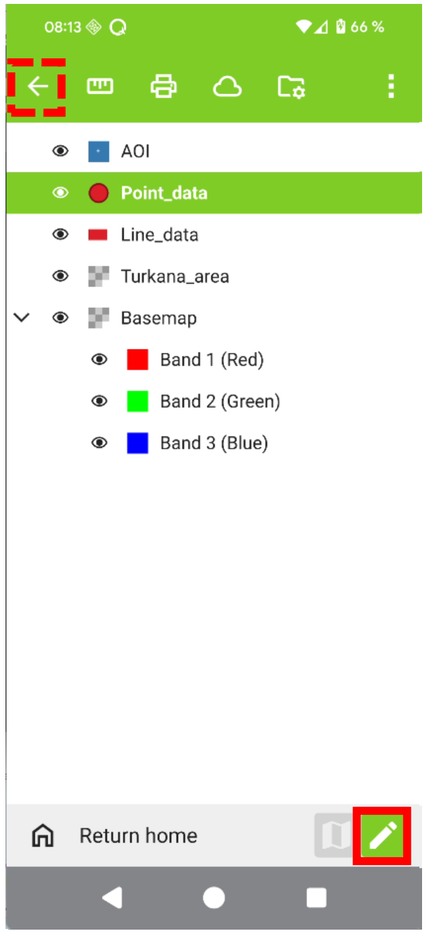


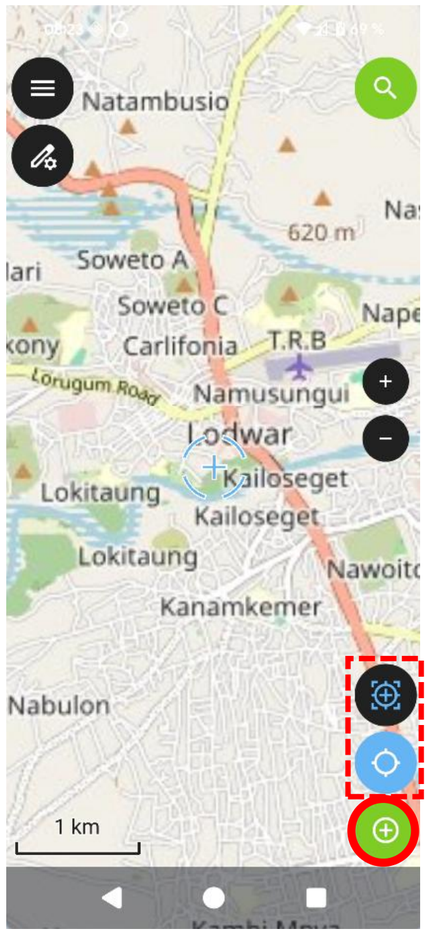
Zoom

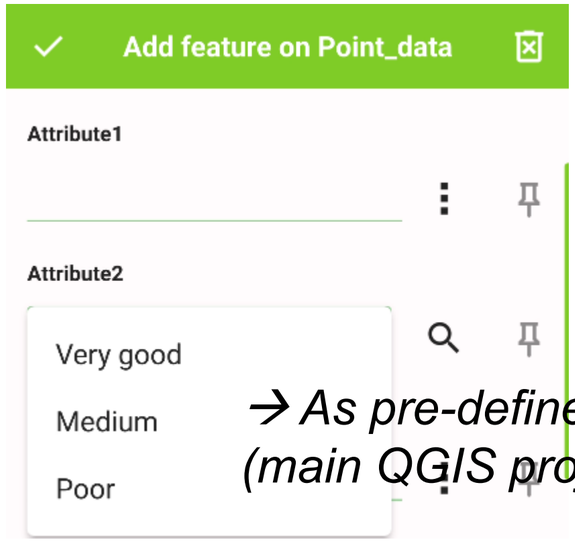
Positioning

QField

- **Data collection – Point data**







→ ***Fill out Attributes***

→ *As pre-defined in the Attributes form (main QGIS project)*

Positioning:

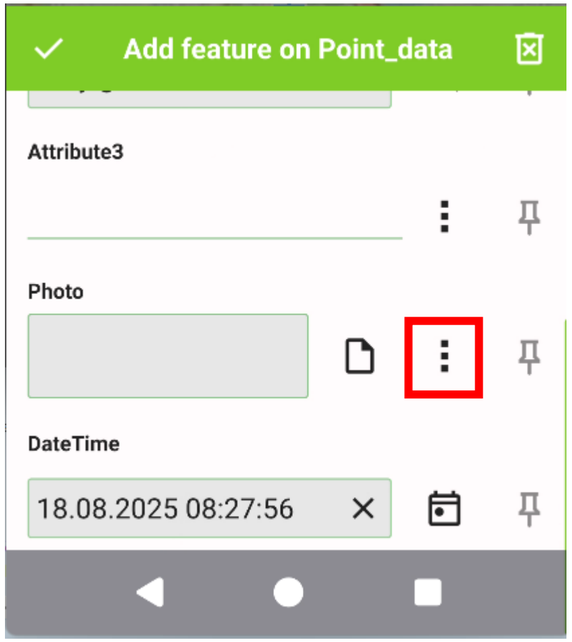
→Lock cursor to position

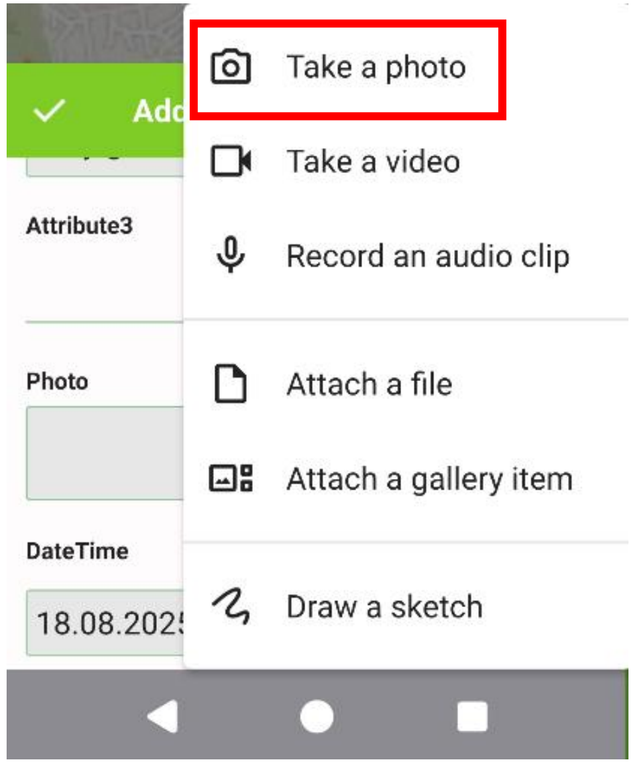
→Move to position

→**Add point to the postion**

QField

- **Attach photo to point**

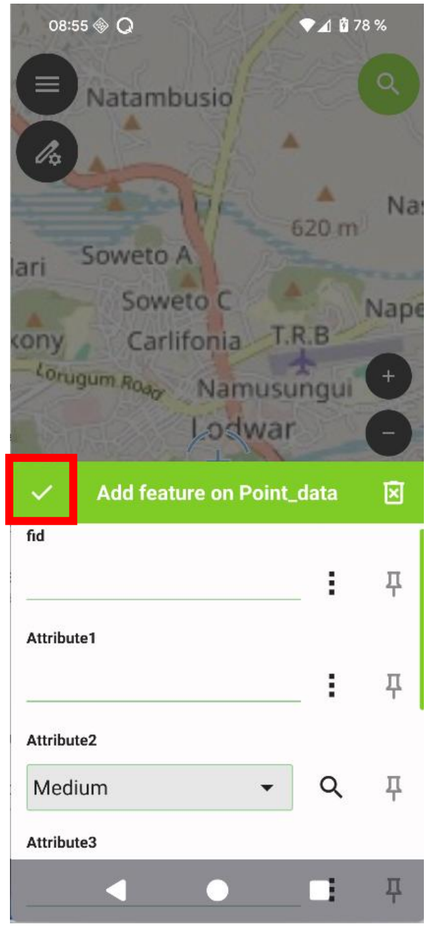




→ ***Take photo and confirm:***

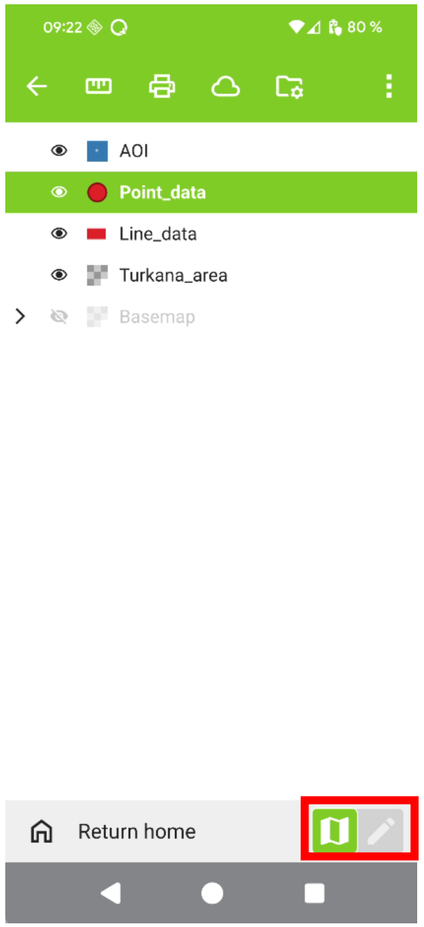
QField

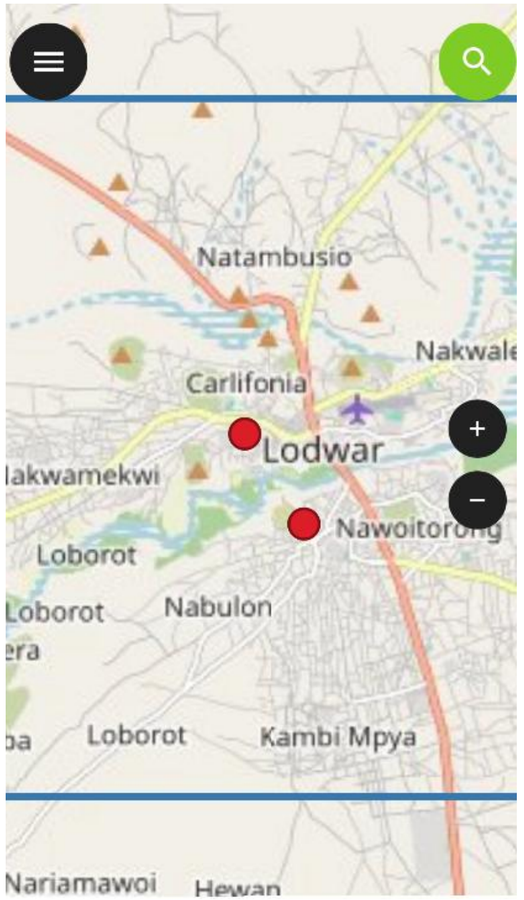
- **Confirm Point data**



Confirm with ✓!

- **Stop data collection at the end**

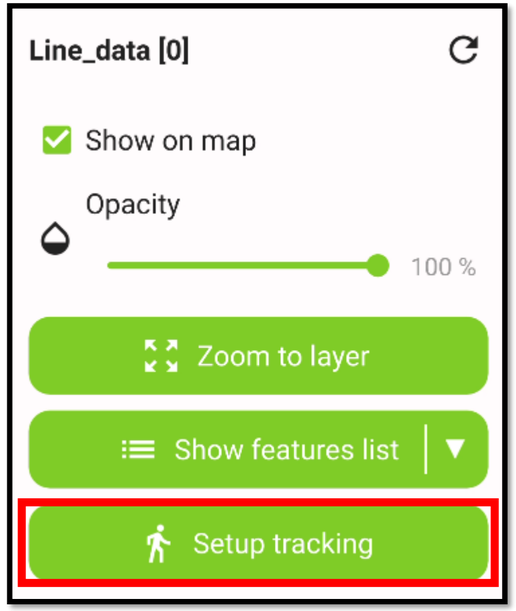


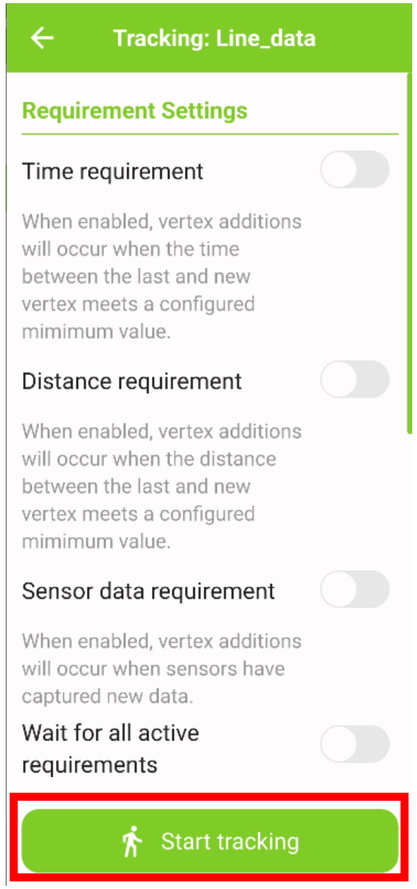


QField

- **Collection of Line data:** Record your path during field work

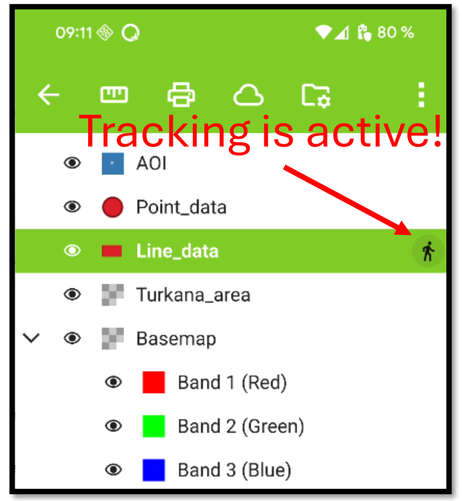
→ **1. Double click on Line data**



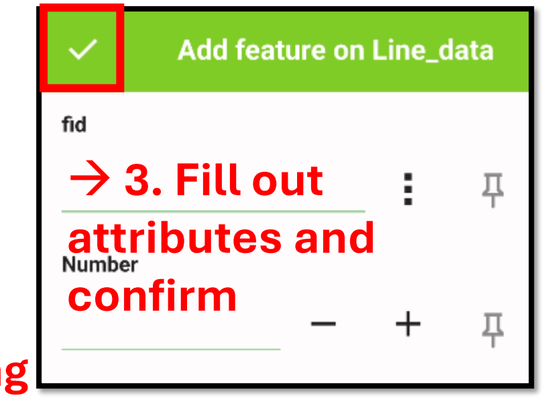


→ Keep defaults

→ **2. Start tracking**

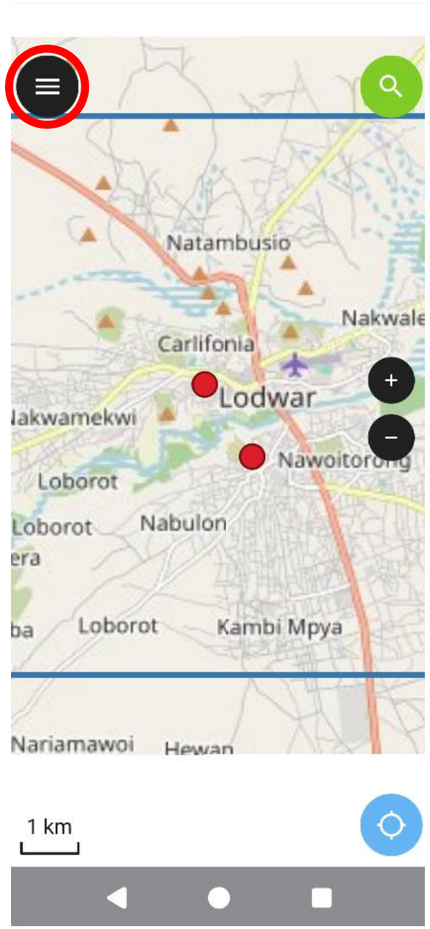


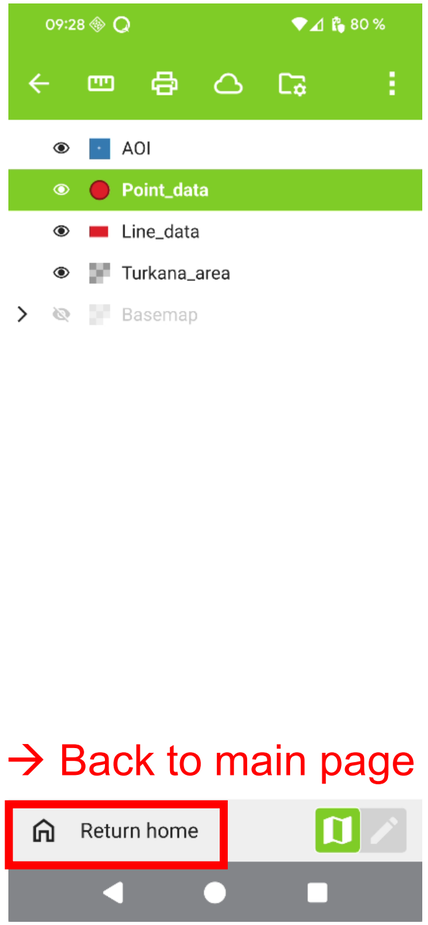
4. Stop tracking at the end: double-click on Line data and choose Stop tracking!

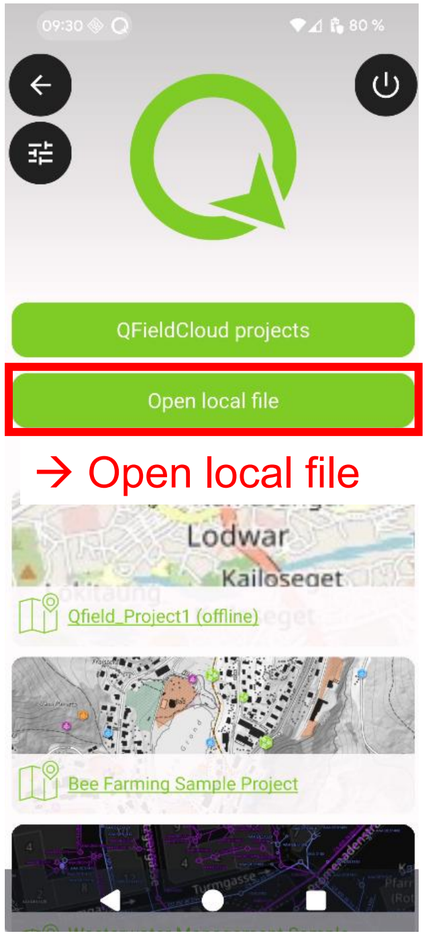


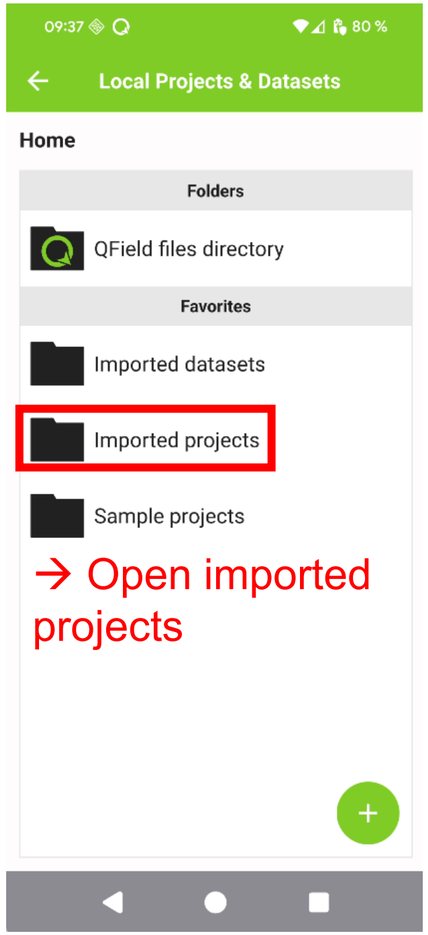
QField

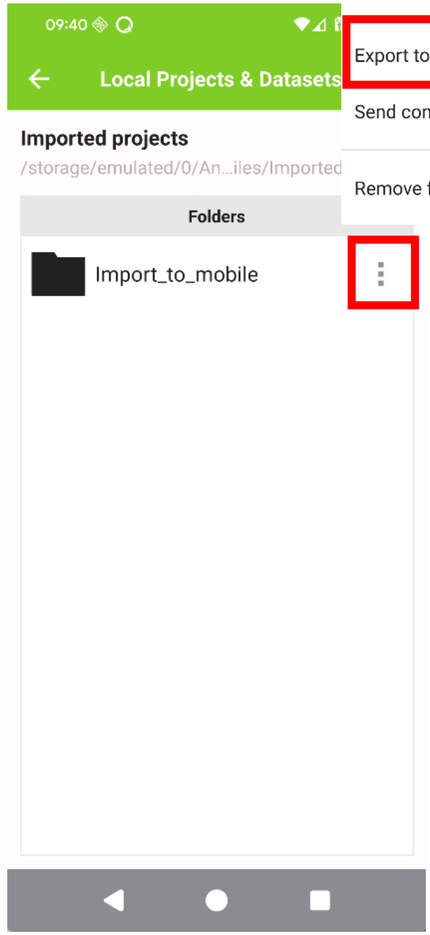
- **Transfer back to QGIS**

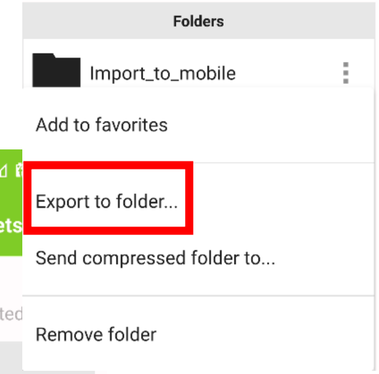




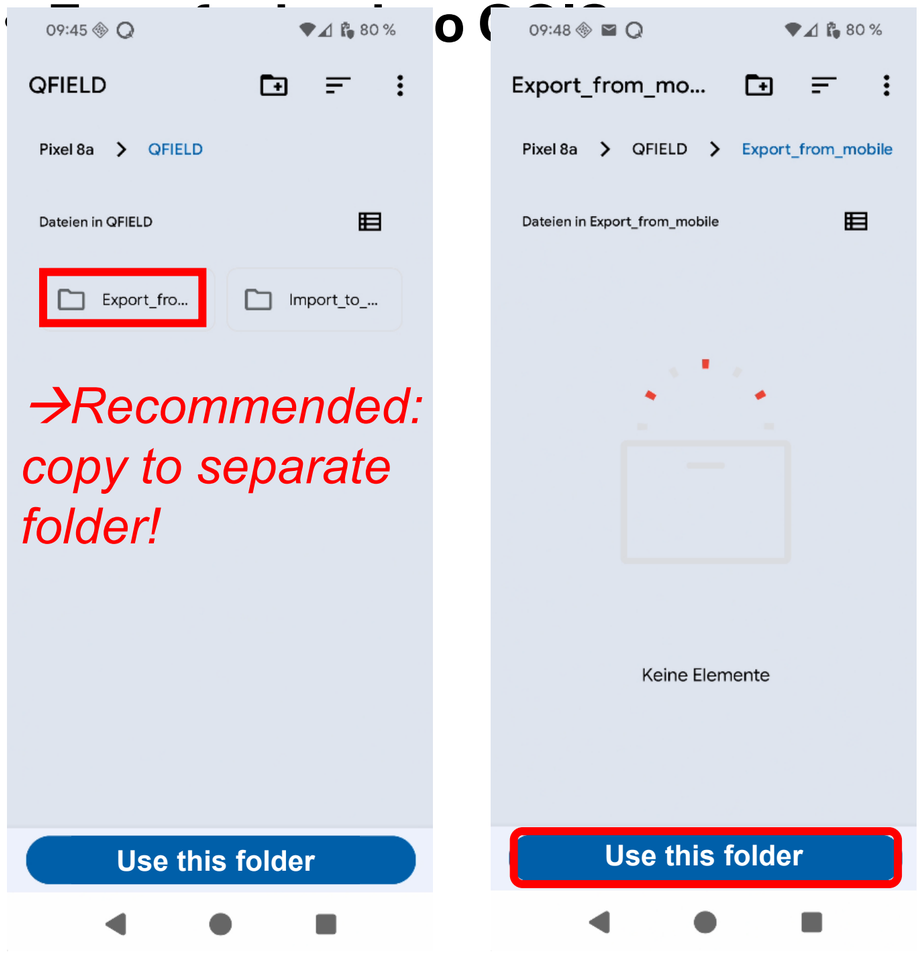






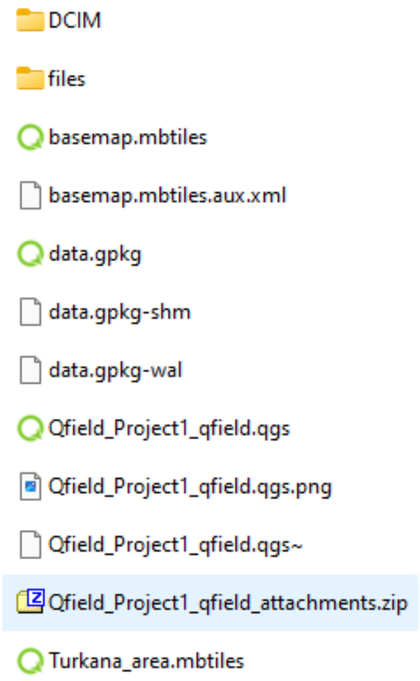


QField



→*Recommended: copy to separate folder!*

Copy the resulting content from the folder back to the computer!



