WorldCereal MOOC I: Reference data for crop type mapping

Exercises ‘Quality Assessment of Reference Data’

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Background

WorldCereal has developed a generic scheme to assess the quality of the reference data by calculating confidence scores.

The scheme differentiates 4 different data types:

- Field Observation Survey (field visit)
- Virtual (and/or automated) Interpretation (by photo, high resolution imagery etc)
- Automated Classification (high-quality classified map)
- Formal Declaration (parcel registrations systems)

The schema includes the spatial, temporal, and thematic accuracy since these are essential aspects of crop mapping.

For more detailed information regarding the involved steps, and a copy of the sheet which is used to compute these dataset quality scores, we refer to the following documents in the supporting data of this exercise:

"*WorldCereal_ConfidenceScoreCalculations_v1_1.pdf*"

"WorldCereal_DataConfidenceScore_Calculator_v3_0.xlsx"

This quality assessment is typically performed **by the WorldCereal moderator** when users decide to make their data publicly available through the WorldCereal Reference Data Module (RDM). Each publicly available dataset in the RDM is characterized by a quality score related to land cover, crop type and/or irrigation information. The following exercises are meant to show how WorldCereal moderators manage the quality of reference data and which factors are typically involved in this process.

Please note that a user of the WorldCereal system does not need to go through these steps before being able to upload and work with their data in the system. These exercises are mainly meant to raise awareness on the aspect of data quality. As such, going through these exercises could make you decide to first work on your dataset to improve its quality before uploading the data into the WorldCereal RDM.

Objectives

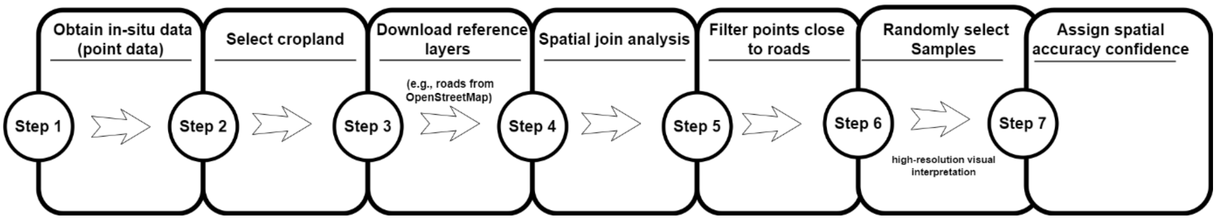
In this series of practical exercises you will learn:

- To investigate spatial, temporal, and thematic accuracy of a dataset
- To estimate the final confidence score of a dataset

The analysis will be conducted within the QGIS environment.

Exercise 1: Investigating Spatial Accuracy

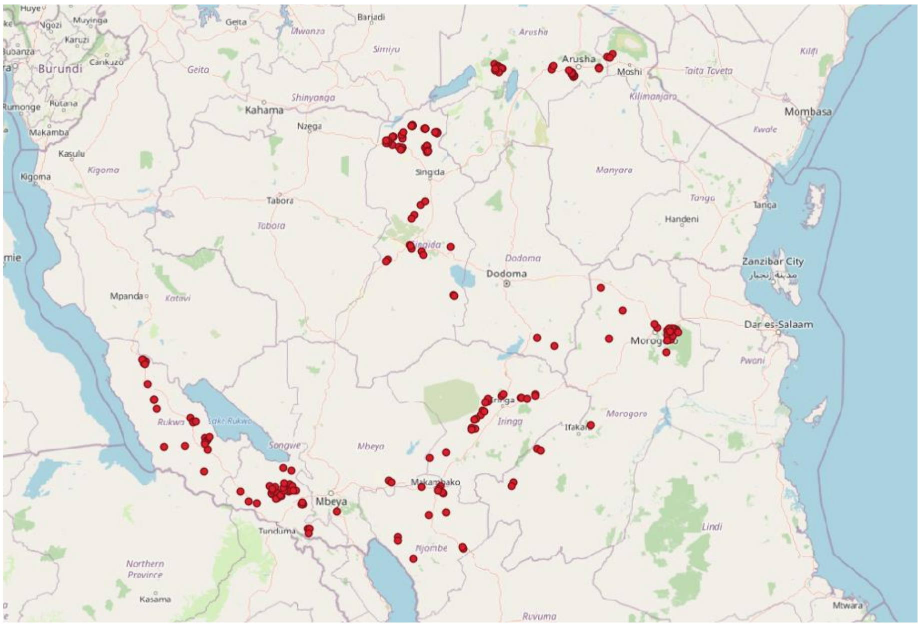
WorldCereal uses seven steps to access the spatial accuracy of point data as shown in the following figure:



Step 1: Obtain in-situ reference data

For the exercises, you will use a subset of the Tanzania Soil Information Service (TanSIS) dataset, as published by Walsh et al. (2017)[1]. The primary objective of this dataset is to develop and codify information on soils, cropping and pastoral systems, and landscapes to evaluate cropland productivity and soil fertility in Tanzania.

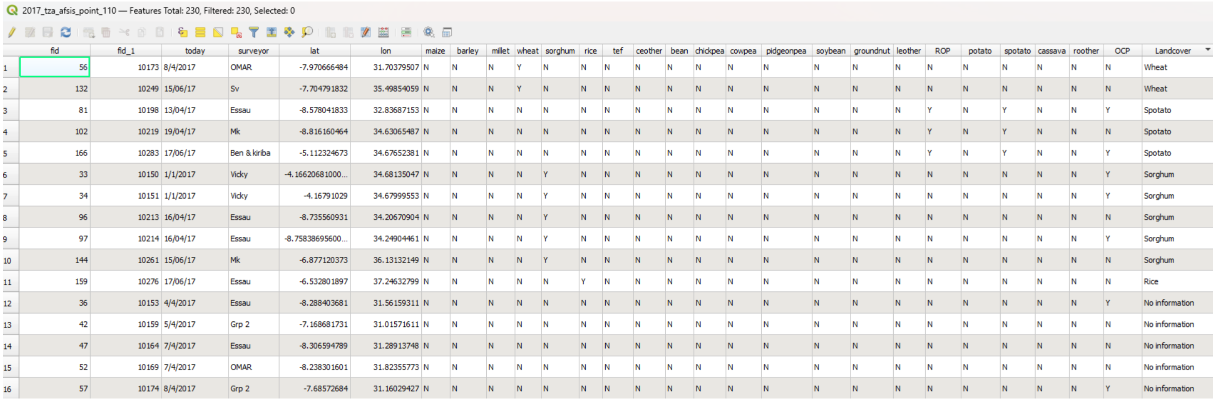
The data is available as a Geopackage file named '2017_tza_afsis_point_110'. The observed locations are presented in the following figure:



Step 2: Select the cropland observations

Open the attribute table and examine the field that contains the crop names. It has 230 data points. The 'Landcover' field includes crops names and 'No information'.

[1] Walsh, Markus, Joel Meliyo, Bruce Scott, Barbara Walsh, and Bob Macmillan. 2021. "Tanzania Soil Information Service (TanSIS)." OSF. September 6. doi:10.17605/OSF.IO/4NGAU.