Folder on mobile:

Export_from_mobile

Import_to_mobile

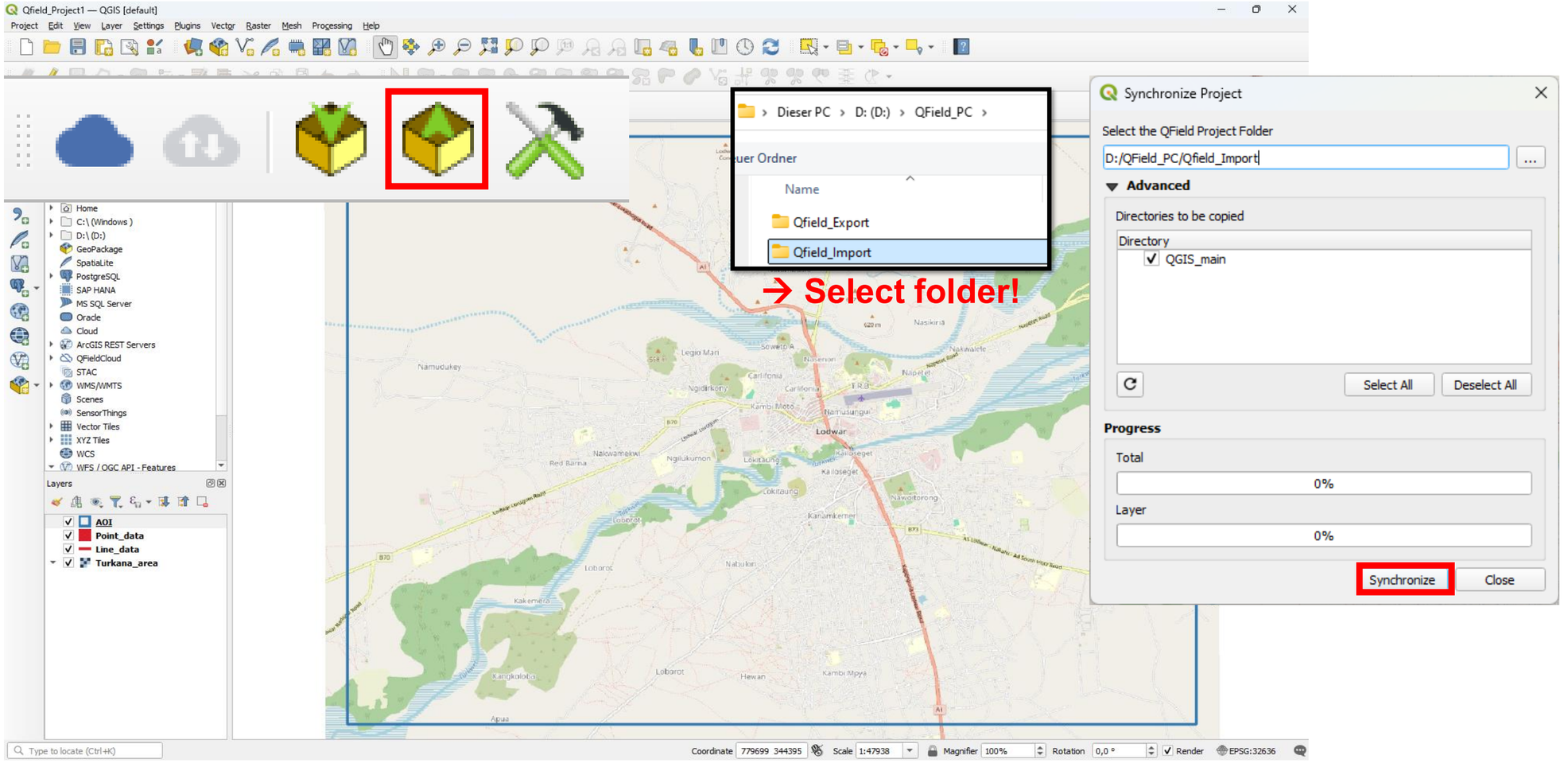
Folder on PC:

Qfield_Export

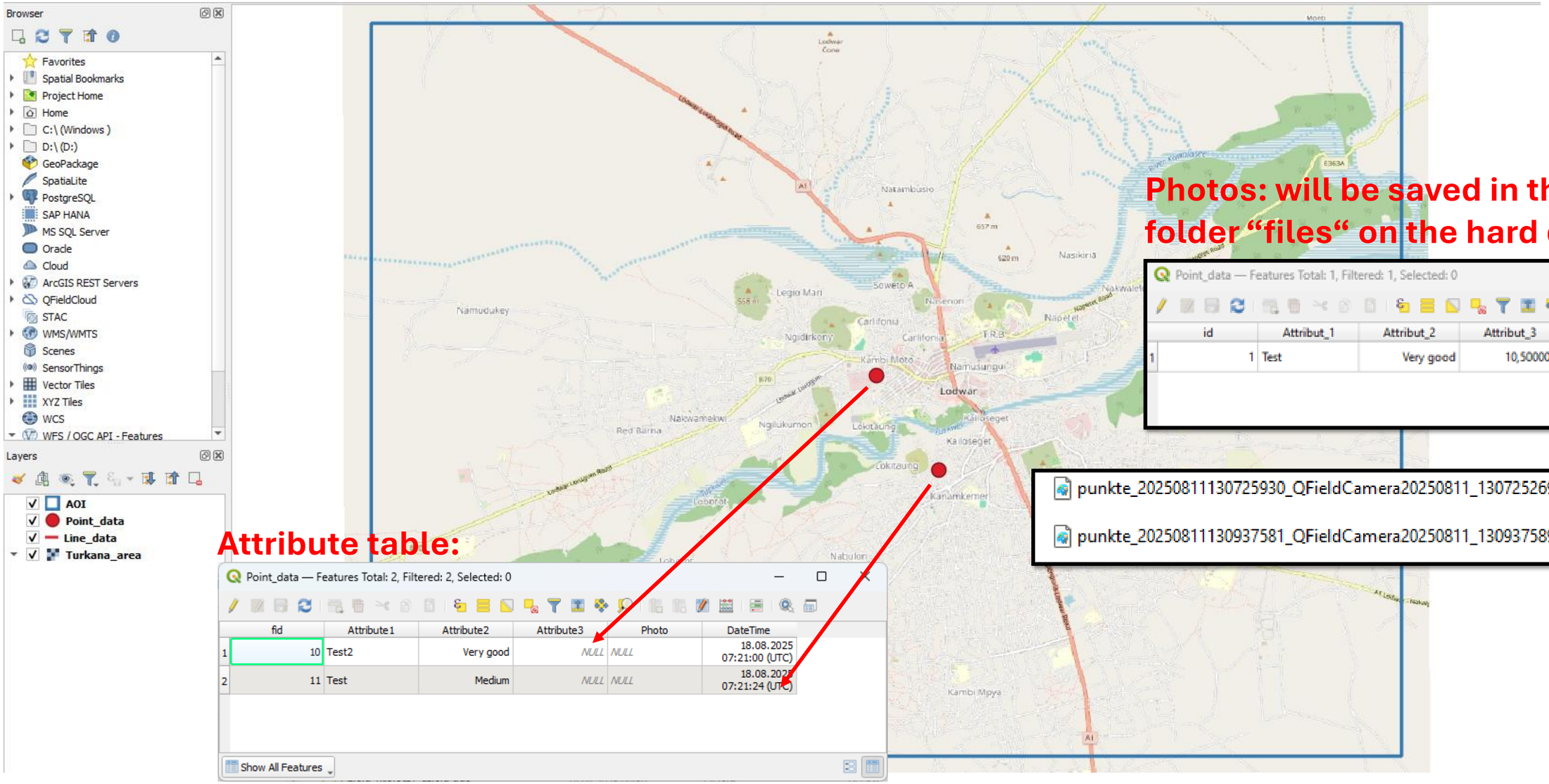
Qfield_Import

QGIS

- **Synchronize from QField**

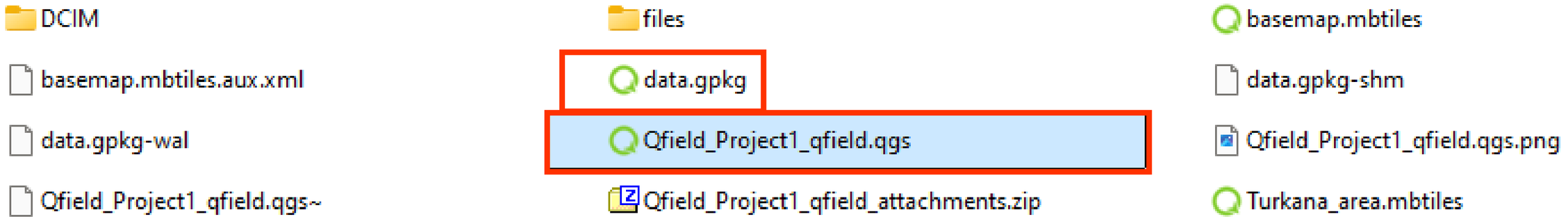


QGIS


Browser
Favorites
Spatial Bookmarks
Project Home
Home
C:\ (Windows)
D:\ (D:)
GeoPackage
SpatiaLite
PostgreSQL
SAP HANA
MS SQL Server
Oracle
Cloud
ArcGIS REST Servers
QFieldCloud
STAC
WMS/WMTS
Scenes
SensorThings
Vector Tiles
XYZ Tiles
WCS
WFS / OGC API - Features
Layers
AOI
Point_data
Line_data
Turkana_area
Photos: will be saved in the folder “files“ on the hard disk:
Point_data — Features Total: 1, Filtered: 1, Selected: 0
id
Attribut_1
Attribut_2
Attribut_3
Photo
1
Test
Very good
10,500000
files/202305230...
punkte_20250811130725930_QFieldCamera20250811_13072526959381881931036 51.jpg
punkte_20250811130937581_QFieldCamera20250811_13093758953796589352042 75.jpg
Attribute table:
Point_data — Features Total: 2, Filtered: 2, Selected: 0
fid
Attribute1
Attribute2
Attribute3
Photo
DateTime
1
10
Test2
Very good
NULL
NULL
18.08.2025 07:21:00 (UTC)
2
11
Test
Medium
NULL
NULL
18.08.2025 07:21:24 (UTC)
Show All Features
Lodwar
Nakambusio
Namudukey
Legio Mari
Soweto A
Nasenori
Carlifonia
Ngidirkony
Kambi Moto
Namusungui
Nakwamekwi
Ngilukumon
Lokitaung
Kalloseget
Kanamkemer
Nabulon
Kambi Mpya
Nasikiria
Napetet

QGIS

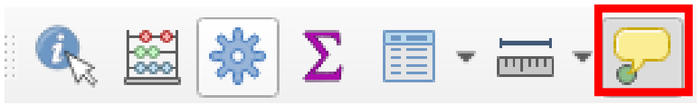
- **Trouble shooting** *(in case synchronization fails)*

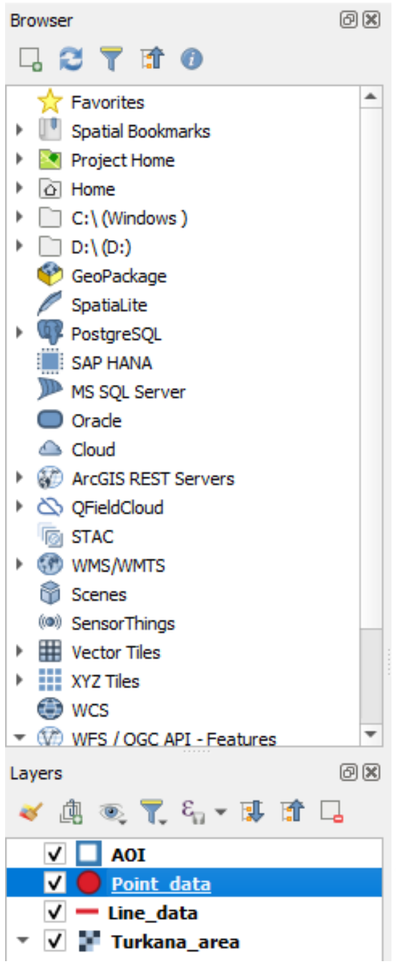


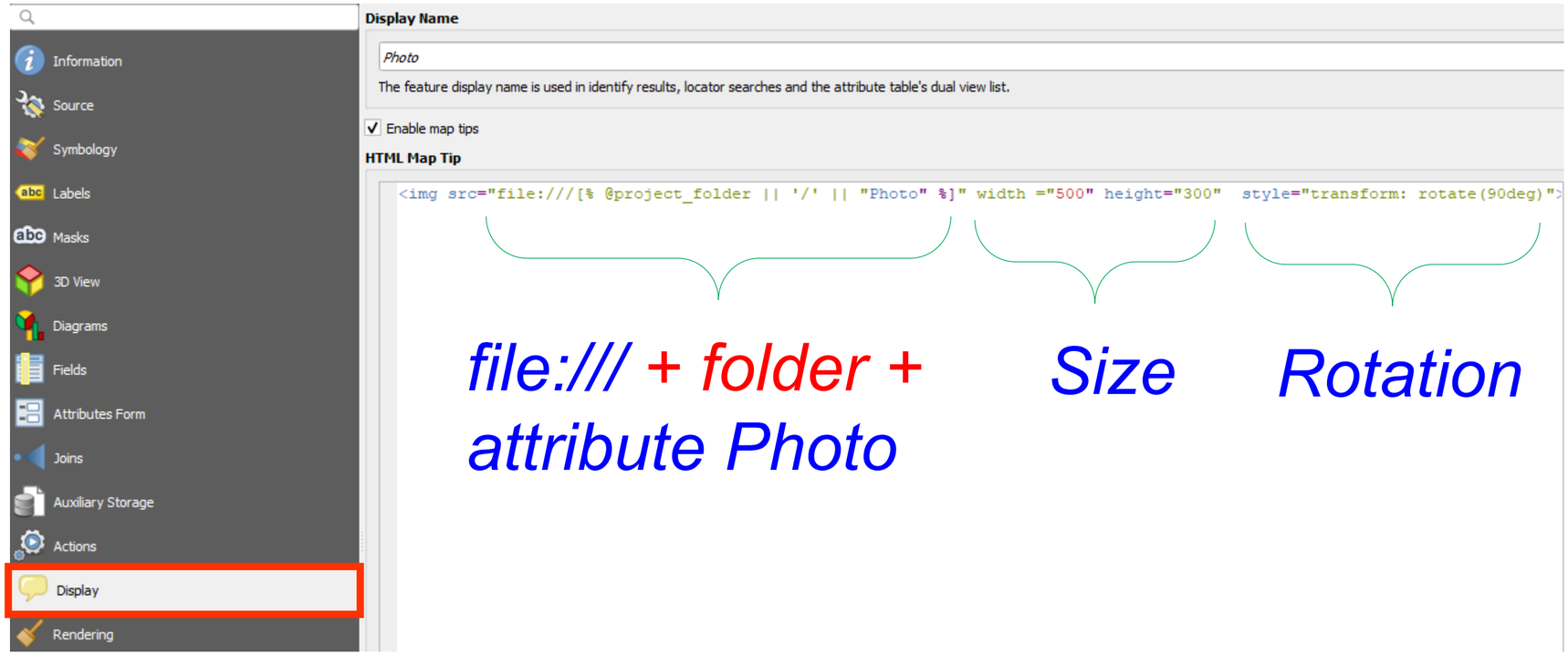
→ *QGIS project for QField (offline-project) can be re-opened with QGIS*
→ *Database (.gpkg) or Shape-File can be opened in the original QGIS project*
→ *Copy content to a new folder on PC*

QGIS

- **Display photo using „Map Tips“ (Attribute toolbar):**





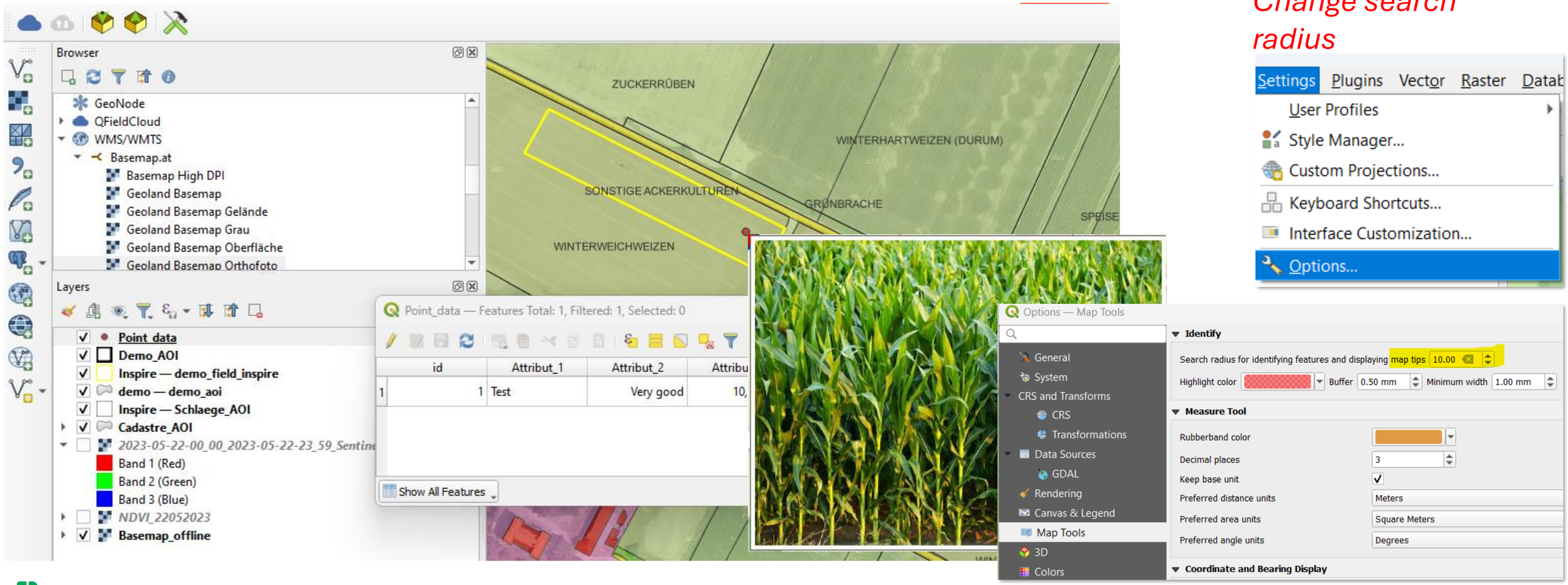


HTML code (example):
<img src="file:///[% @project_folder || '/' || "Photo" %]" width ="500" height="300" style="transform: rotate(90deg)">

QGIS

- **Display photo using „Map Tips“ (Attribute toolbar):**

Change search radius



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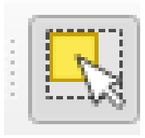
Day 2: Editing data