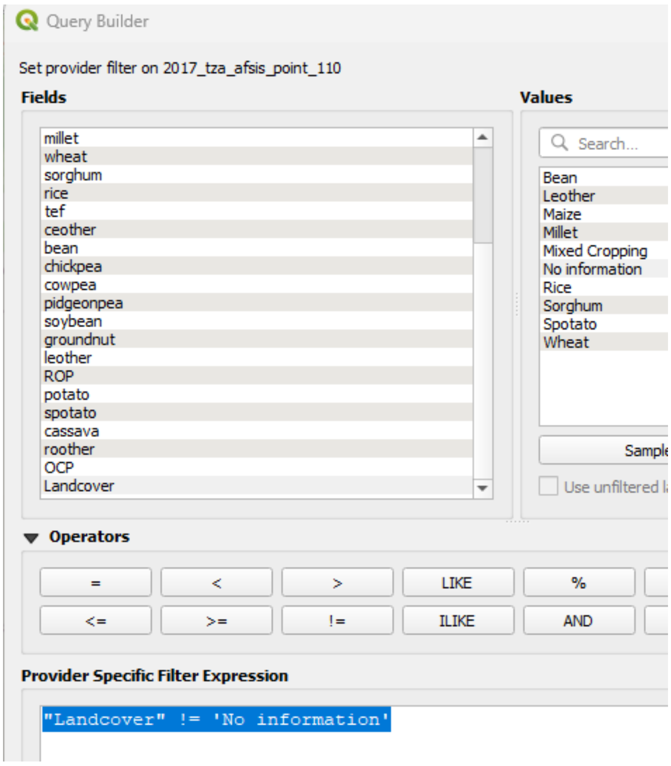


2017_tza_afsis_point_110 — Features Total: 230, Filtered: 230, Selected: 0

	fid	fid_1	today	surveyor	lat	lon	maize	barley	millet	wheat	sorghum	rice	tef	ceother
1	56	10173	8/4/2017	OMAR	-7.970666484	31.70379507	N	N	N	Y	N	N	N	N
2	132	10249	15/06/17	Sv	-7.704791832	35.49854059	N	N	N	Y	N	N	N	N
3	81	10198	13/04/17	Essau	-8.578041833	32.83687153	N	N	N	N	N	N	N	N
4	102	10219	19/04/17	Mk	-8.816160464	34.63065487	N	N	N	N	N	N	N	N
5	166	10283	17/06/17	Ben & kiriba	-5.112324673	34.67652381	N	N	N	N	N	N	N	N
6	33	10150	1/1/2017	Vicky	-4.16620681000...	34.68135047	N	N	N	N	Y	N	N	N
7	34	10151	1/1/2017	Vicky	-4.16791029	34.67999553	N	N	N	N	Y	N	N	N
8	96	10213	16/04/17	Essau	-8.735560931	34.20670904	N	N	N	N	Y	N	N	N
9	97	10214	16/04/17	Essau	-8.75838695600...	34.24904461	N	N	N	N	Y	N	N	N
10	144	10261	15/06/17	Mk	-6.877120373	36.13132149	N	N	N	N	Y	N	N	N
11	159	10276	17/06/17	Essau	-6.532801897	37.24632799	N	N	N	N	N	Y	N	N
12	36	10153	4/4/2017	Essau	-8.288403681	31.56159311	N	N	N	N	N	N	N	N
13	42	10159	5/4/2017	Grp 2	-7.168681731	31.01571611	N	N	N	N	N	N	N	N
14	47	10164	7/4/2017	Essau	-8.306594789	31.28913748	N	N	N	N	N	N	N	N
15	52	10169	7/4/2017	OMAR	-8.238301601	31.82355773	N	N	N	N	N	N	N	N
16	57	10174	8/4/2017	Grp 2	-7.68572684	31.16029427	N	N	N	N	N	N	N	N

	bean	chickpea	cowpea	pidgeonpea	soybean	groundnut	leother	ROP	potato	spotato	cassava	roother	OCP	Landcover
1	N	N	N	N	N	N	N	N	N	N	N	N	N	Wheat
2	N	N	N	N	N	N	N	N	N	N	N	N	N	Wheat
3	N	N	N	N	N	N	N	Y	N	Y	N	N	Y	Spotato
4	N	N	N	N	N	N	N	Y	N	Y	N	N	N	Spotato
5	N	N	N	N	N	N	N	Y	N	Y	N	N	Y	Spotato
6	N	N	N	N	N	N	N	N	N	N	N	N	Y	Sorghum
7	N	N	N	N	N	N	N	N	N	N	N	N	Y	Sorghum
8	N	N	N	N	N	N	N	N	N	N	N	N	N	Sorghum
9	N	N	N	N	N	N	N	N	N	N	N	N	Y	Sorghum
10	N	N	N	N	N	N	N	N	N	N	N	N	N	Sorghum
11	N	N	N	N	N	N	N	N	N	N	N	N	N	Rice
12	N	N	N	N	N	N	N	N	N	N	N	N	Y	No information
13	N	N	N	N	N	N	N	N	N	N	N	N	N	No information
14	N	N	N	N	N	N	N	N	N	N	N	N	N	No information
15	N	N	N	N	N	N	N	N	N	N	N	N	N	No information
16	N	N	N	N	N	N	N	N	N	N	N	N	Y	No information

Select all cropland using the Query Builder. The following query can be used to select cropland data:



In this dataset, there are 21 data points that have no crop information and 209 points with crop information.

Save the cropland data in the Geopackage file '2017_tza_afsis_point_110_crop.gpkg'.

Step 3: Download reference layers

You will use OpenStreetMap (OSM) datasets for this purpose. OSM data can be downloaded from Geofabrik: (https://download.geofabrik.de/). QGIS also offers the QuickOSM plugin (https://plugins.qgis.org/plugins/QuickOSM/), which allows you to download data directly in QGIS.

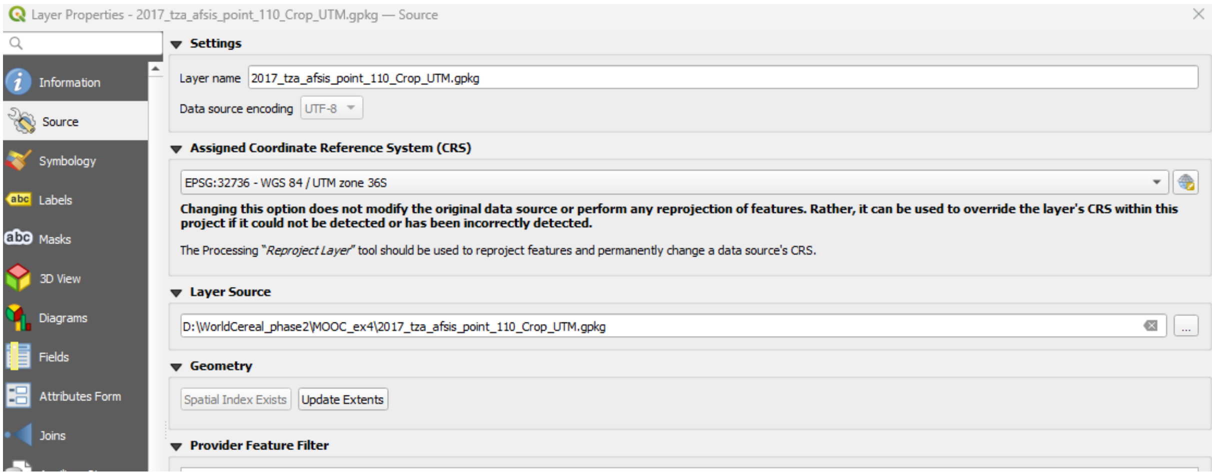
For this exercise, you can use the OSM road layers for Tanzania already prepared for the MOOC: tza_osm_road.gpkg.

Step 4: Perform spatial join analysis

The aim of this step is to determine whether a point is located properly within the field or if the point is too close to, or on, a road. To achieve this, you will use the spatial join operation in QGIS. For analysis within a single country, use the country's local or national projection system to minimize distortion. For larger regions like Africa, avoid UTM zones due to inconsistencies when crossing zones and instead use a continent-wide projection, such as Africa Albers Equal Area Conic, for consistent and accurate measurements. Ensure both the point dataset and the road layer are in the same projection before performing the spatial join to avoid mismatches and ensure accurate results.

The datasets are about Tanzania, hence we will use UTM zone 36S.

Use "Assign projection" tool.