Modify features

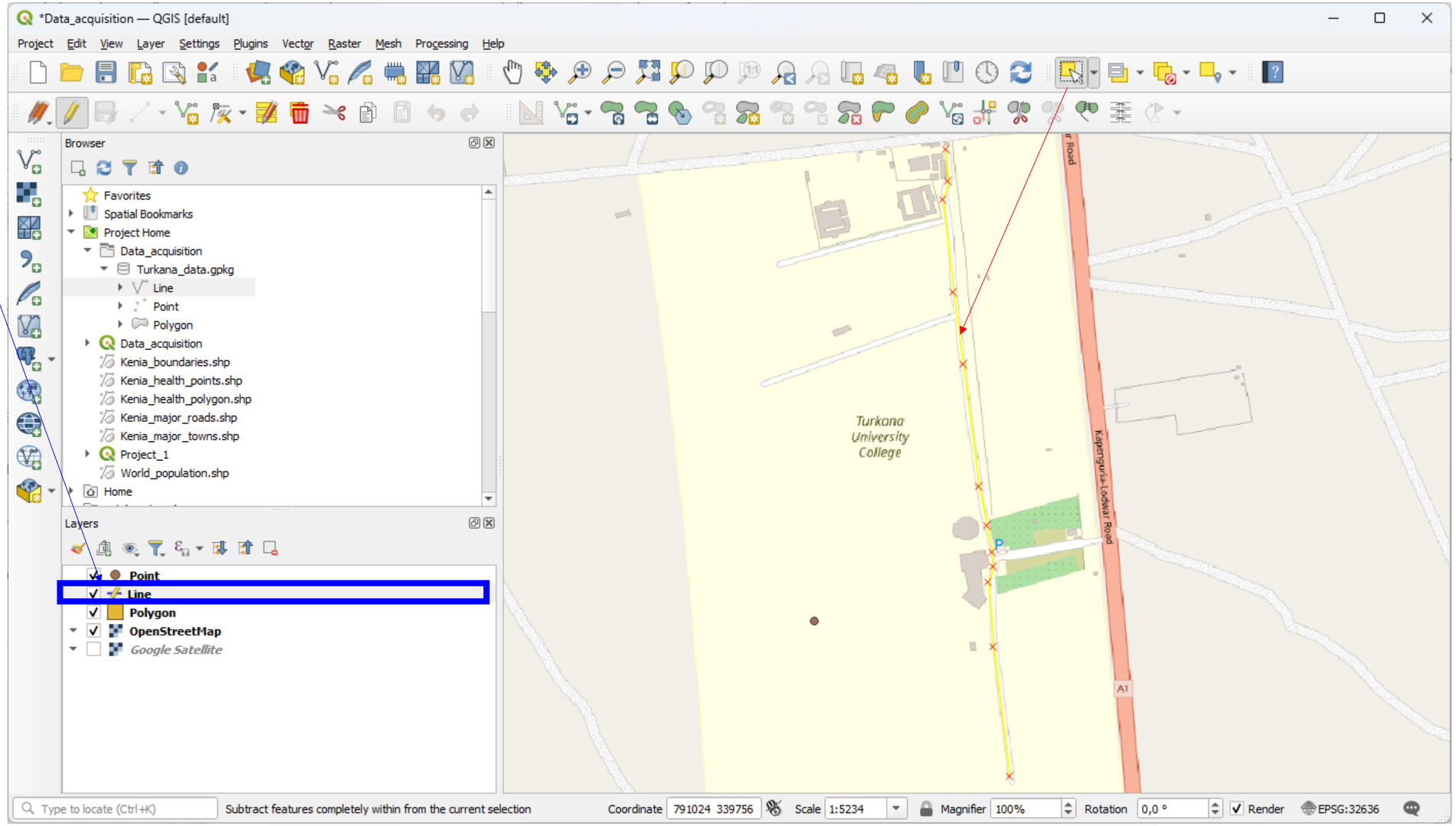
Science for [life]

Delete feature

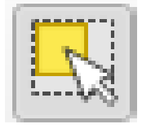
1. **Highlight layer**
2. **Select feature**

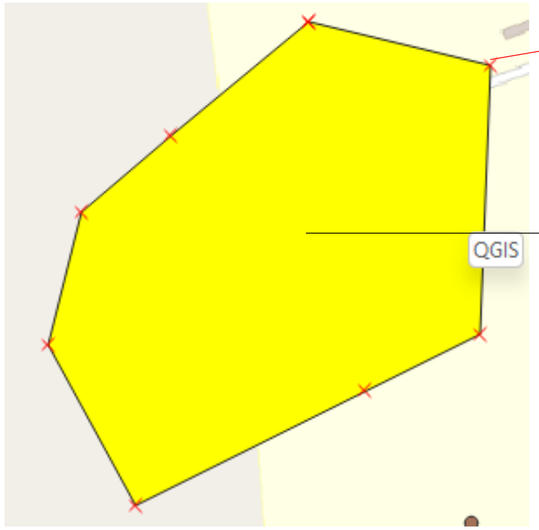


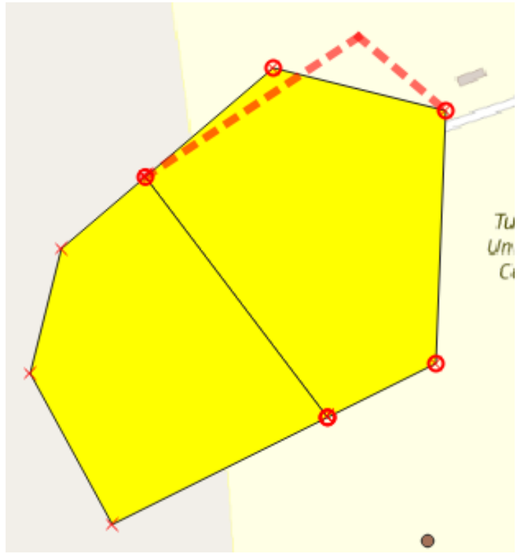
3. **Delete feature**



Edit vertices

- **Refine objects**
  - Select object 
  - Vertex tool: 
    - Delete vertex: click on vertex, press Delete
    - Move vertex: click on vertex, hold mouse button, move to new position
    - Add vertex: click on edge, move to correct position

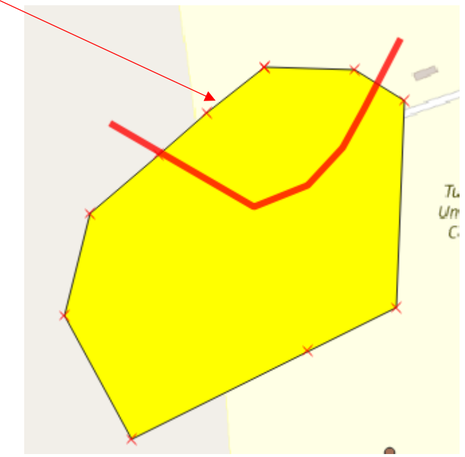


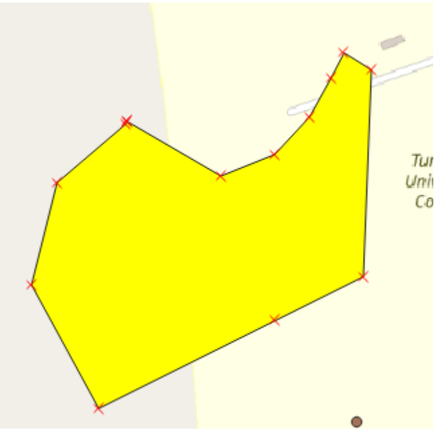


Modifying features

- **Advanced Digitizing Toolbar**

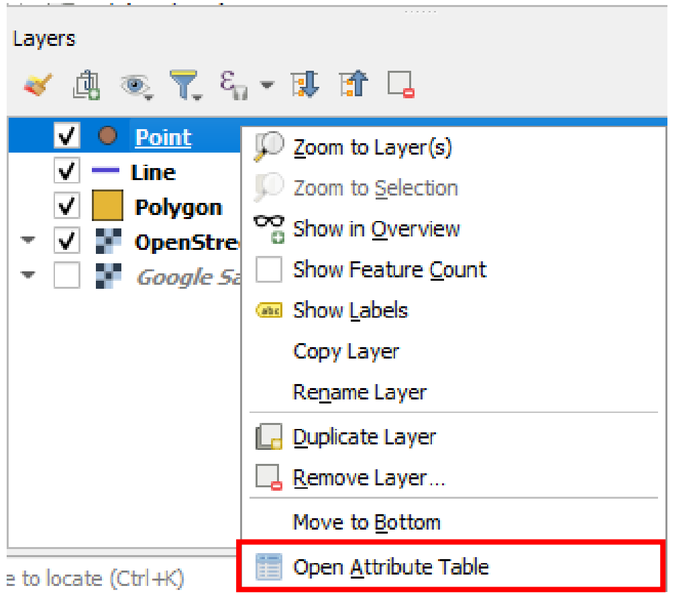
- Turn on advanced digitization tools (control panel)
- Move object, rotate object, scale object,…
- Fill Ring: Create island polygon
- Reshape features: Changing lines and boundaries
- Split features
- Merge selected features

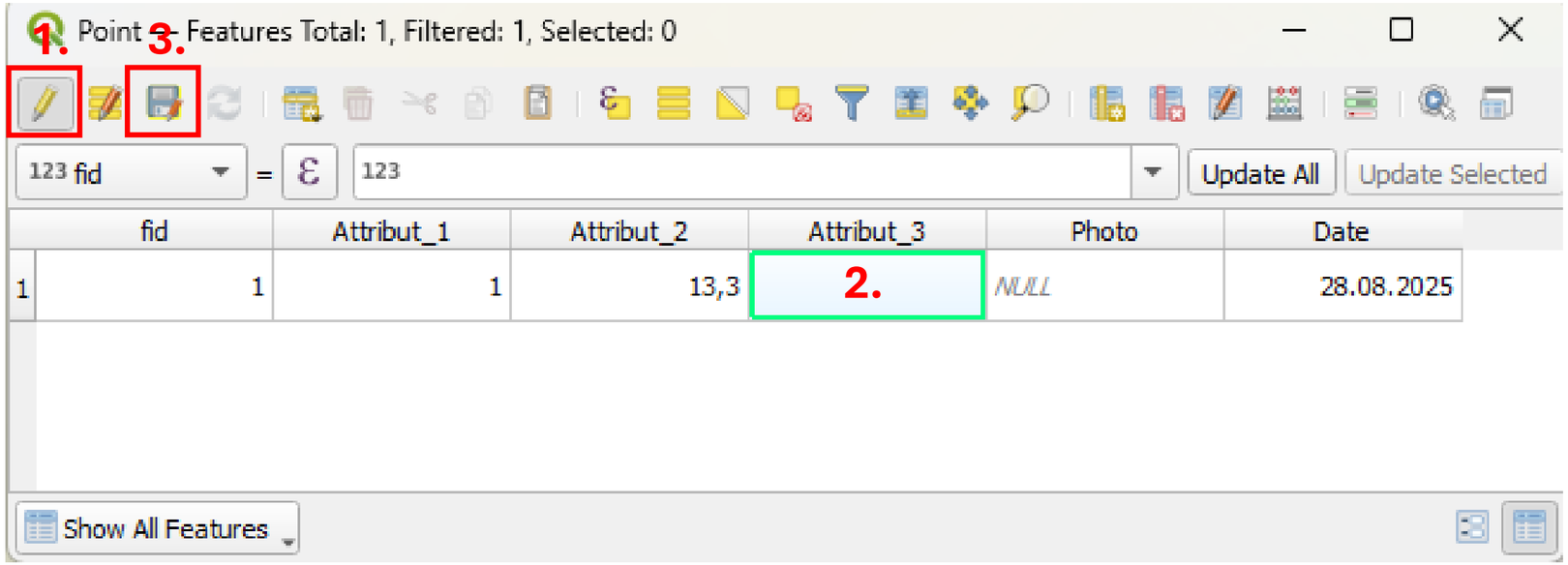




Edit attributes

- **Attribute table**

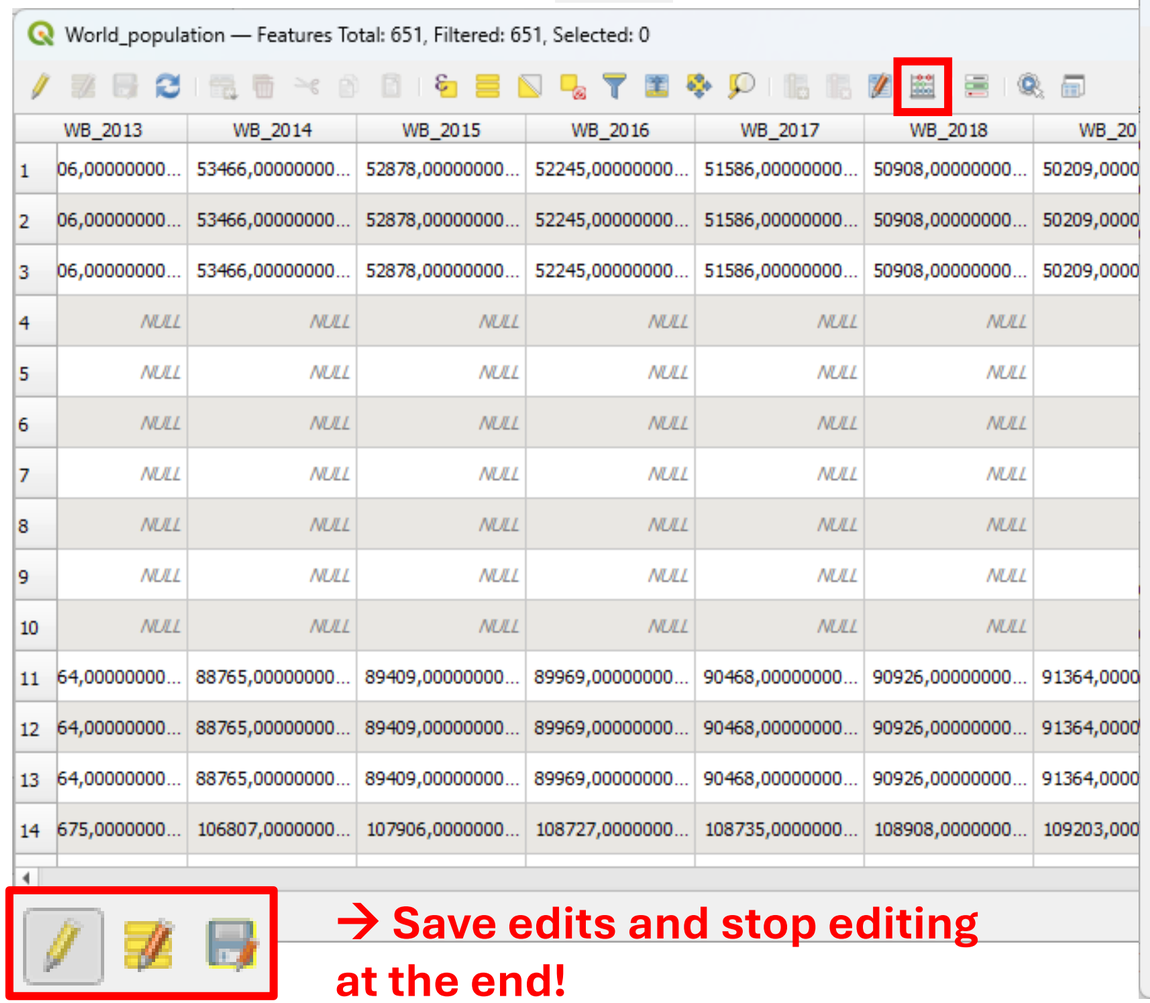




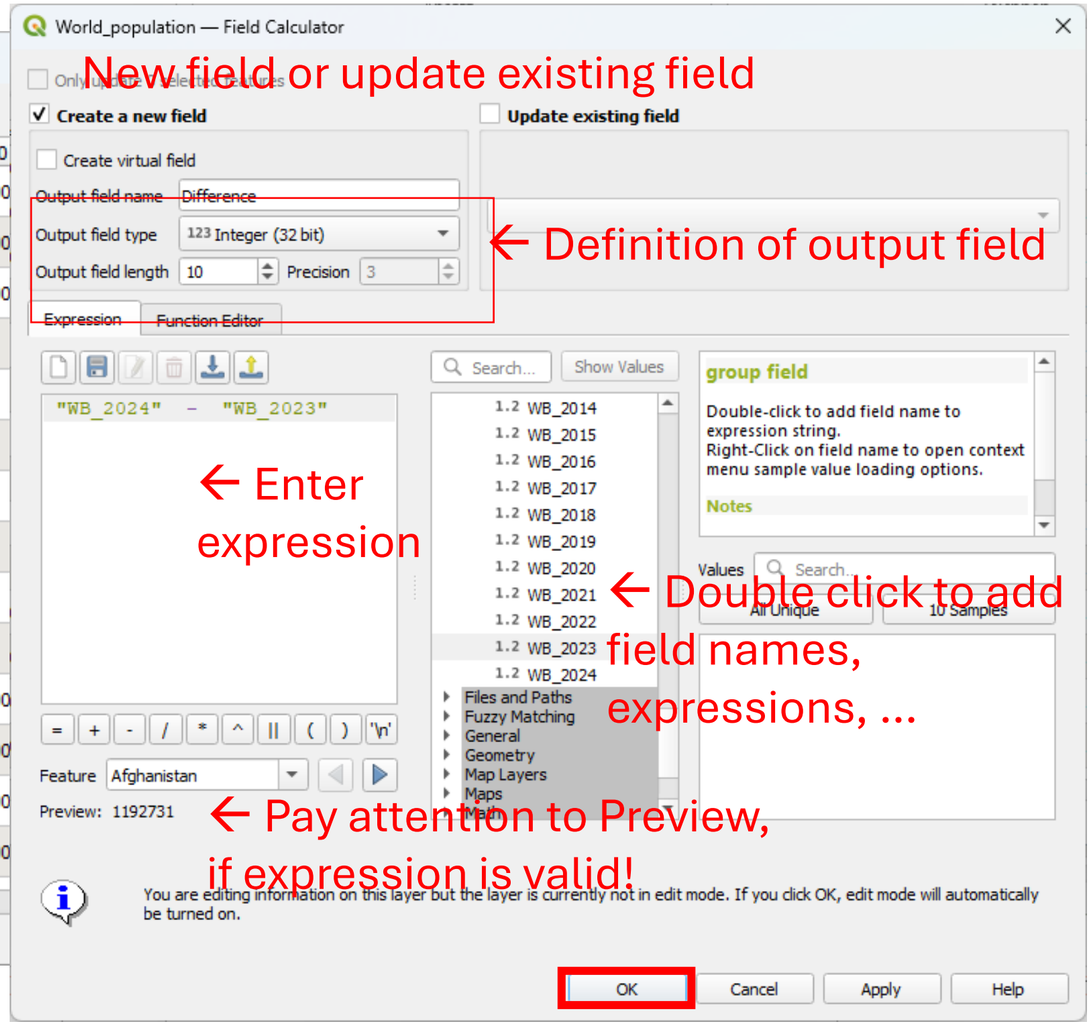
1. Start editing
2. Edit the cell
3. Save edits
4. (1.) Stop editing

Edit attributes

- **Field calculator**



→ **Save edits and stop editing at the end!**



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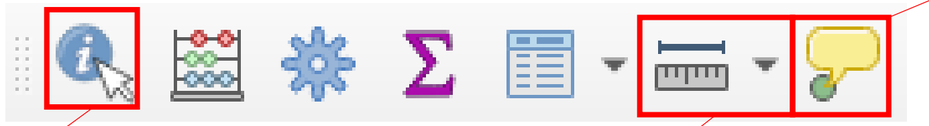
Day 2: Data analysis

Geoprocessing

Science for [life]