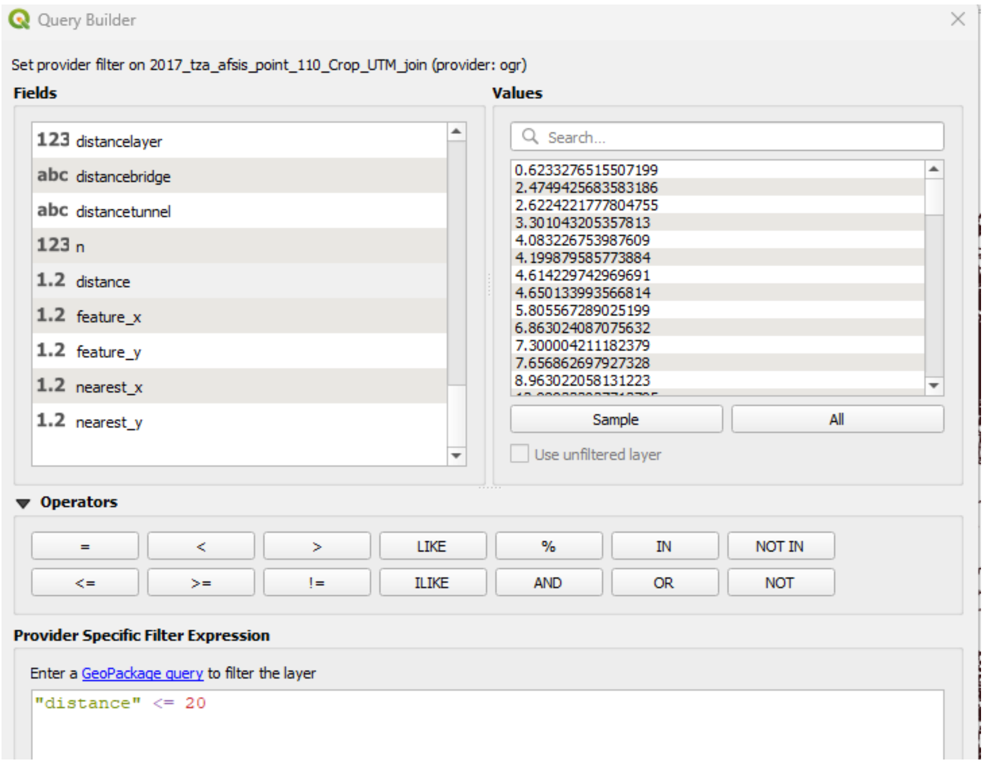


Save the data as Geopackage files '2017_tza_afsis_point_110_crop_UTM' and 'tza_osm_road_UTM'.

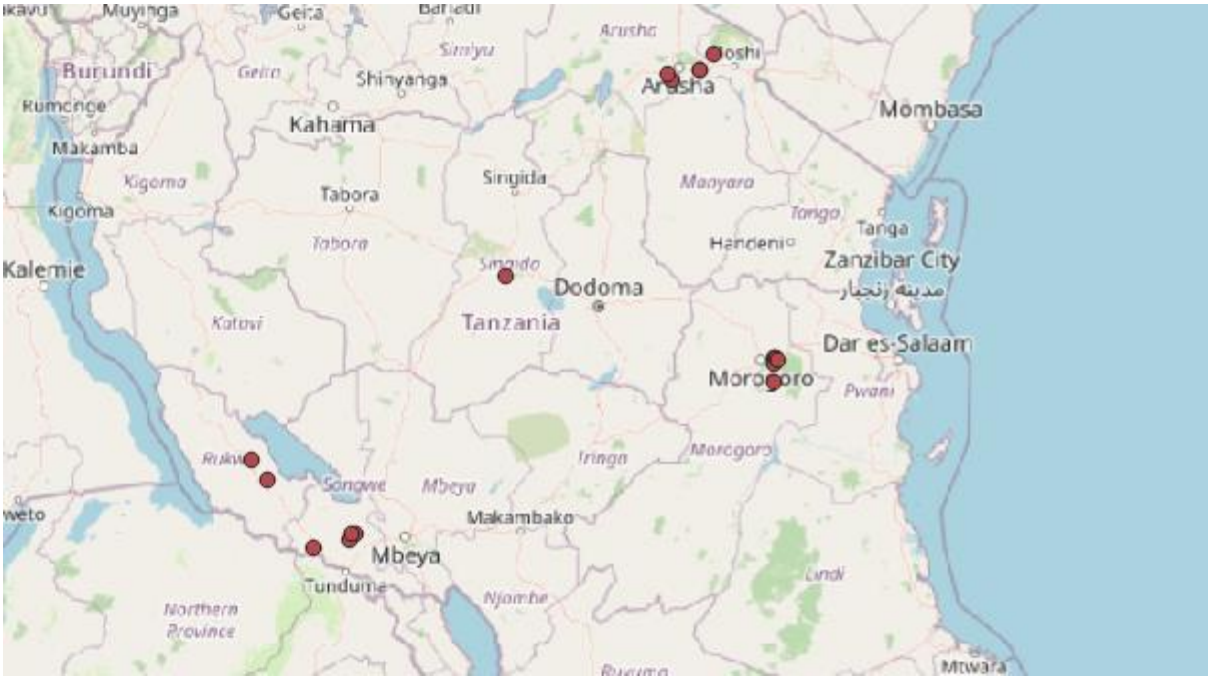
Then, use the '***Join attributes by nearest*** ' tool and save the data as Geopackage file '2017_tza_afsis_point_110_Crop_UTM_join'.

Step 5: Filter points near road

Next, you will select the points located within crop fields. For this purpose, points near roads will be excluded. Specifically, points within a 20-meter distance from the road will be rejected, while points further than 20 meters will be selected.