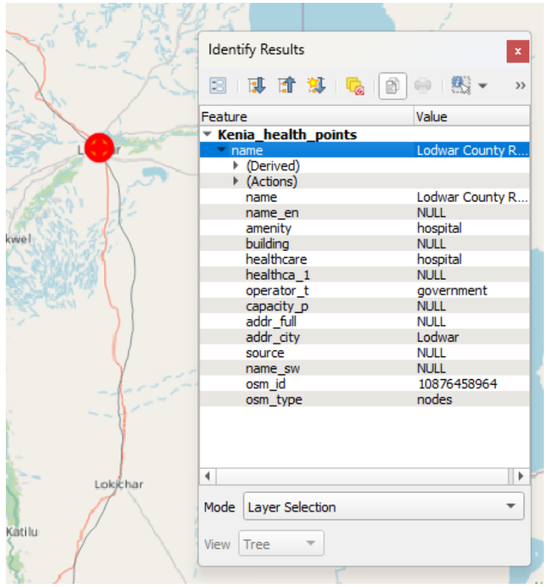
Basic analysis tools

- **Attributes toolbar**



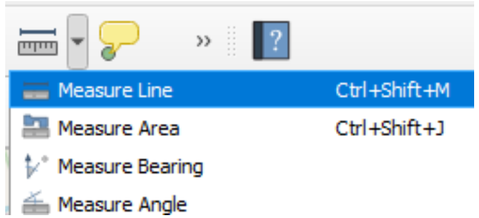
- **Show Map Tips**

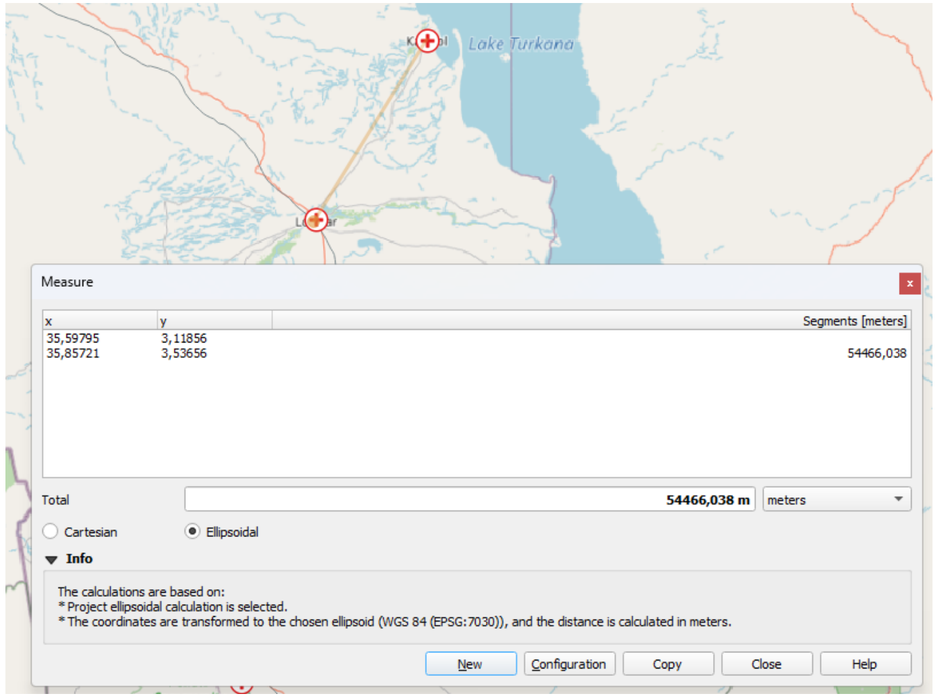
- **Identify features**



→ Content of attribute table for single feature

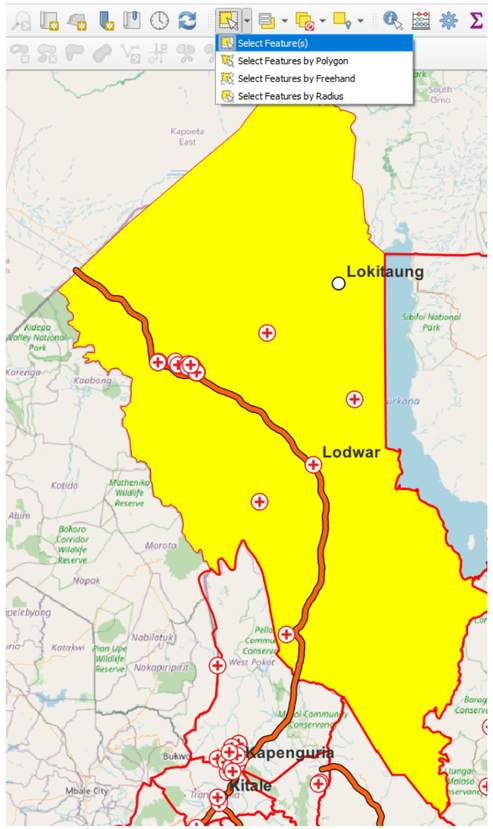
- **Measurements**

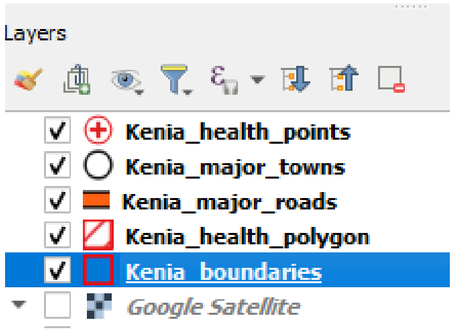




Selection

- **Select features by area or single click**



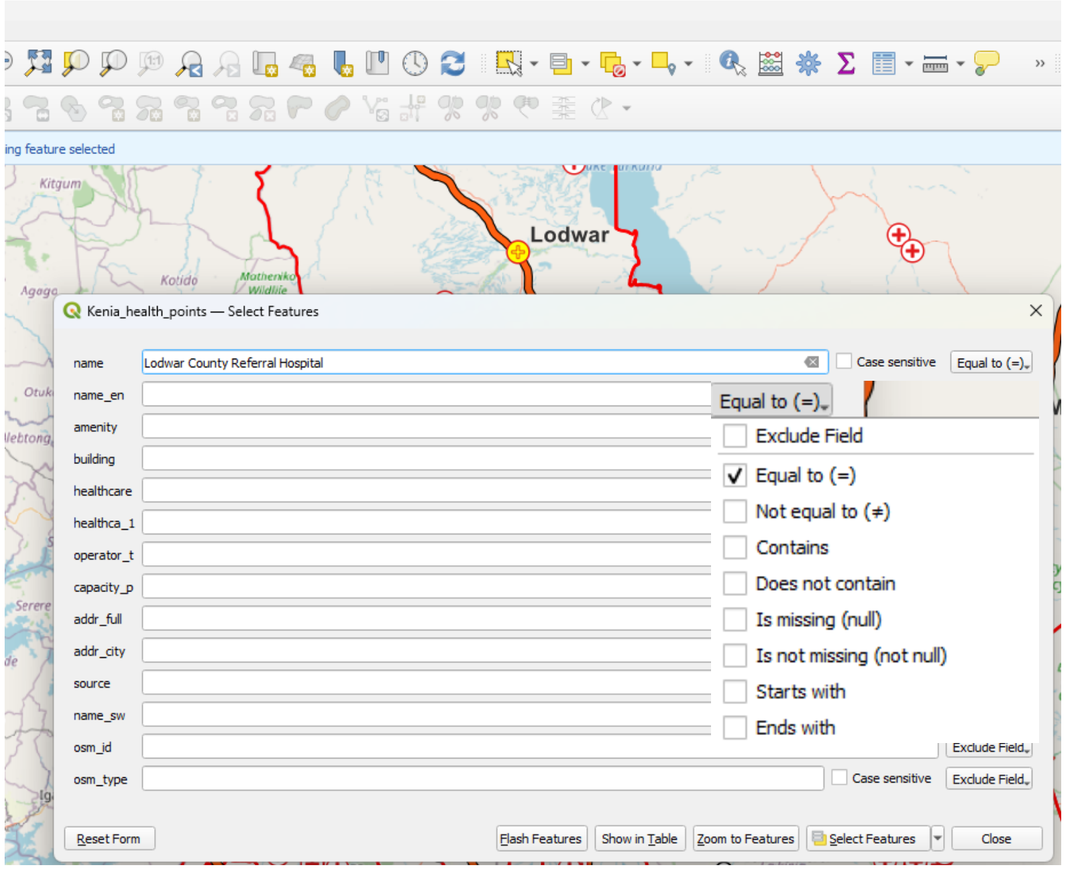


→ Highlight layer to select features from

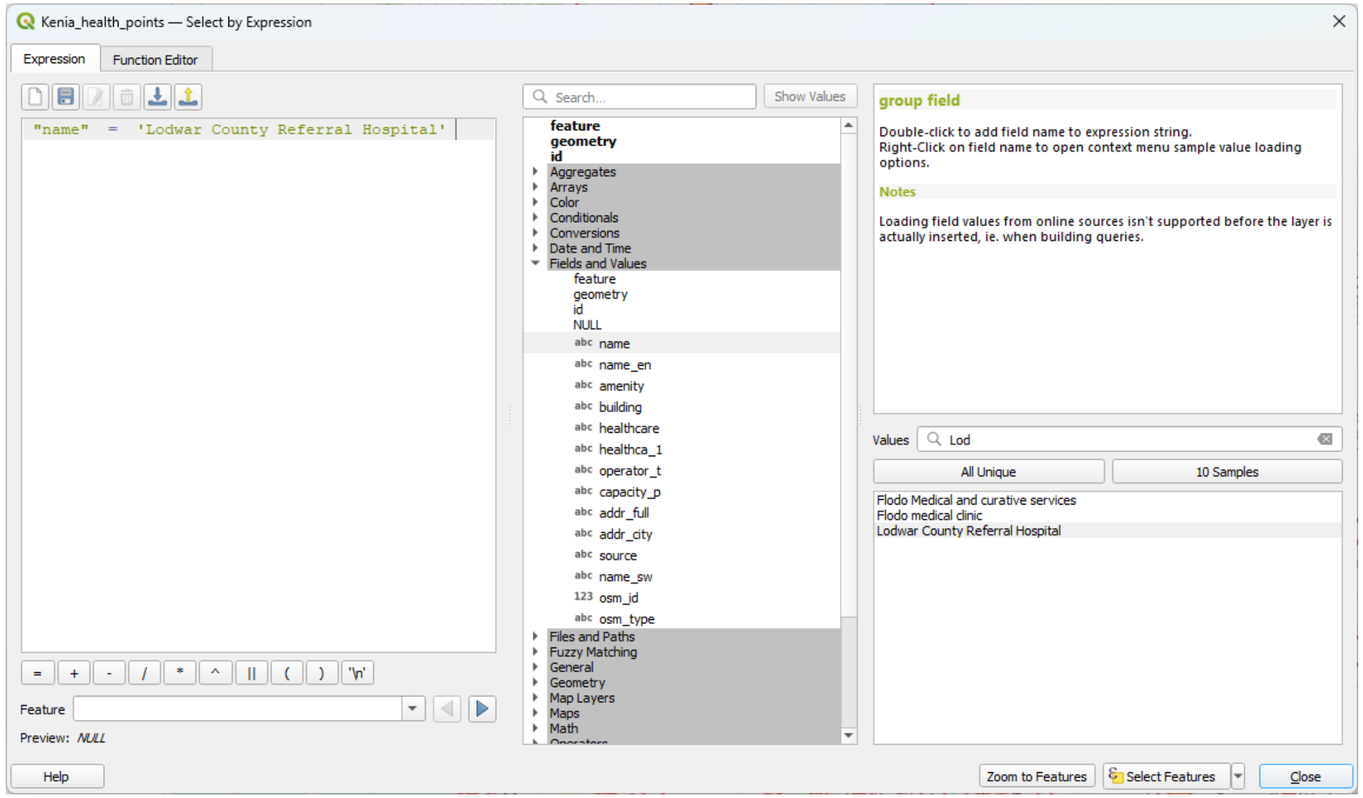
- **Deselect features**

Selection

- **Select features by value**

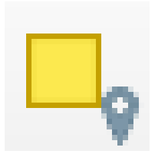


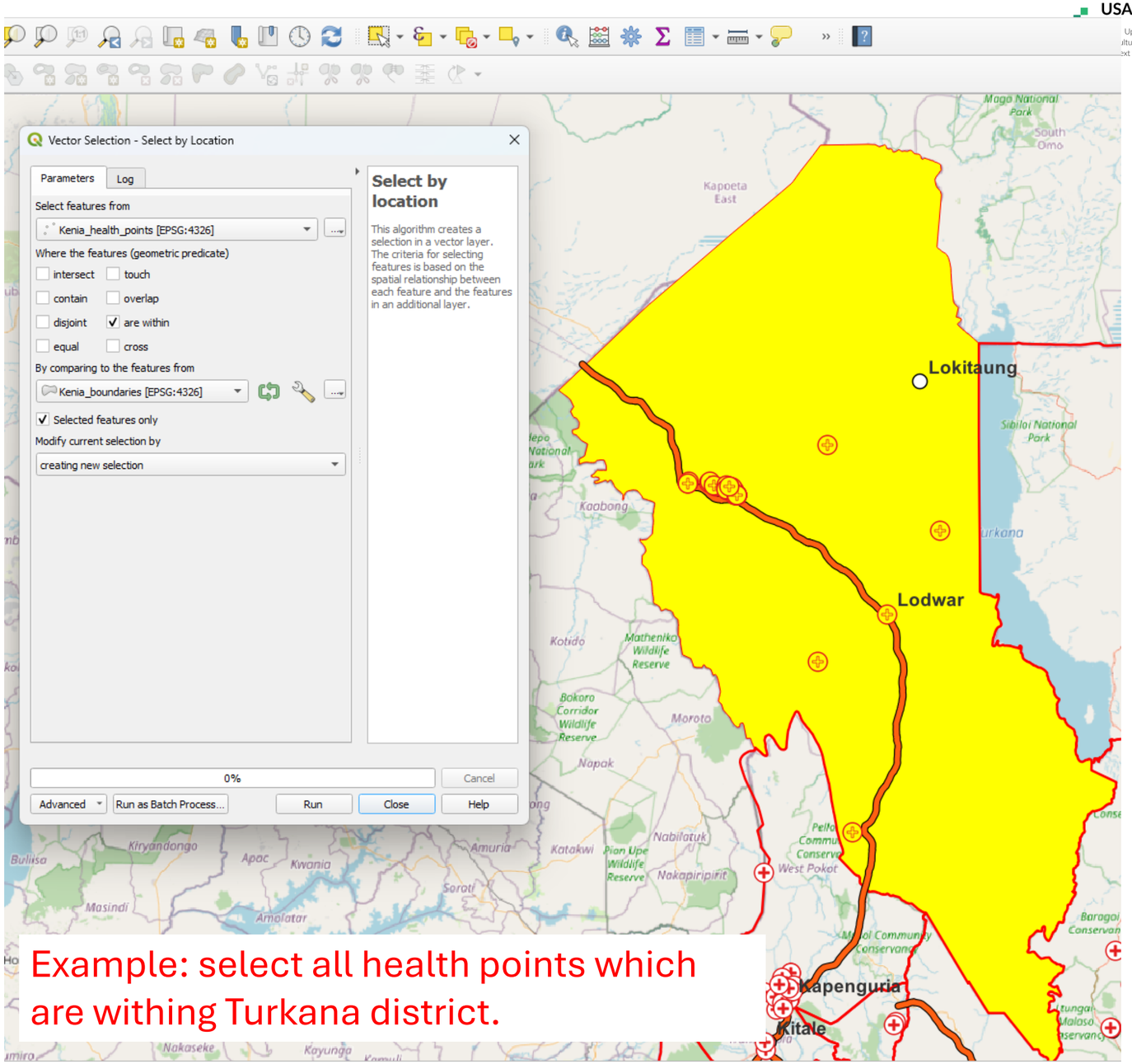
- **Select features by expression**



Selection

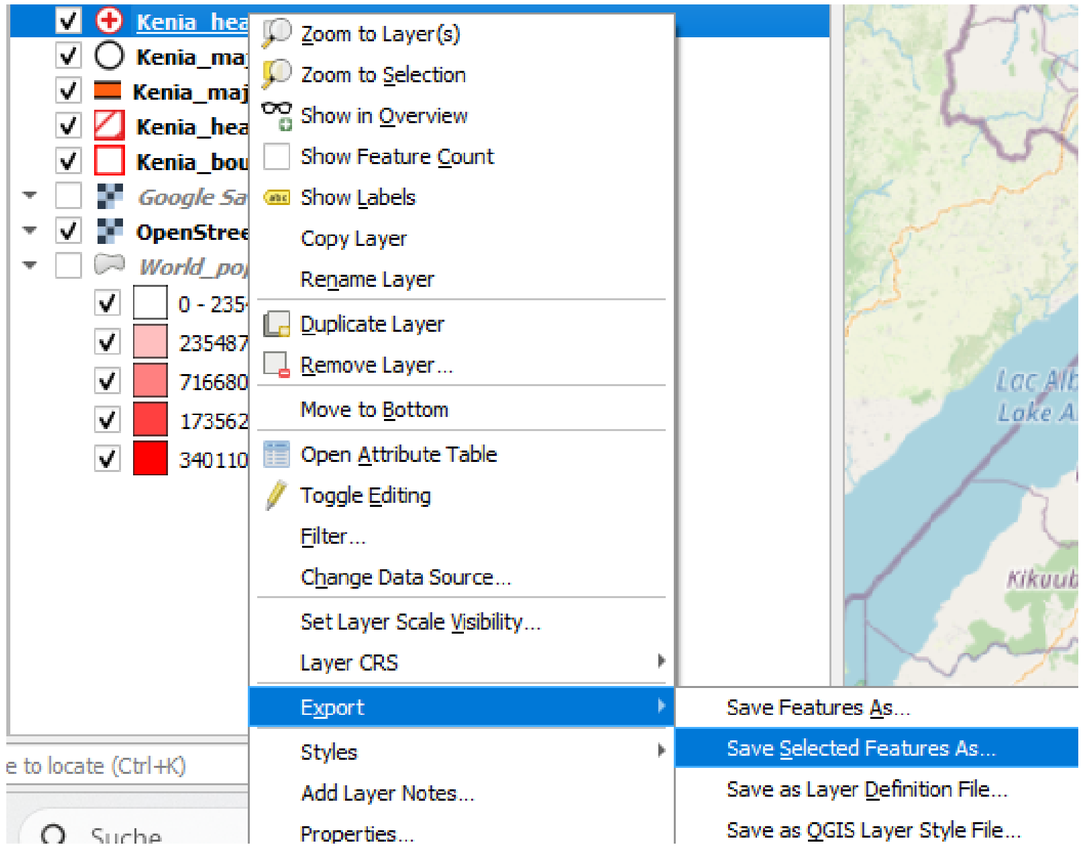
- **Select by location**

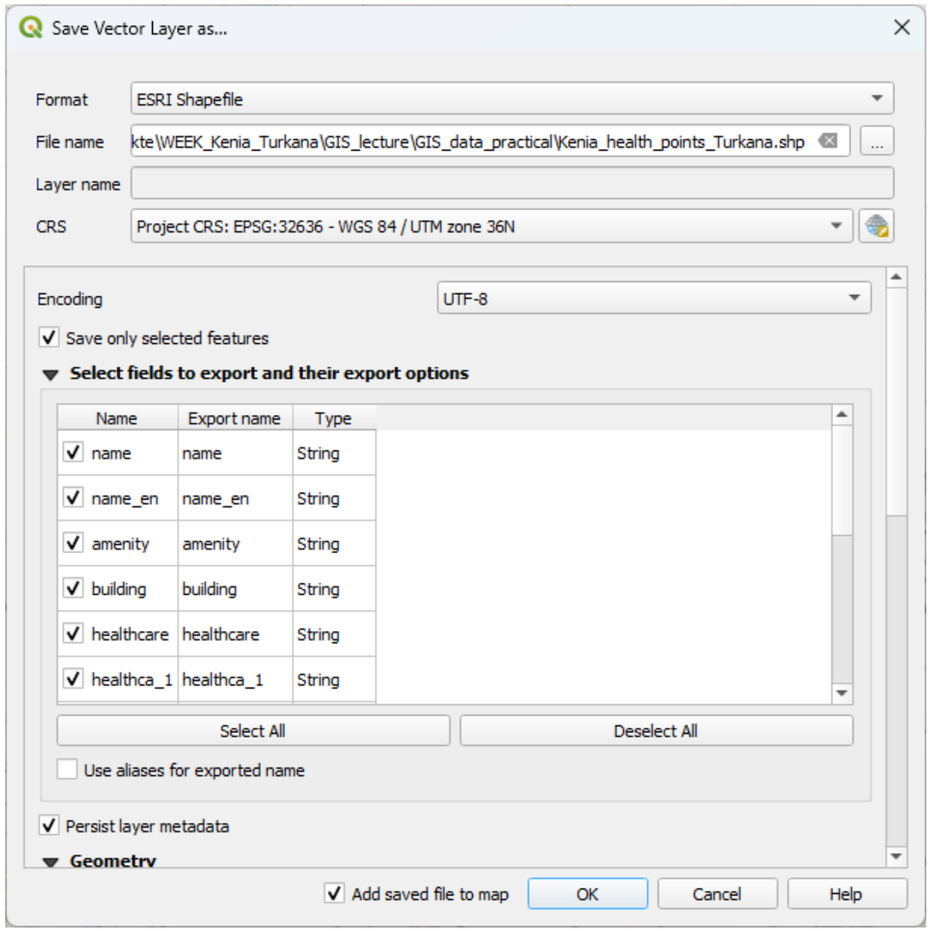




Export selected features

- **Create a new layer with just the selected objects**

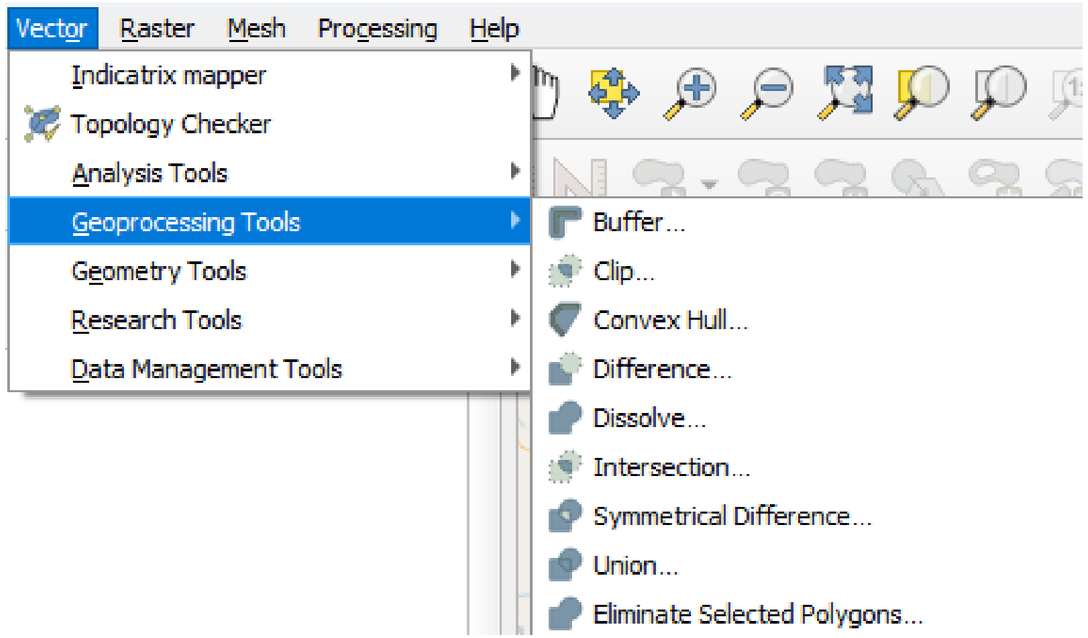




- Data type
- New name
- Coordinate reference systeme
- Attribute fields to export
- …

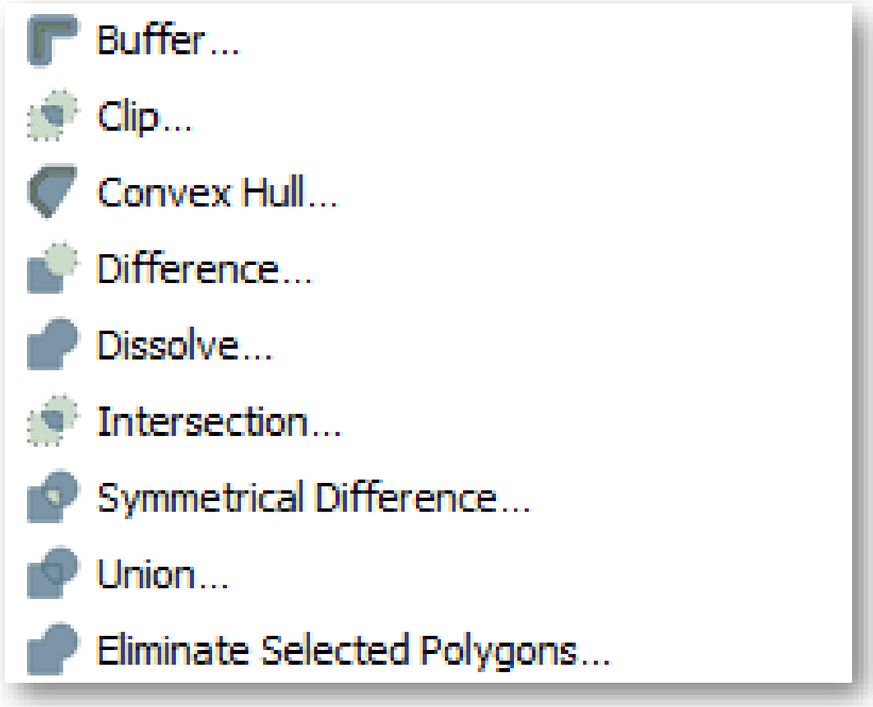
Geoprocessing

- QGIS geoprocessing involves using specialized tools within the QGIS GIS software **to manipulate spatial data, creating new datasets** by performing operations like buffering (creating zones around features), clipping (extracting features within a boundary), dissolving (aggregating features), unioning (combining layers), and intersecting (finding overlapping areas). These tools are fundamental for data preparation, analysis, and generating insights for decision-making in fields such as urban planning, agriculture, and environmental management



Geoprocessing

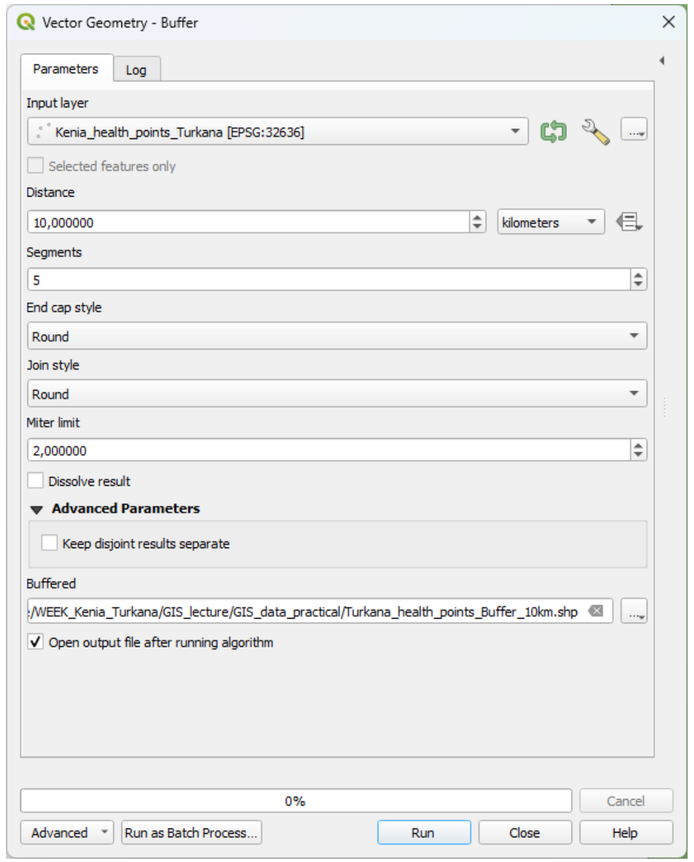
- **Buffer**
- **Clip**
- **Difference**
- **Dissolve**
- **Intersection**
- **Union**



Output: always a new layer. Either permanent (saved on harddisk asShape-File or GeoPackage) or temporary.

Buffer

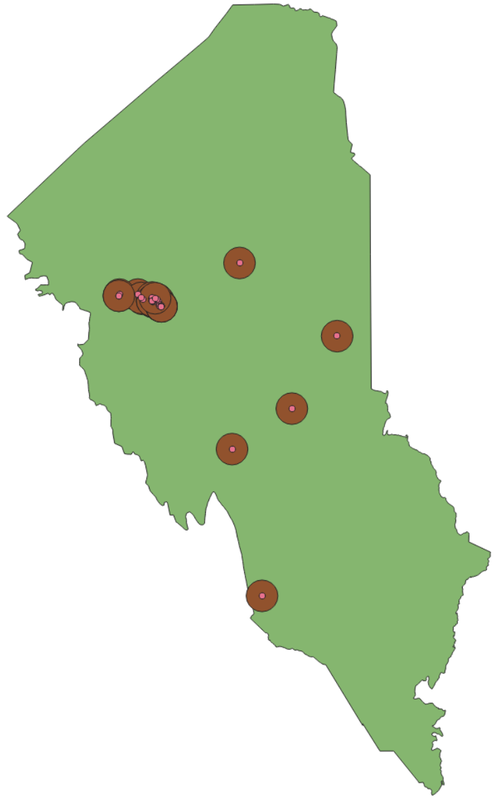
- **Proximity:** Computes a buffer area for all the features in an input layer, using a fixed or data defined distance. It is possible to use a negative distance for polygon input layers. In this case the buffer will result in a smaller polygon (setback).

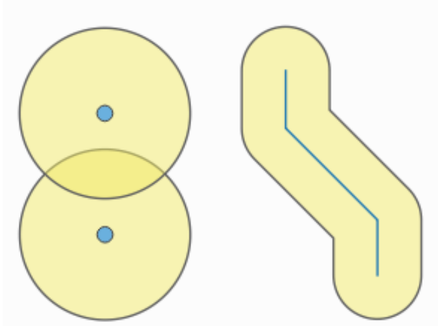


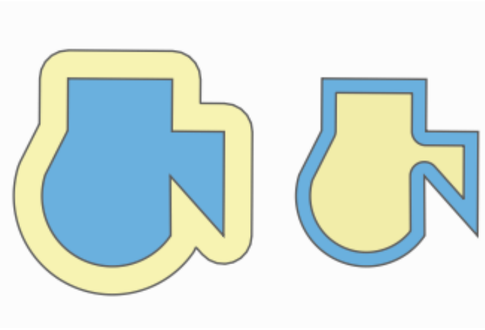
→ Input

→ Distance (depends on CRS of the layer!)

→ Output layer (Shape-File or GPKG)

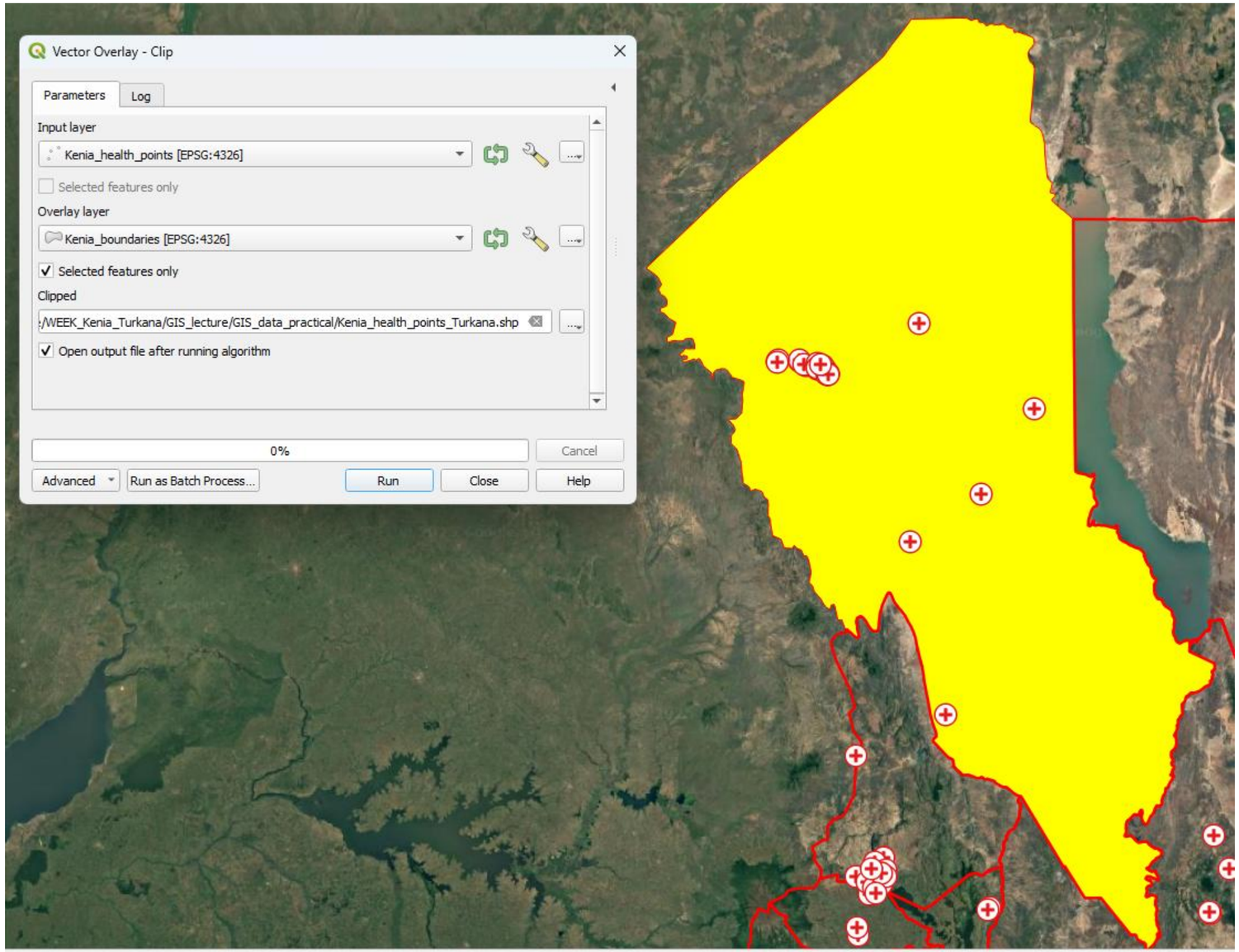






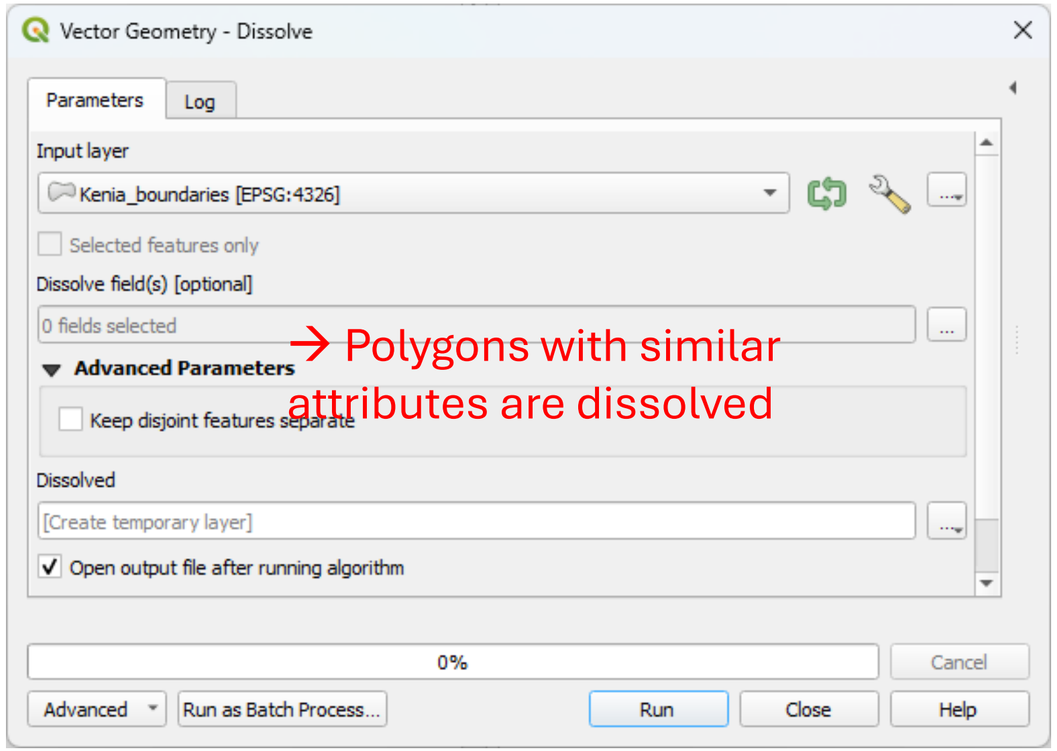
Clip

- **Clip objects:** Clips a vector layer using the features of an additional polygon layer. Only the parts of the features in the input layer that fall within the polygons of the overlay layer will be added to the resulting layer.

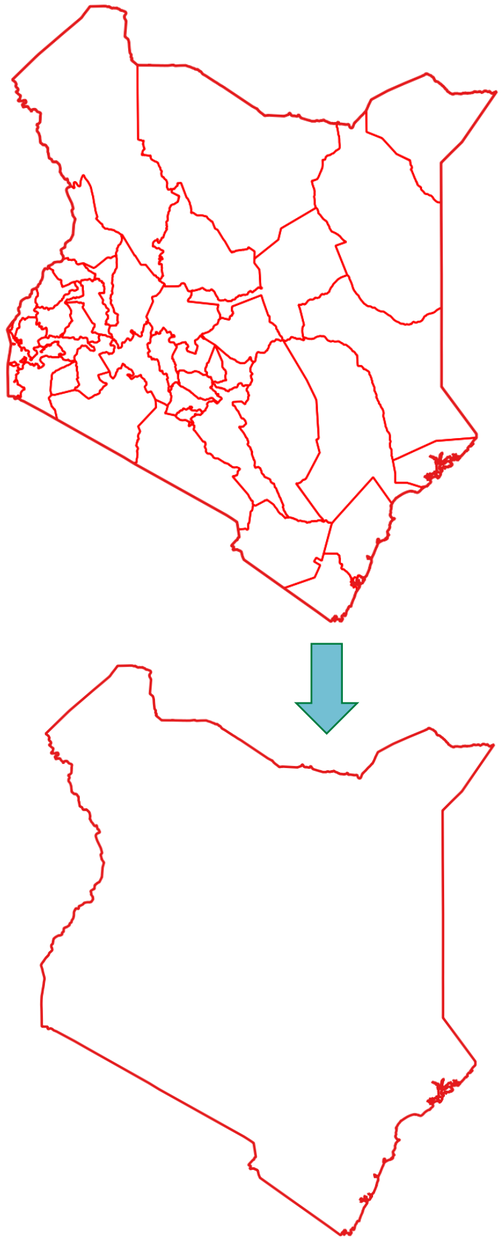


Dissolve

- Dissolving objects based on shared attribute. Leeds do connected features (adjacent polygons) or multipart features.

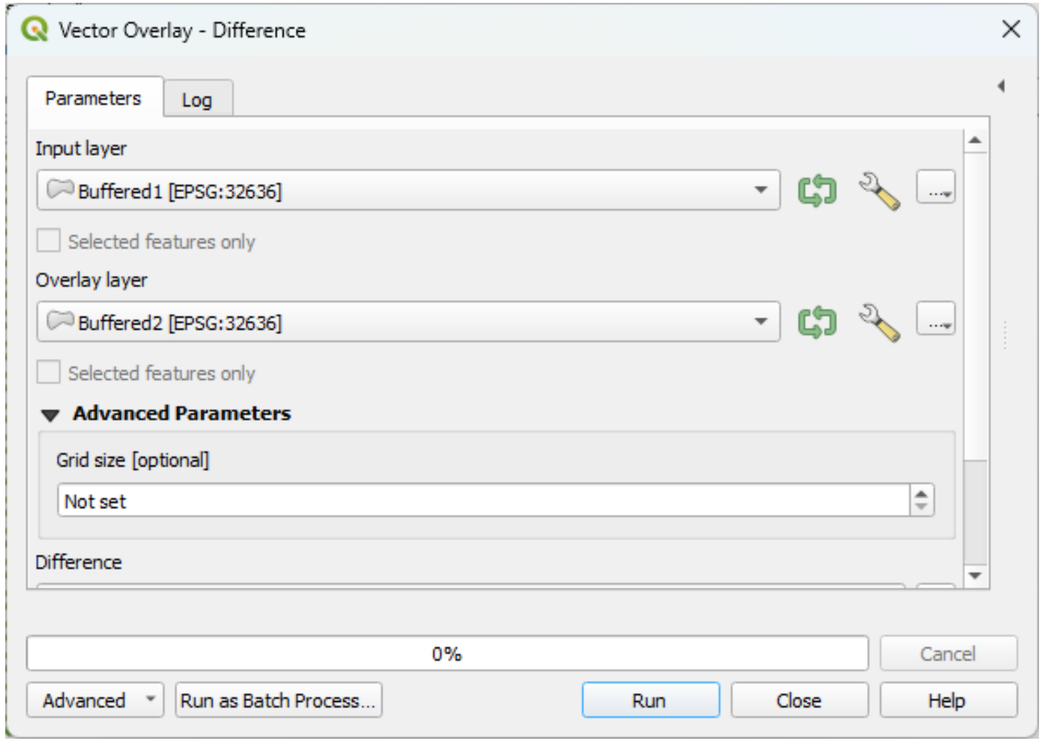


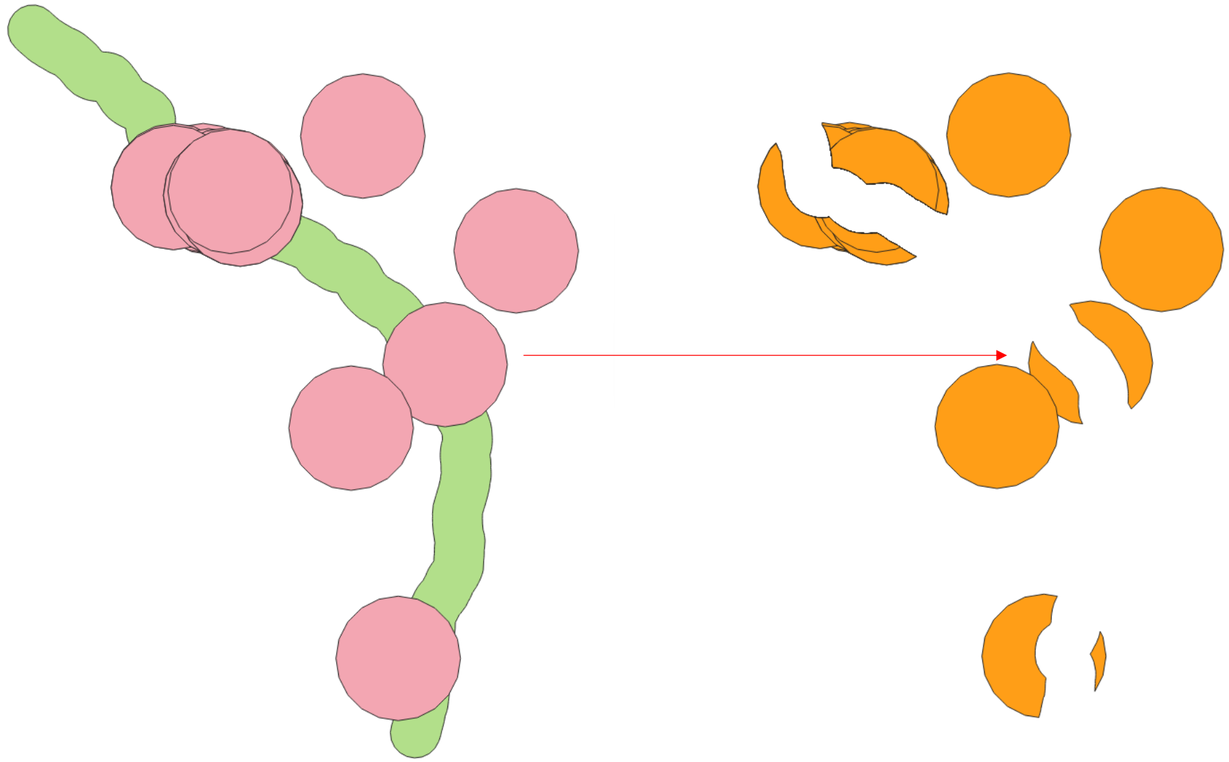
→ Polygons with similar attributes are dissolved



Difference

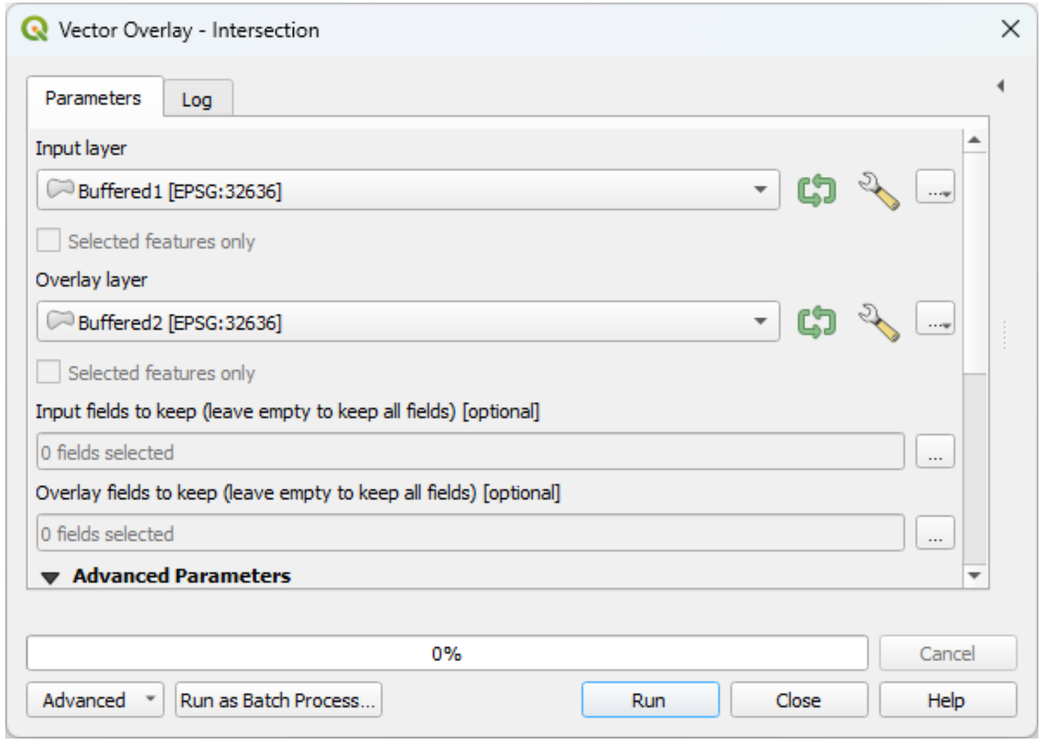
- Extracts features from the input layer that don't fall within the boundaries of the overlay layer.