In this dataset, 17 data points are close to road. Figure shows the rejected data points:

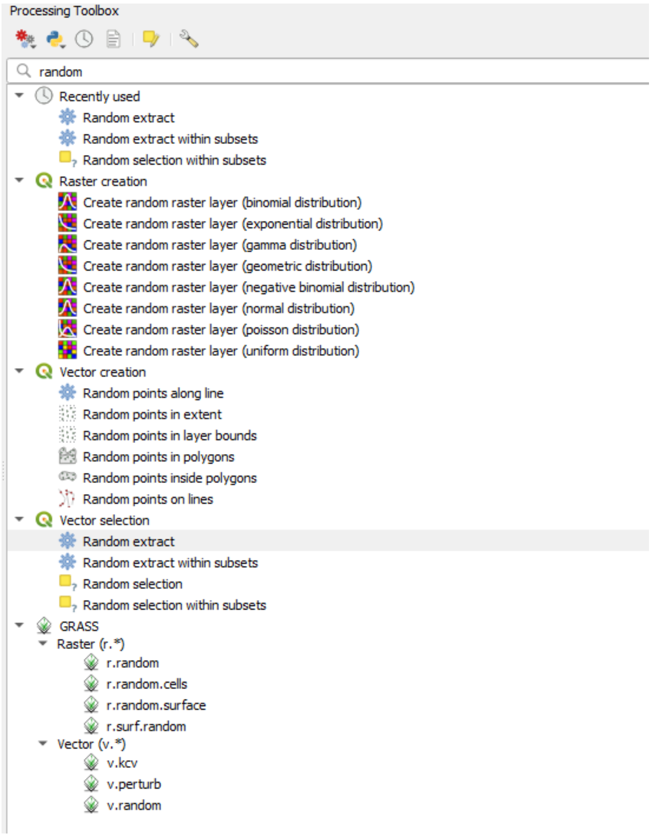


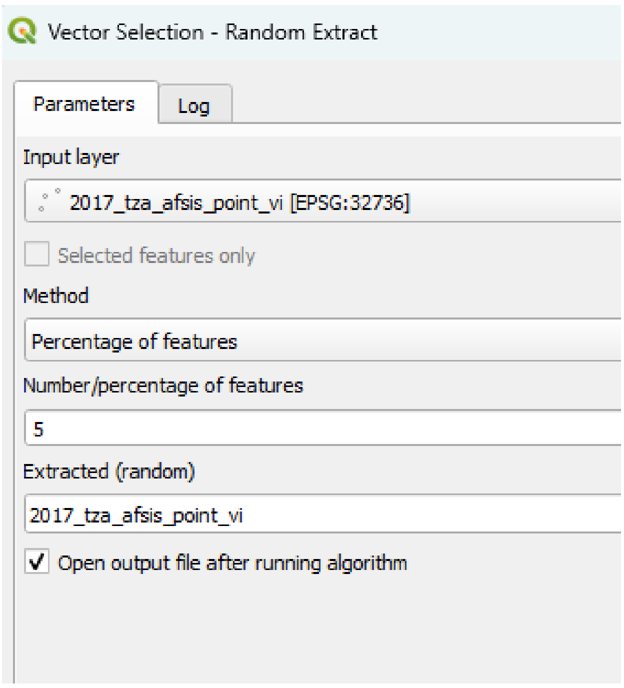
Further investigation of the data point using high-resolution Google Satellite data clearly indicates that the data point is located on the road.

Data points located more than 20 meters from the road are considered reliable cropland observations. In this case, you will select 192 data points and save these selected data points as Geopackage file '2017_tza_afsis_point_crop_UTM_accepted.

Step 6: Random selection of points for visual interpretation.