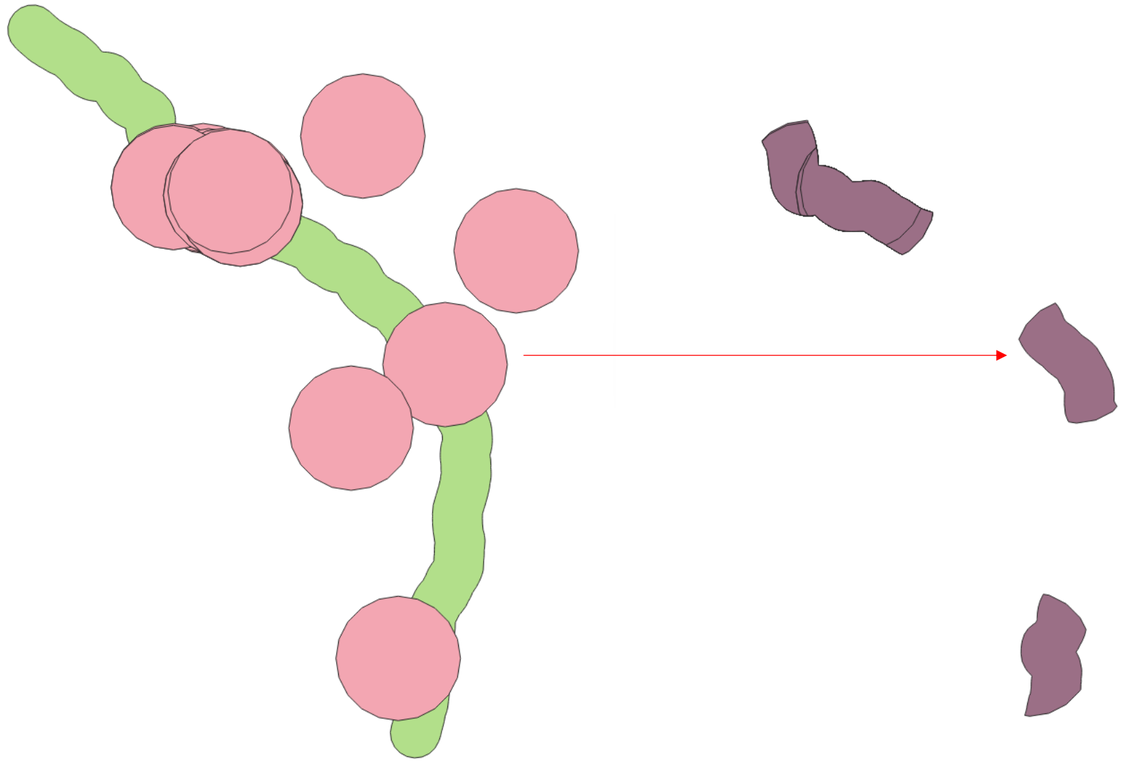




Intersect

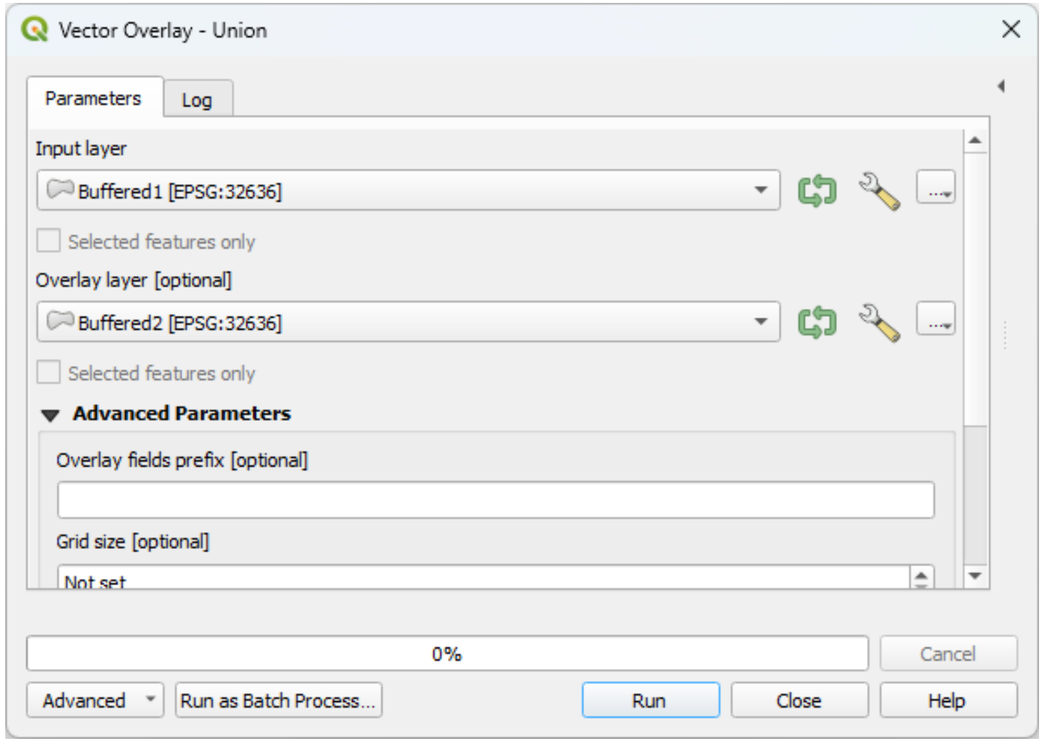
- An Intersect is an analytical operation that can be used to select any part of a feature that intersects with one or more other features.

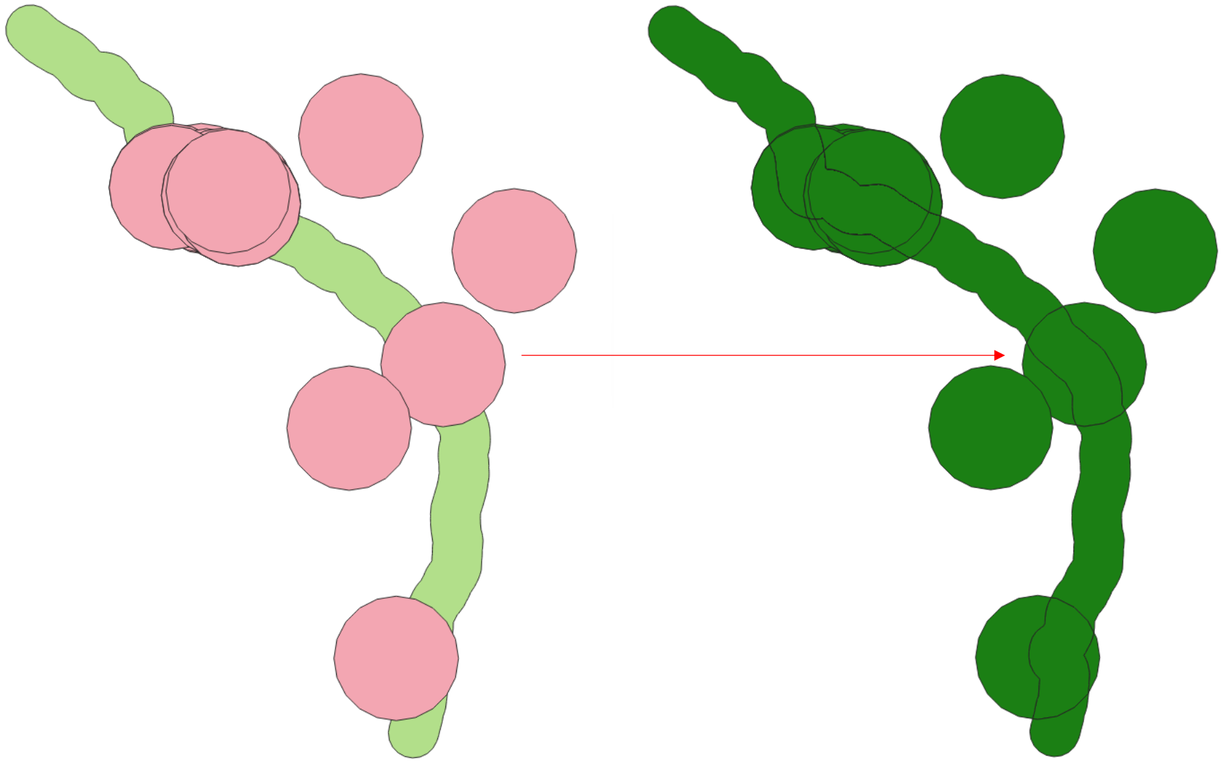




Union

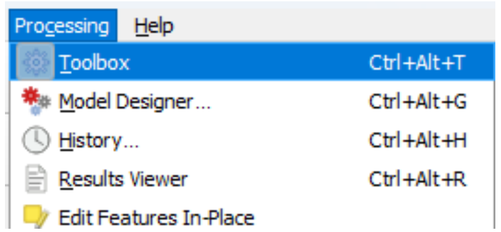
- Union checks overlapping features within an input layer and creates separate features for overlapping and non-overlapping parts.

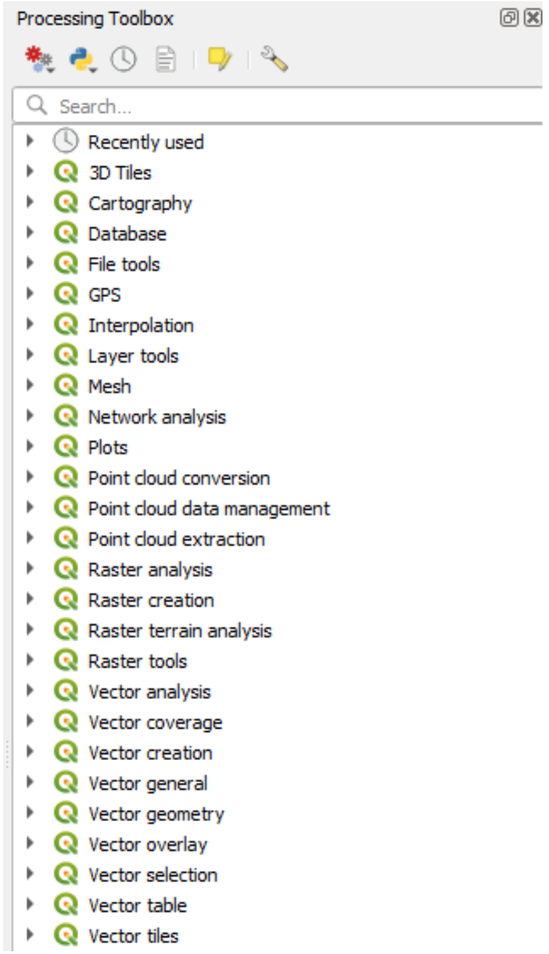


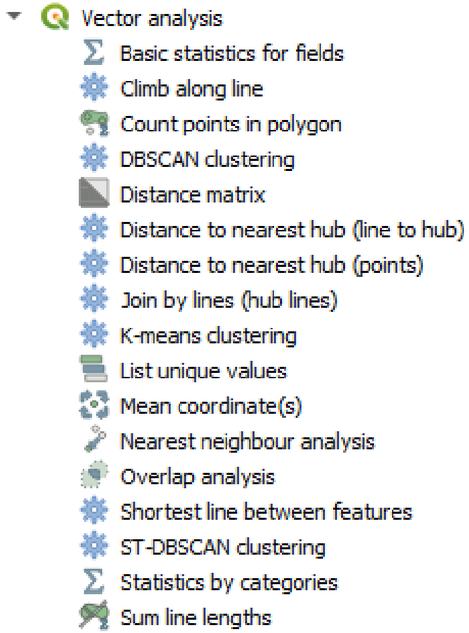


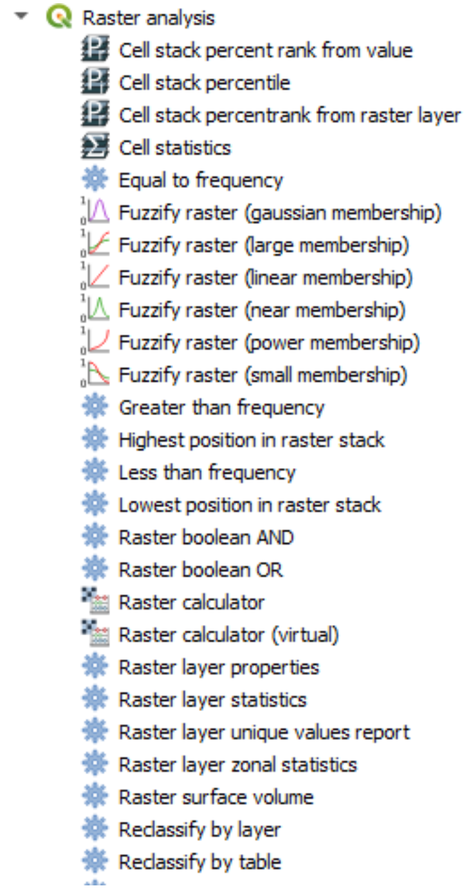
Processing Toolbox

- **QGIS offers many more tools to analyse vector and data for different purposes.**



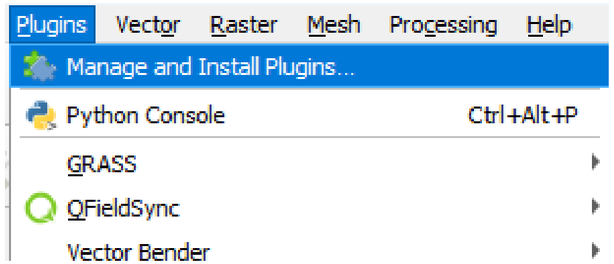


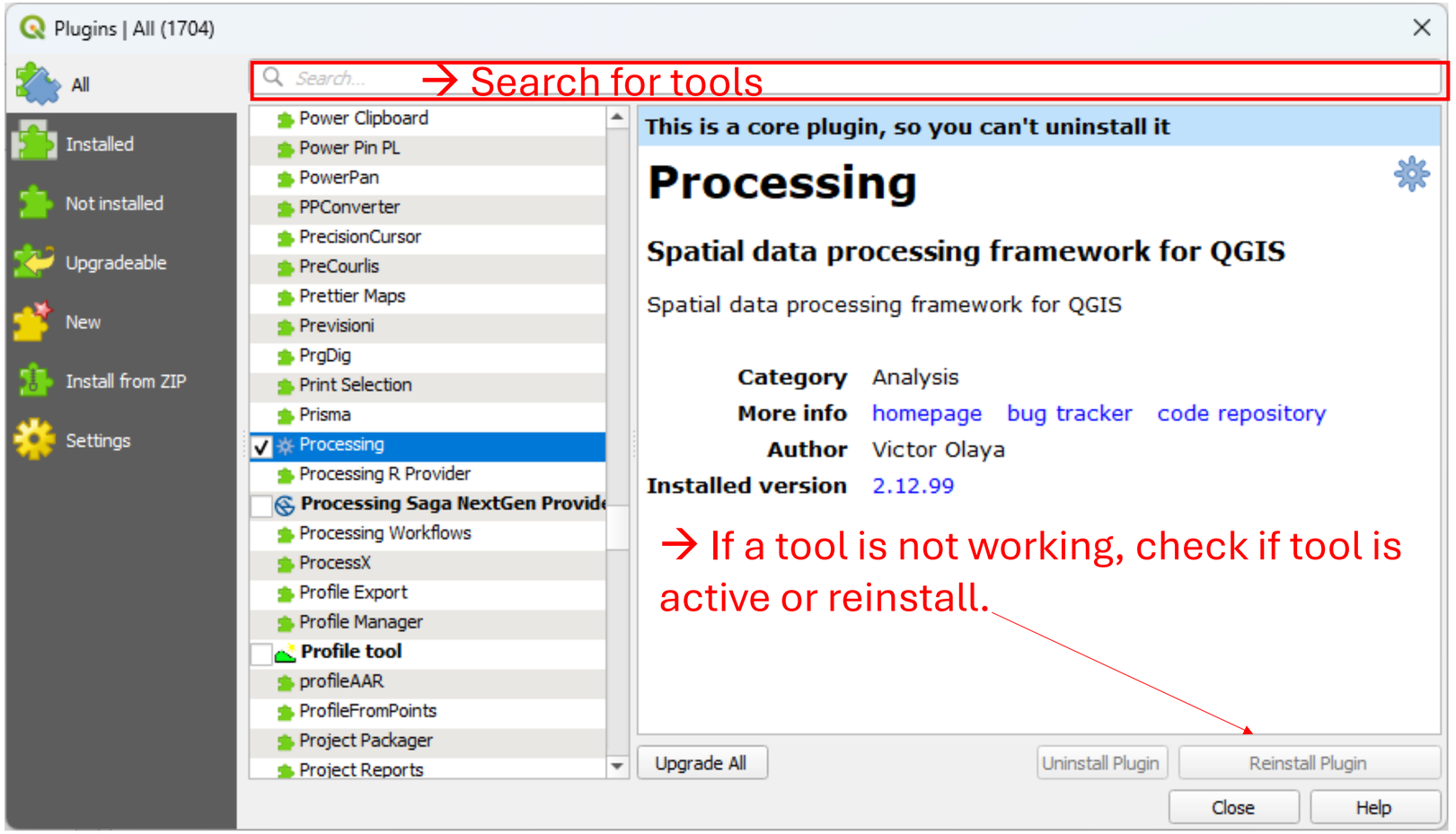




Plugins

- **Many tools developed by the user community for sophisticated analysis**





USAGE-NG
Up-skilling Agricultural Engineering Next Generation
Co-funded by the European Union

BOKU UNIVERSITY

Day 2: Map production

Layouting

Science for [life]

Maps

A map is a symbolized representation of reality, such as a portion of the Earth's surface, designed to communicate spatial information effectively.

Key Characteristics of Maps

- **Scale:**

A map is a scaled model of reality, meaning distances on the map are proportional to actual distances on Earth.

- **Symbols & Legend:**

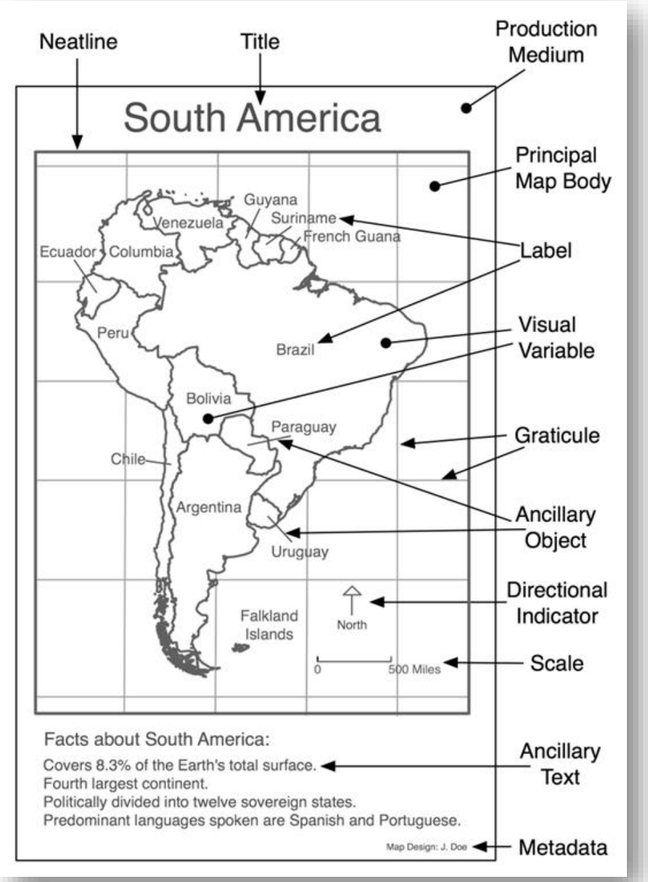
Maps use symbols to represent features like cities, rivers, and roads, and a legend (or key) explains what these symbols mean.

- **Title:**

Every map has a title that clearly states the subject of the map, such as "World Map" or "Vegetation Map".

- **Direction:**

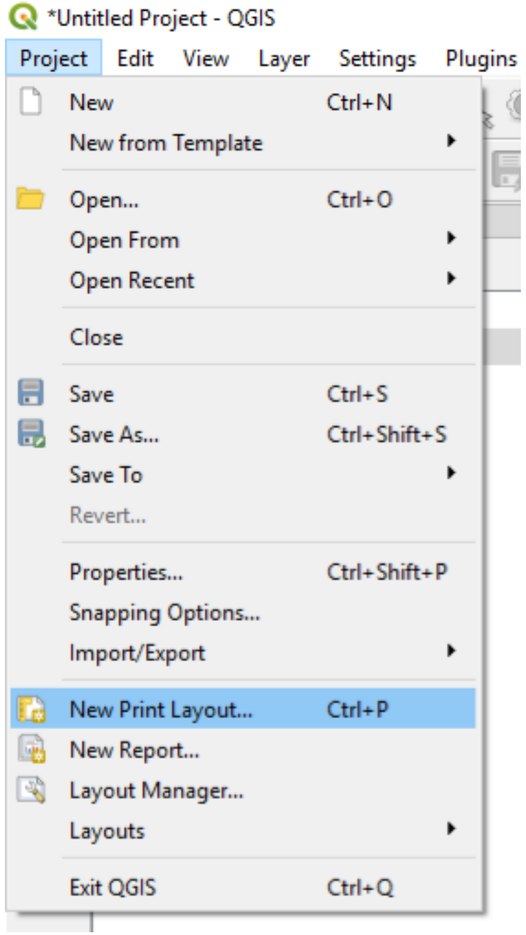
A compass rose or directional indicator shows the direction (usually North) so that other directions can be determined

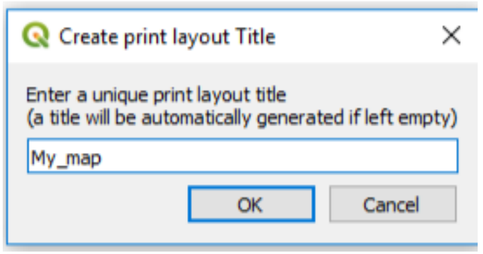


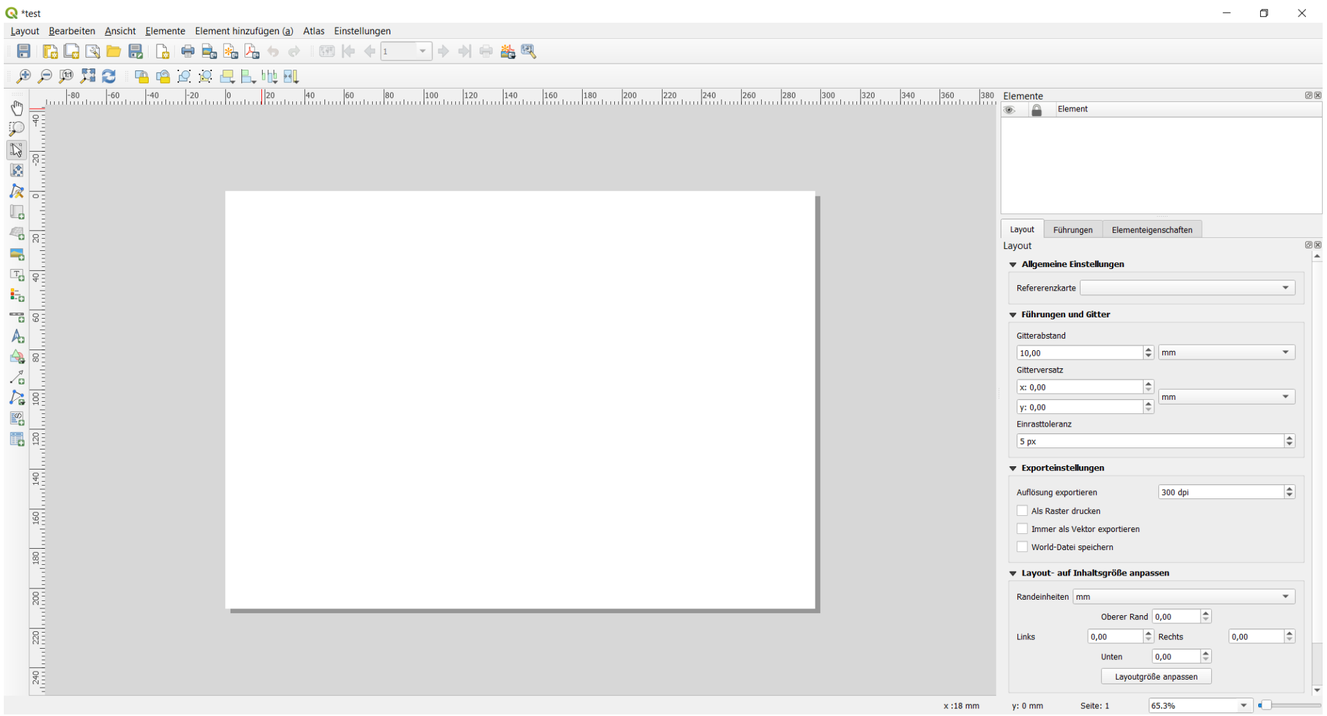
https://open.maricopa.edu/gist/chapter/4-2-map-design-and-map-elements/

QGIS: Designing a map

- **Print layout** →*new window but part of the main project*

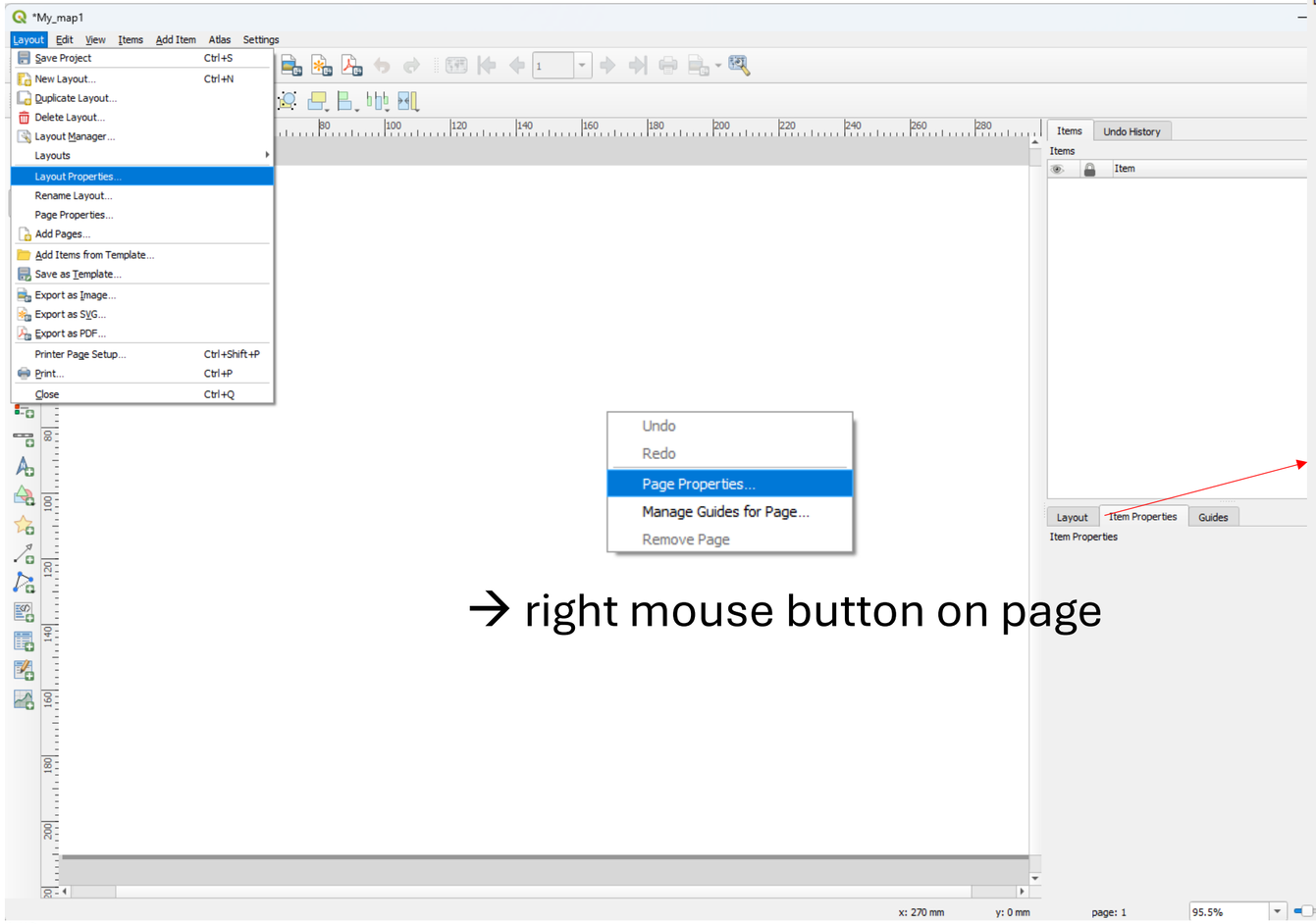




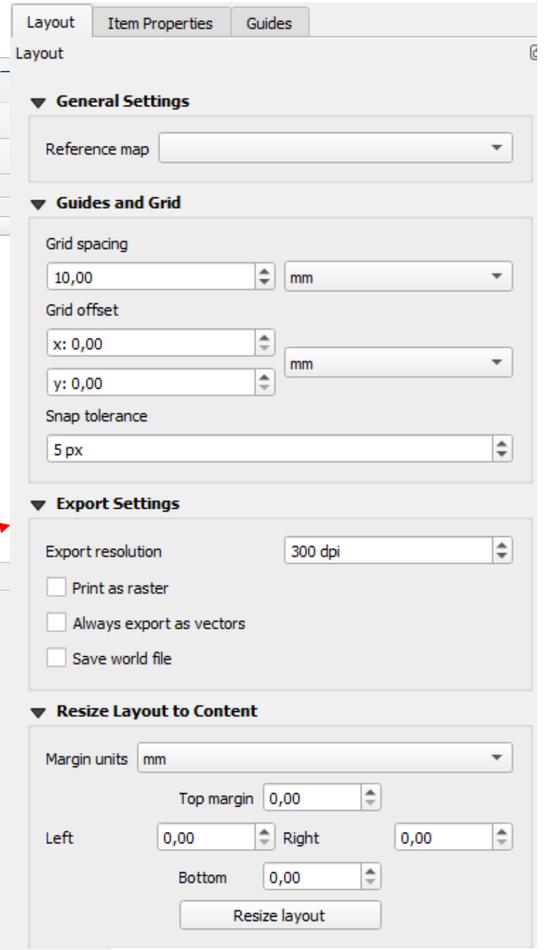


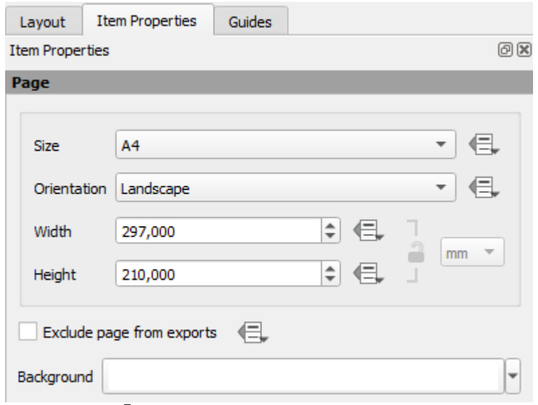
QGIS: Designing a map

- **Layout properties / Page properties**



→ right mouse button on page



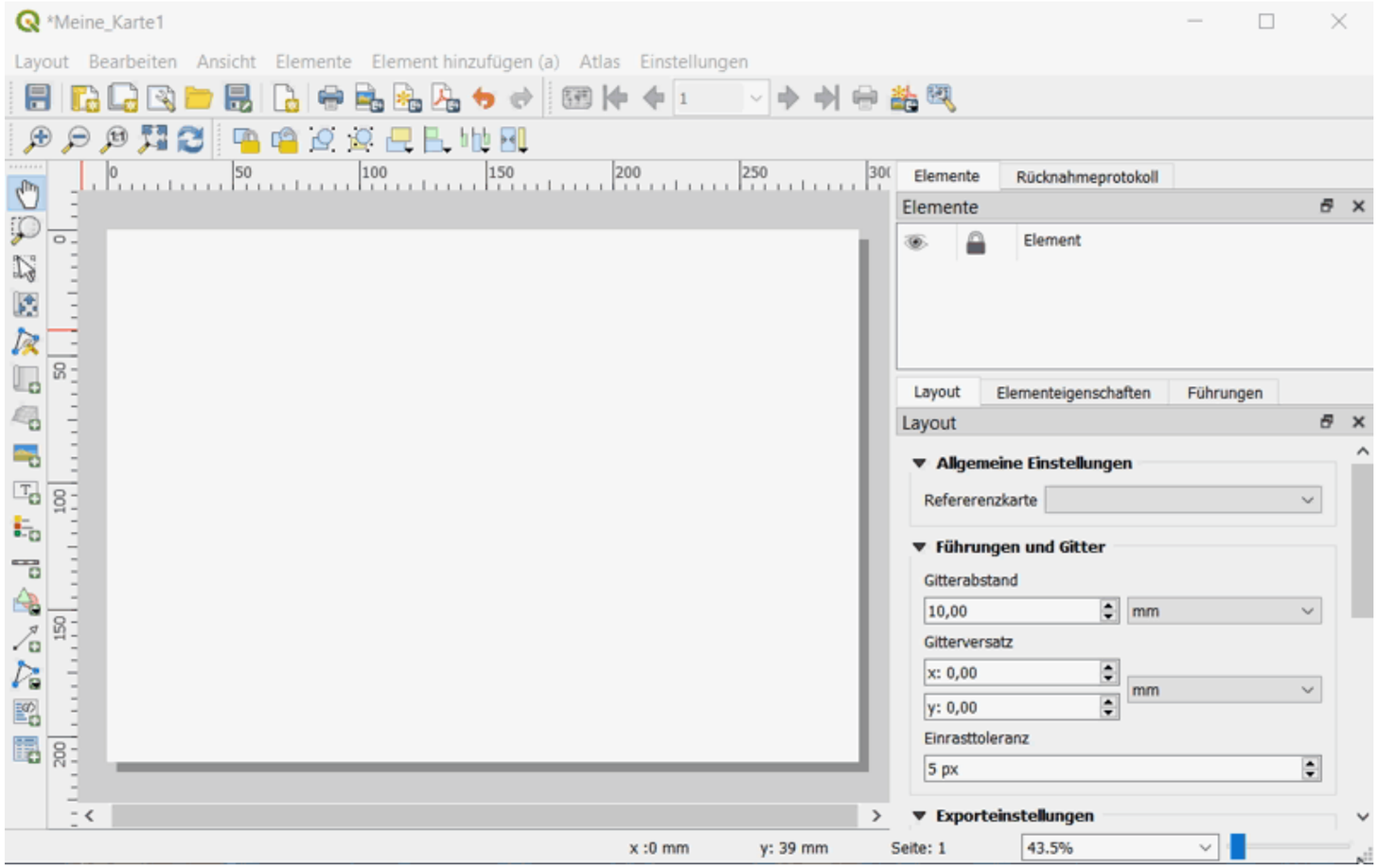


→ Size of the map
→ Orientation

QGIS: Designing a map

- **Add map** 

→ Compilation of the content is related to the main program!



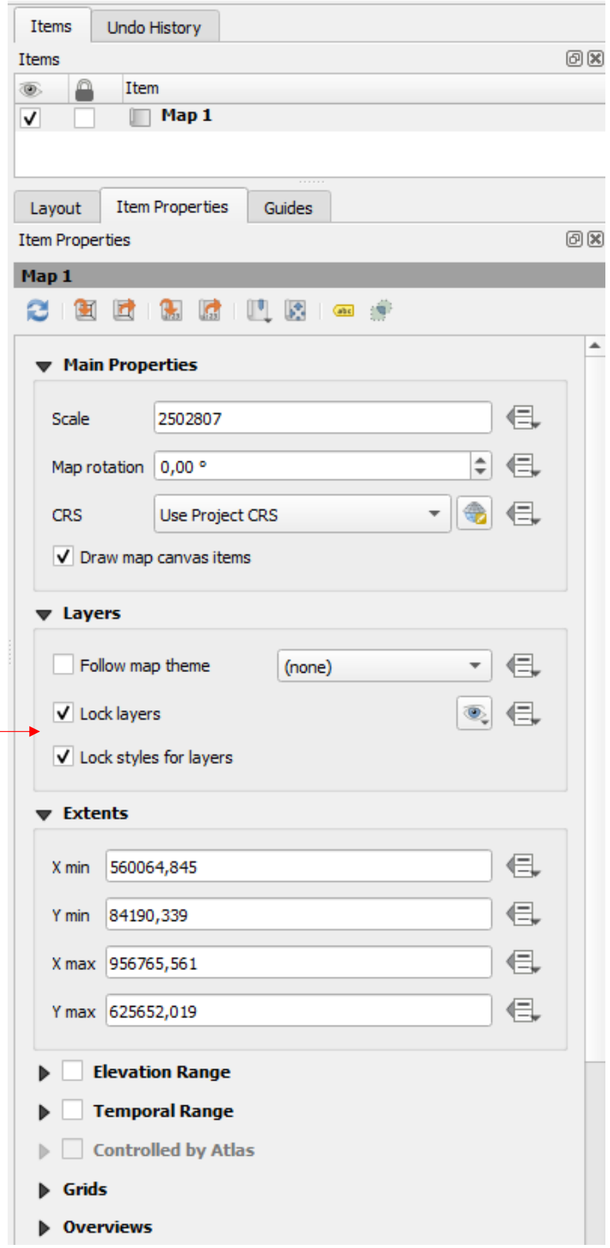
Draw a rectangle: all visible layers are transferred

QGIS: Designing a map

- **Select/move entry:** Select map elements, move, resize them

- **Move element content:** Readjust the map (the mouse wheel can be used to change the scale)
- **Elements:**