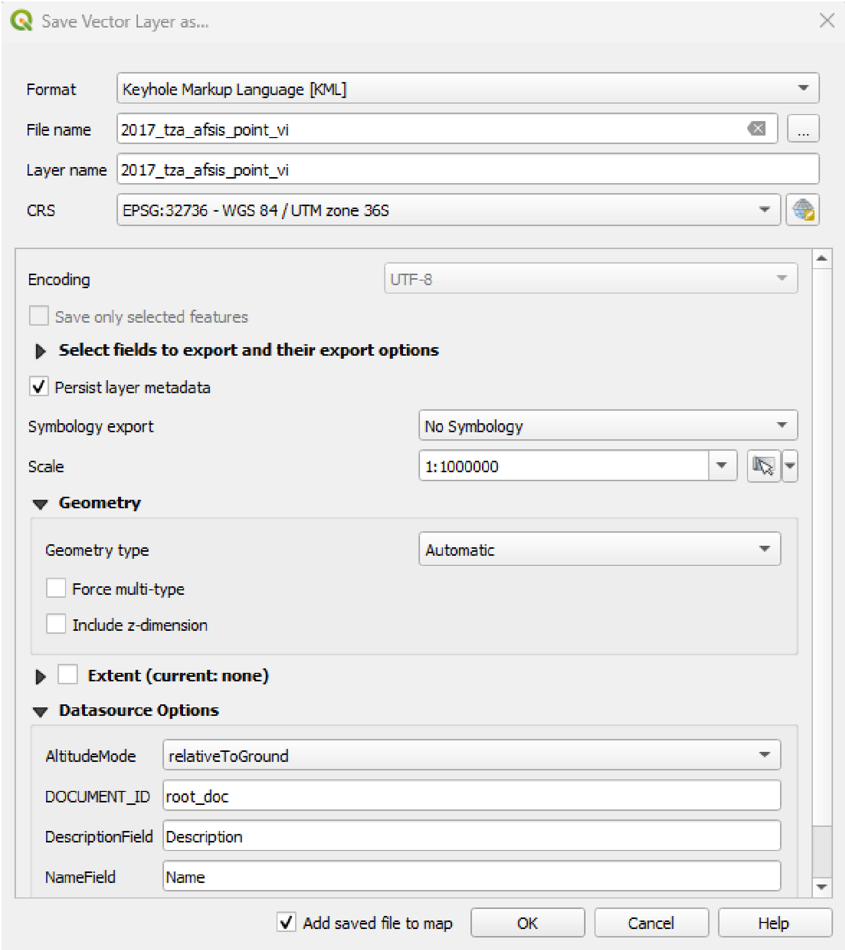
To gain an understanding of the data quality of the remaining data, we will randomly select 5% of the data for further visual inspection. Use the Random Extract tool in QGIS to randomly select 5% of the data points:





Save the sample as Geopackage file ’2017_tza_afsis_point_vi’.

Export this sample as KML format.

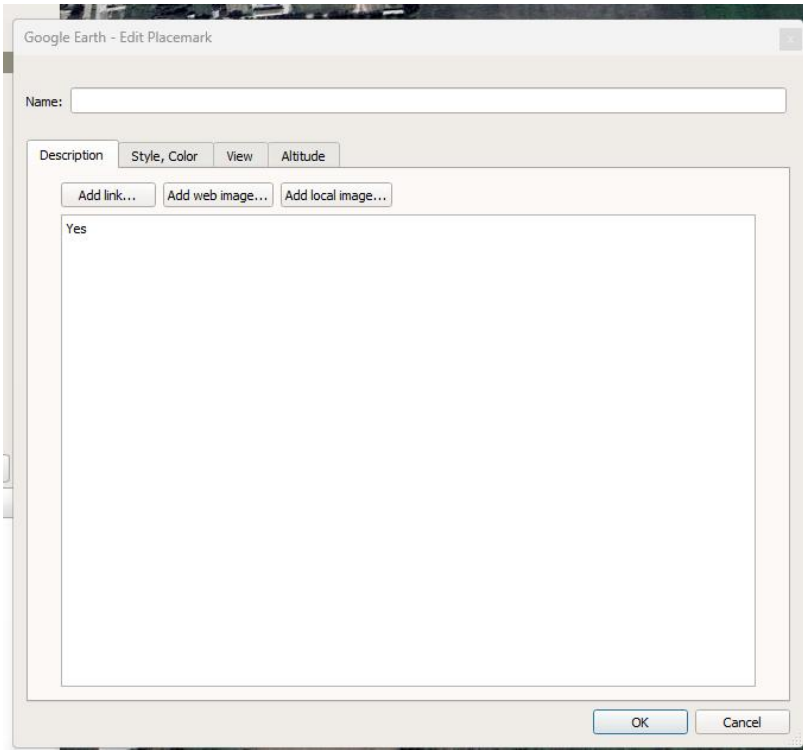


Detailed guidelines involving visual inspection of samples can be found in the following document, contained within the supporting materials of this exercise:

“Guidelines_Visual_Inspection_Samples_v1_0.pdf”

Load the Dataset into Google Earth Engine and perform visual interpretation of the sample dataset. For example, the location below is perfect in the crop field.