Lock layers: if good settings fit.
Additional: Lock layer styles

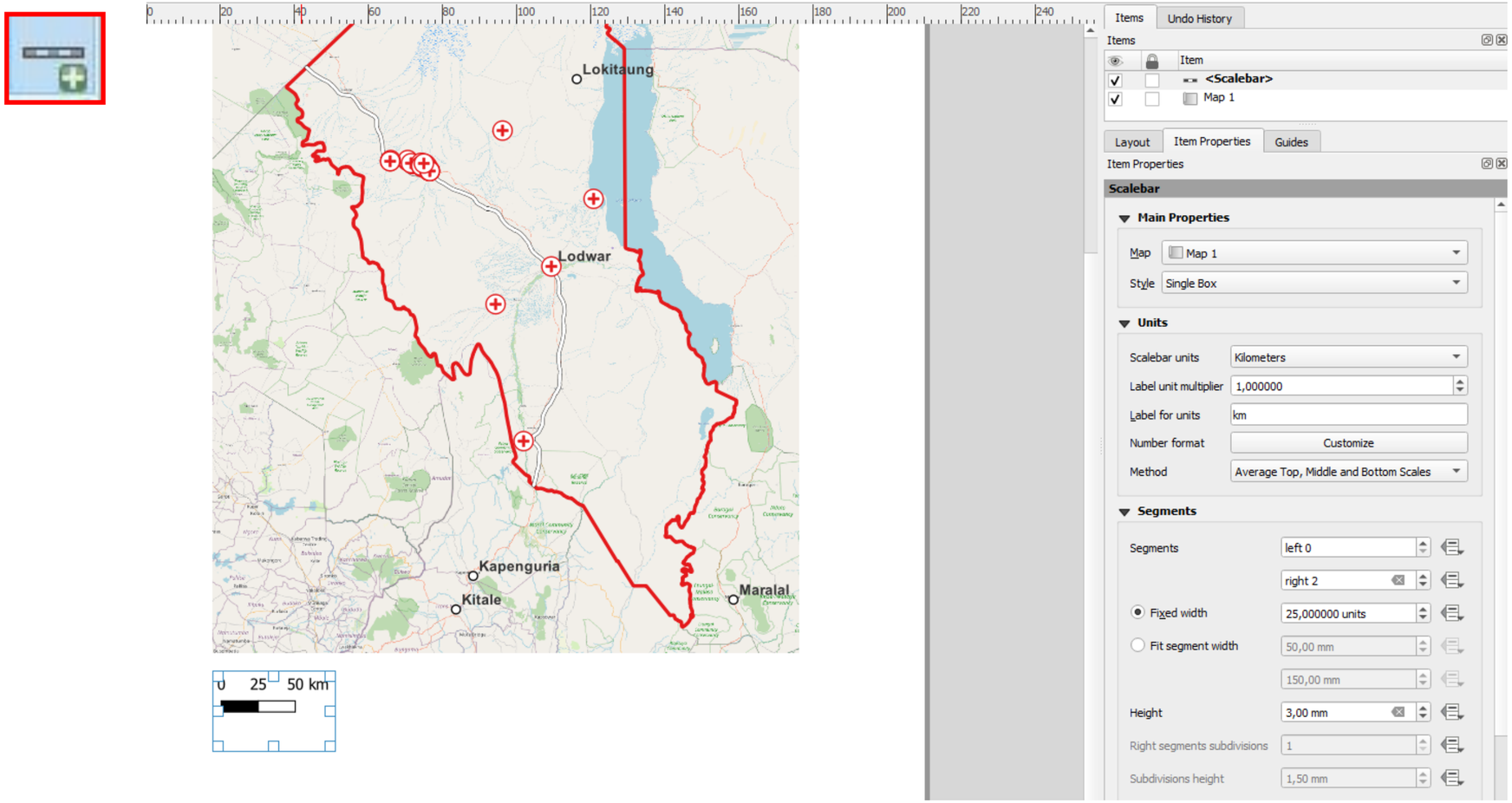


→ Items can be deleted here

→ Adust scale

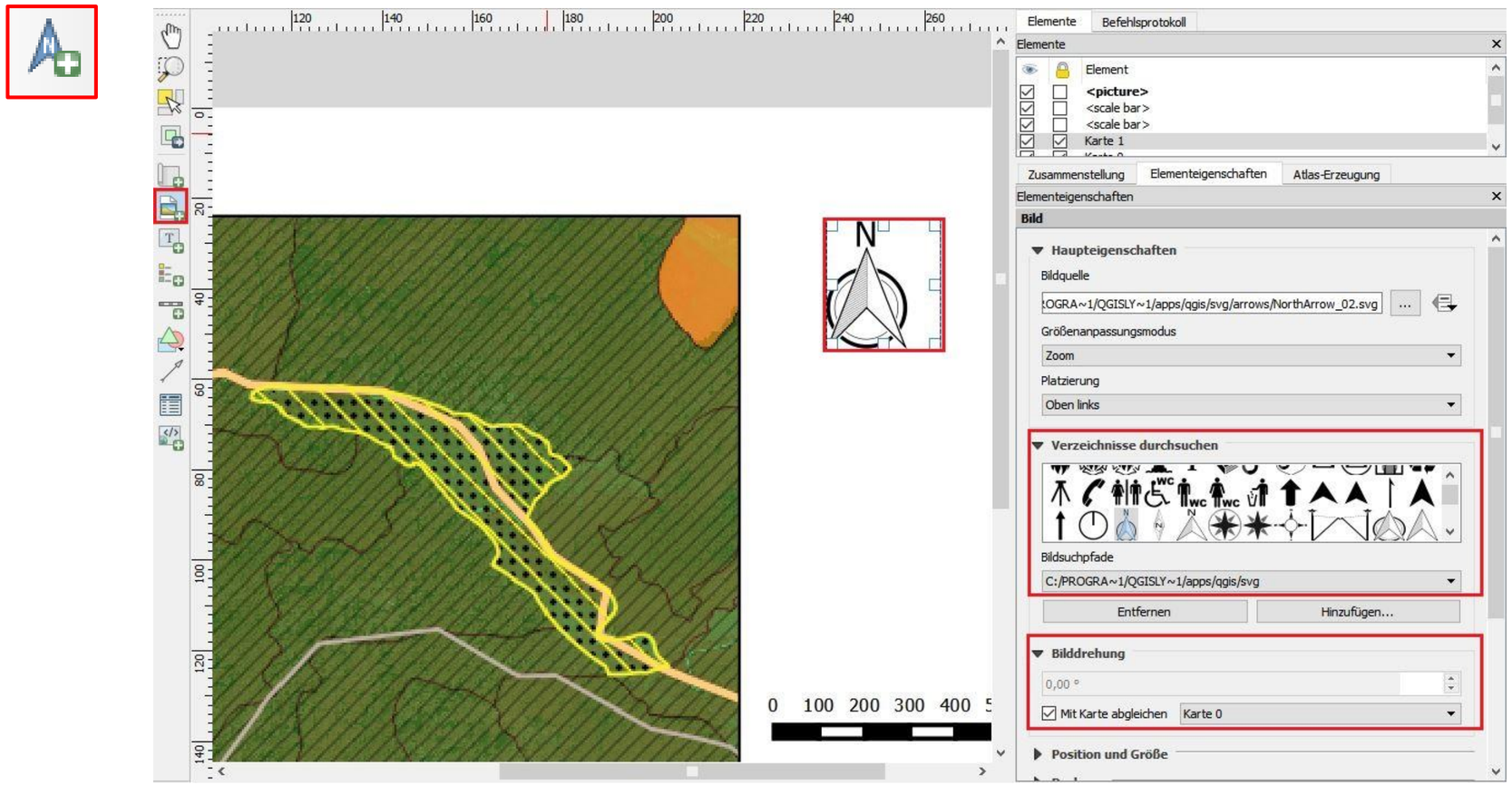
QGIS: Designing a map

- **Scale bar or scale number**



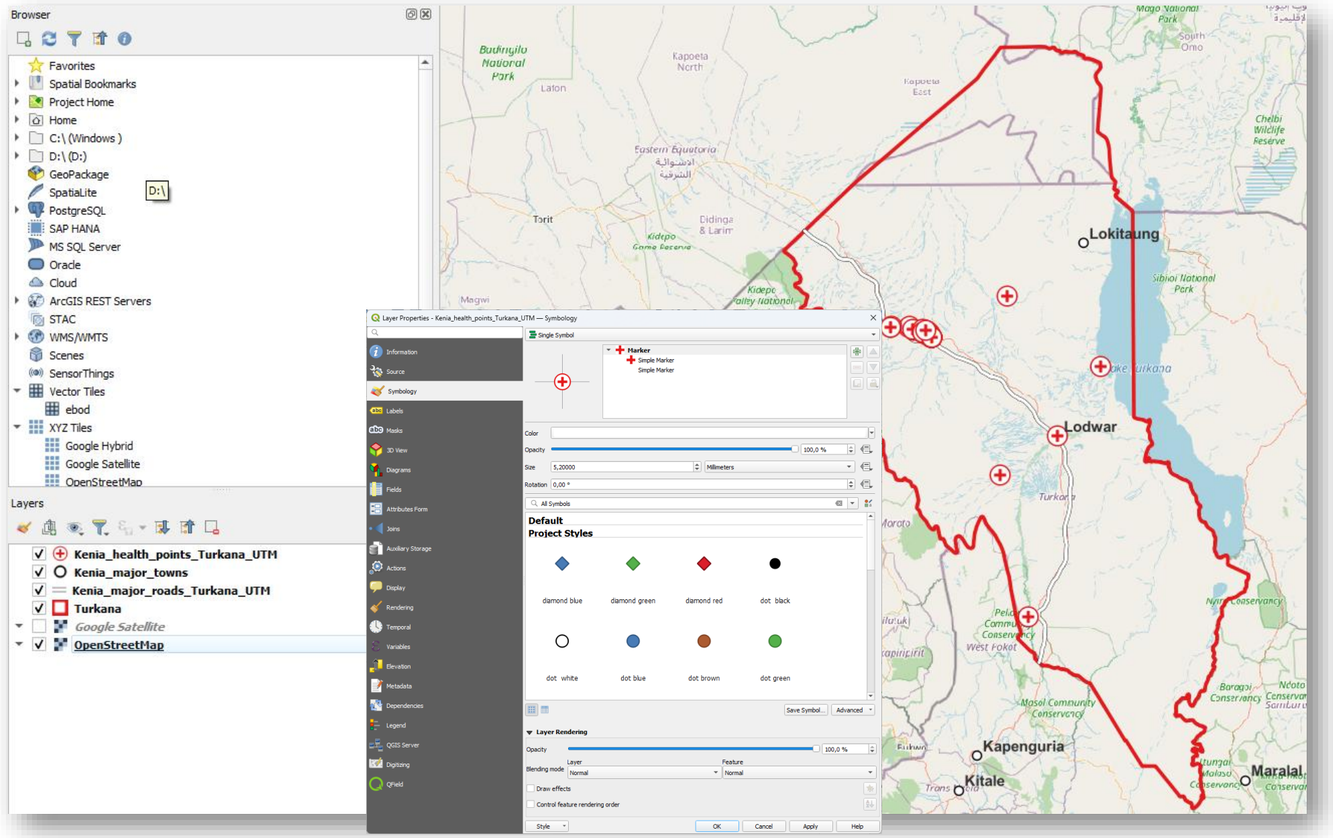
QGIS: Designing a map

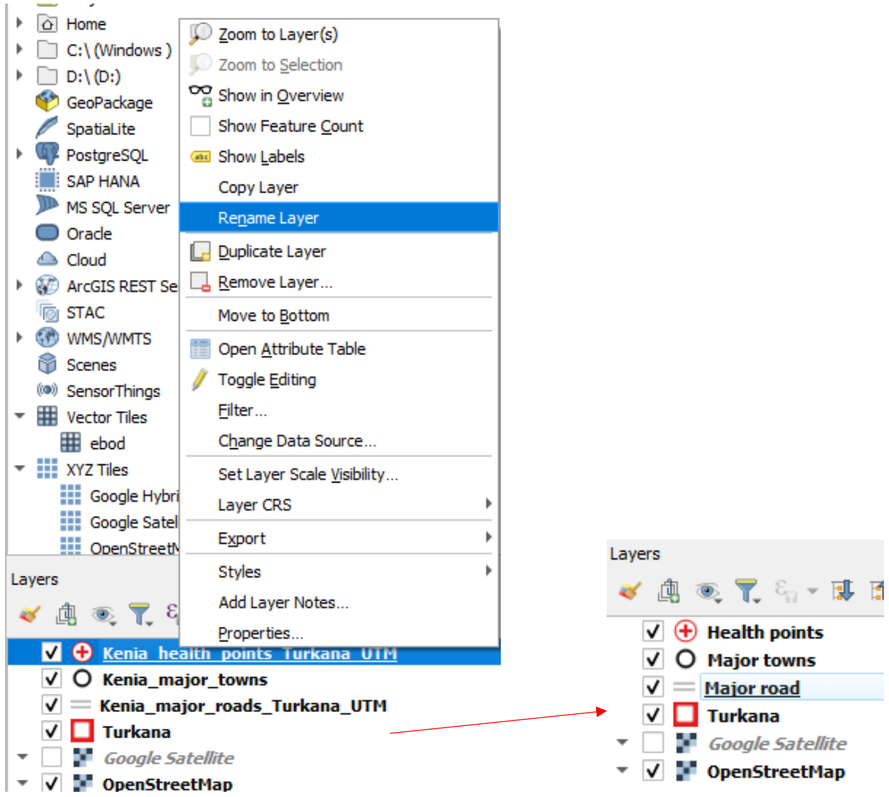
- **North arrow:** Button or these are located in the installation directory. The easiest way is to go to the browse directories section.



QGIS: Designing a map

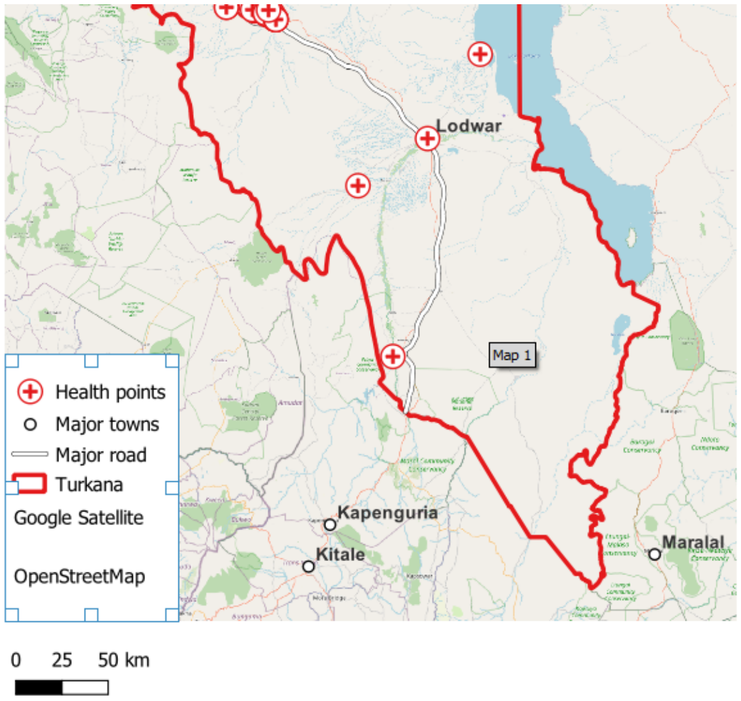
- **Legende:** is supposed to explain map content. Symbols and colors are taken from the main QGIS program (abbreviations or codes should be explained!).

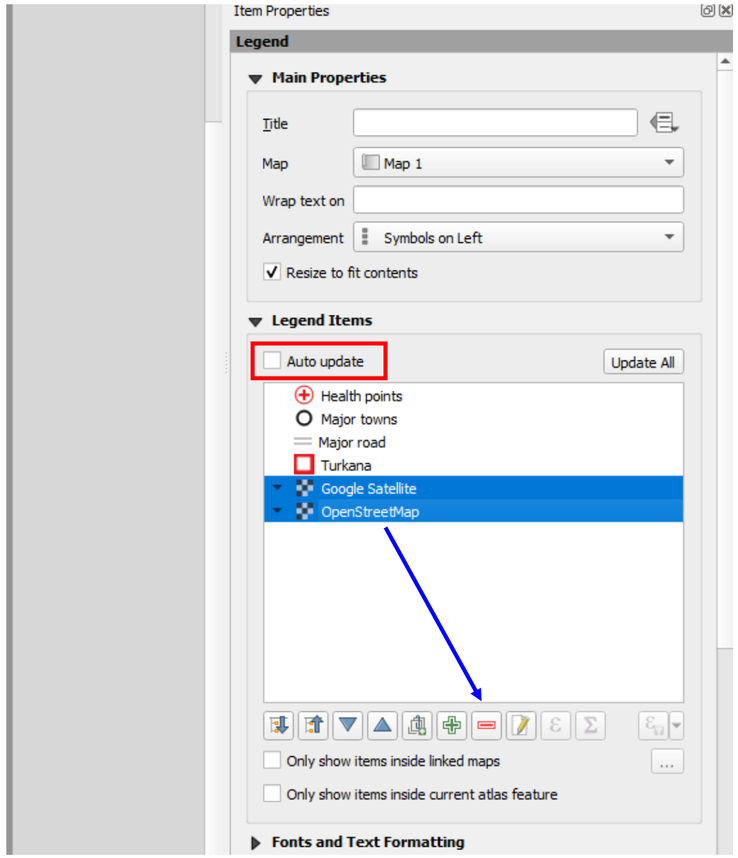




QGIS: Designing a map

- **Add legend:** remove those layers that do not appear in the map or do not need to be explained (e.g. Google satellite).

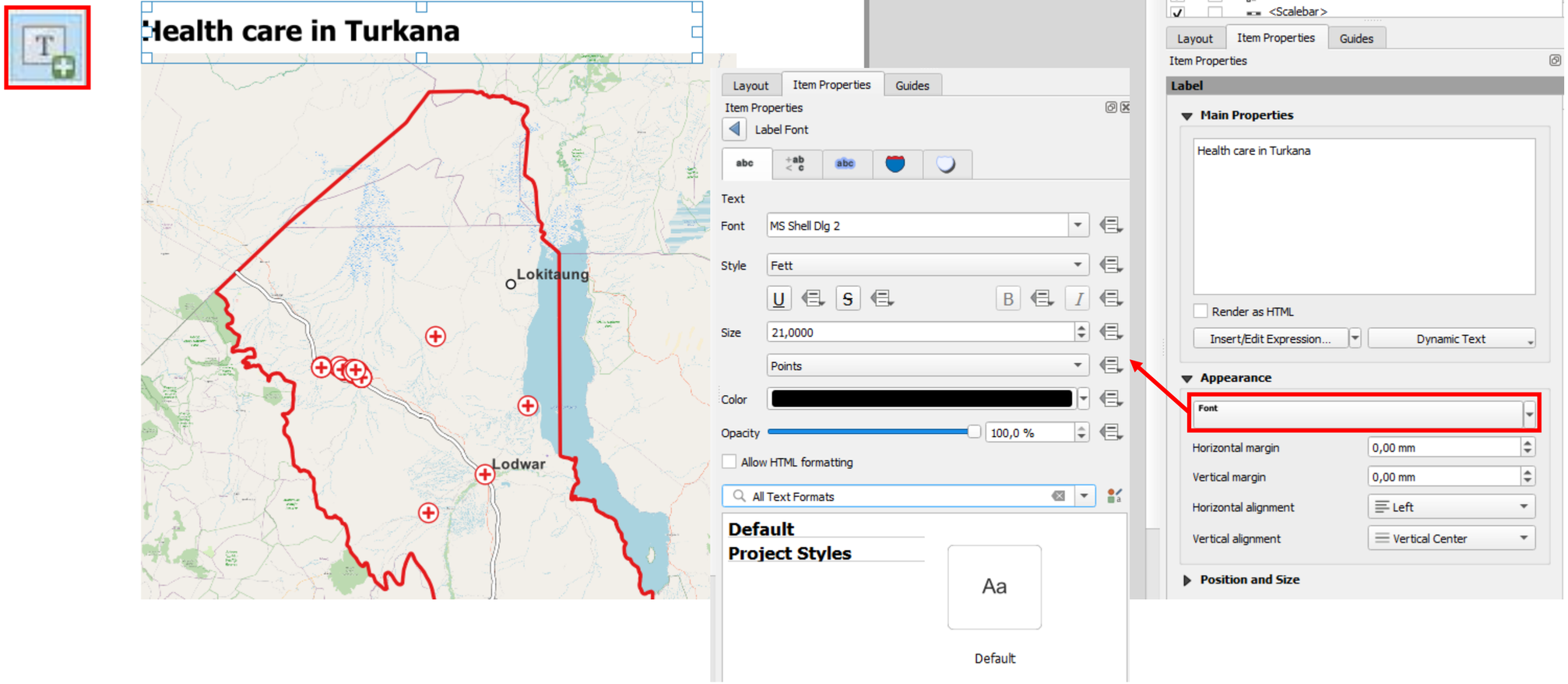




→ Turn Auto update off

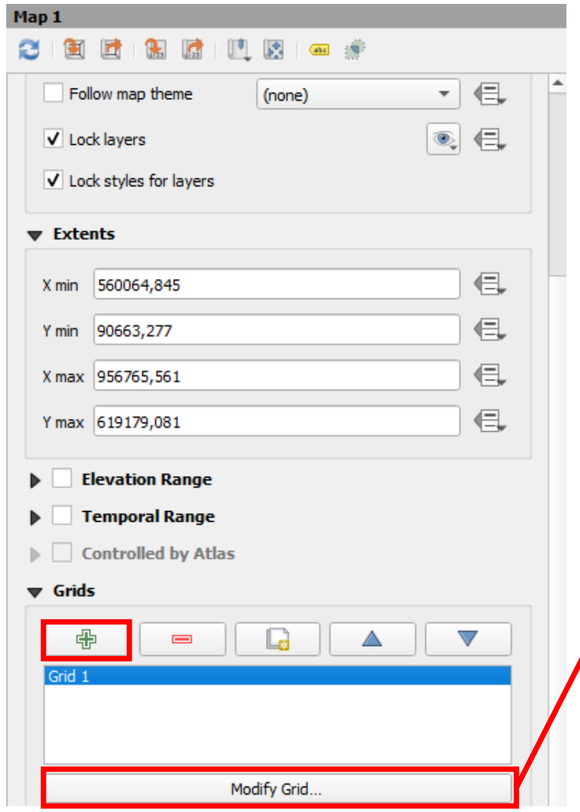
QGIS: Designing a map

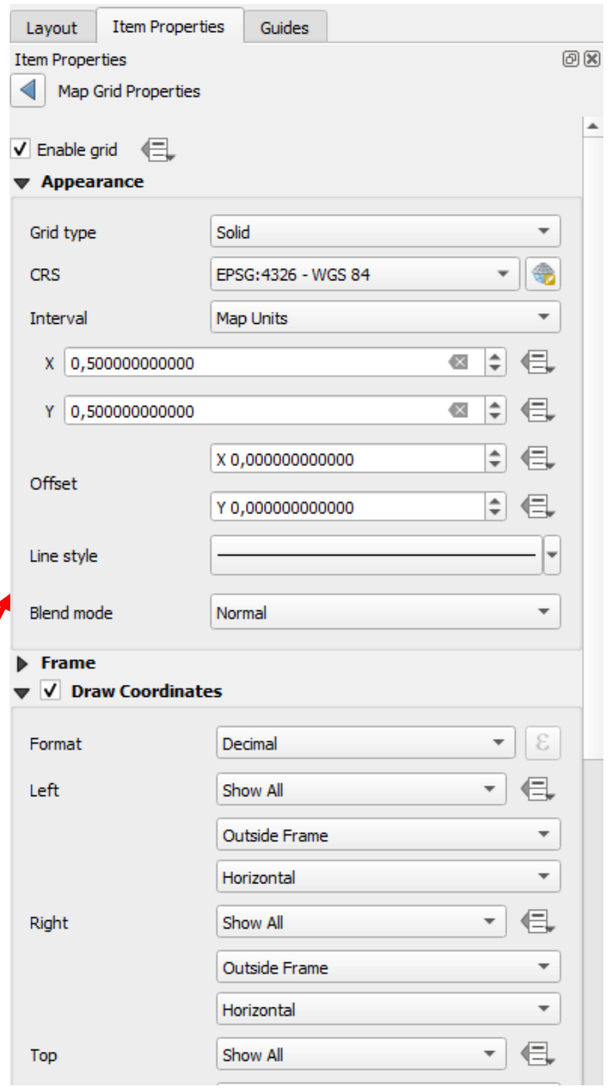
- **Title, text, and other elements**



QGIS: Designing a map

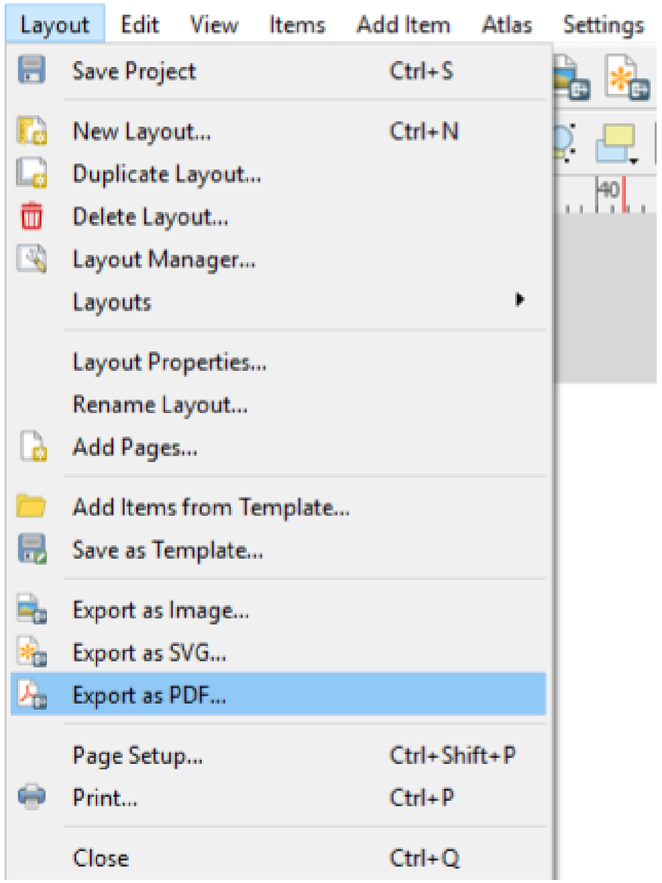
- **Grid**

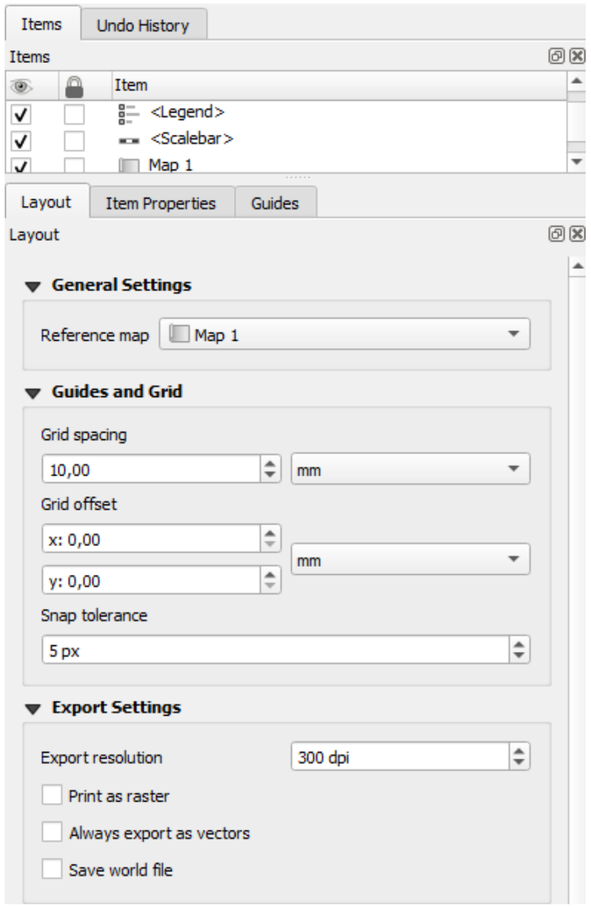


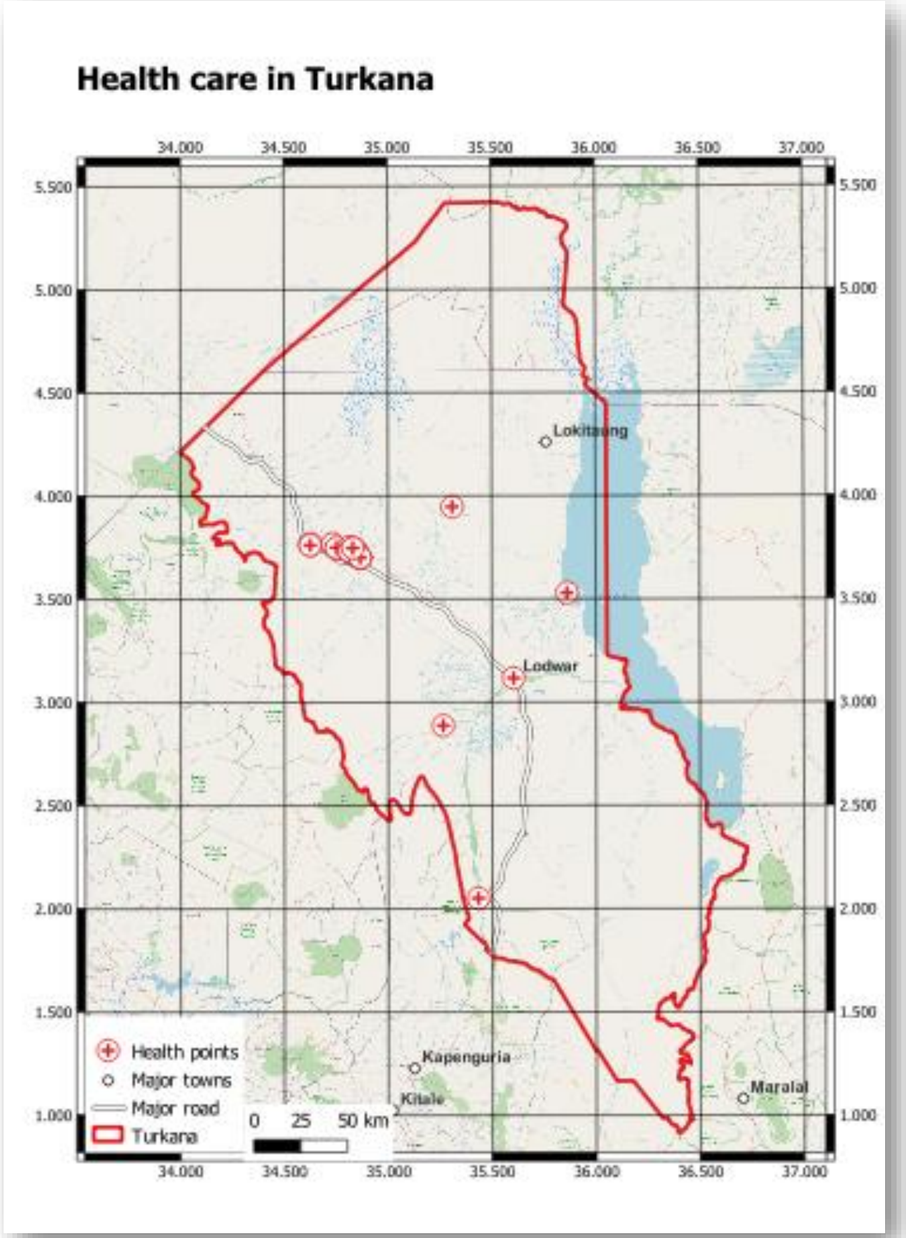


QGIS: Designing a map

- **Export as image or PDF:**







Thank you!

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