Add in description "Yes" if mapping is accurate Else "No".



Visual inspection is subjective and often depends on the interpreter. In this case, nine points were evaluated, two of which were not in the crop field (see the example in the following figure).

Save your results and count the number of suspicious cases.

Step 7: Finally assign the spatial accuracy case

WorldCereal proposes different case scenarios (as shown in the table below) to value the analysis of visual interpretation.

Case	Description
Case 0	Expert evaluated samples of cleaned data show no issues
Case 1	Expert evaluated samples of cleaned data show issues (between 1-10%)
Case 2	Expert evaluated samples of cleaned data show issues (between 10-25%)
Case 3	Expert evaluated samples of cleaned data show issues (between 25-50%)
Case 4	Expert evaluated samples of cleaned data show issues (between 25-50%)

In the exercise above, there were 9 samples, 2 of which were found to be suspicious, placing this scenario under Case 2 (issues between 10-25%).

Exercise 2: Investigating Temporal Accuracy

Open the attribute table of Geopackage '2017_tza_afsis_point_crop_UTM_accepted'.

Examine attributes to find the date when the crop was observed.

2017_tza_afsis_point_110 — Features Total: 230, Filtered: 230, Selected: 0

	fid	fid_1	today	surveyor	lat	lon	maize	barley	millet	wheat	sorghum	rice	
1	56	10173	8/4/2017	OMAR	-7.970666484	31.70379507	N	N	N	Y	N	N	N
2	132	10249	15/06/17	Sv	-7.704791832	35.49854059	N	N	N	Y	N	N	N
3	81	10198	13/04/17	Essau	-8.578041833	32.83687153	N	N	N	N	N	N	N
4	102	10219	19/04/17	Mk	-8.816160464	34.63065487	N	N	N	N	N	N	N
5	166	10283	17/06/17	Ben & kiriba	-5.112324673	34.67652381	N	N	N	N	N	N	N
6	33	10150	1/1/2017	Vicky	-4.16620681000...	34.68135047	N	N	N	N	Y	N	N
7	34	10151	1/1/2017	Vicky	-4.16791029	34.67999553	N	N	N	N	Y	N	N
8	96	10213	16/04/17	Essau	-8.735560931	34.20670904	N	N	N	N	Y	N	N
9	97	10214	16/04/17	Essau	-8.75838695600...	34.24904461	N	N	N	N	Y	N	N
10	144	10261	15/06/17	Mk	-6.877120373	36.13132149	N	N	N	N	Y	N	N
11	159	10276	17/06/17	Essau	-6.532801897	37.24632799	N	N	N	N	N	Y	N
12	36	10153	4/4/2017	Essau	-8.288403681	31.56159311	N	N	N	N	N	N	N
13	42	10159	5/4/2017	Grp 2	-7.168681731	31.01571611	N	N	N	N	N	N	N
14	47	10164	7/4/2017	Essau	-8.306594789	31.28913748	N	N	N	N	N	N	N
15	52	10169	7/4/2017	OMAR	-8.238301601	31.82355773	N	N	N	N	N	N	N
16	57	10174	8/4/2017	Grp 2	-7.68572684	31.16029427	N	N	N	N	N	N	N

Show All Features

Exercise 3: Overall dataset confidence score calculation

Open the confidence calculator Excel file, supplied in the supporting material to this exercise:

"WorldCereal_DataConfidenceScore_Calculator_v3_0.xlsx"

Evaluate the dataset:

- Spatial Accuracy:
    - No GPS information
    - Spatial context analysis: Case 2 (Expert evaluated samples of cleaned data show issues (between 10-25%)).
- Temporal Accuracy: survey date is present
- Validation: was done by the original data holder (see 10.17605/OSF.IO/4NGAU with information on raw and tidy files and the ODK form Crop_scout.xlsx for info on spatial accuracy)

Calculate the confidence score (e.g., 82.8%).

FieldObservationSurvey / Windshield (at dataset level)

Quality Category	Description	Score & Reduction factor	Weight (%)	Total Score
Geometry (spatial accuracy based on GPS)	If GPS info is not present	95	40	22.8
Geometry (spatial context analysis by benchmarking against non-arable spatial features e.g., roads, water bodies, railway, buildings, nature areas etc.)	Case 2: Evaluated samples of cleaned data show issues (between 10-25%)	0.4		
Level of accuracy of time	Real date	100	35	35
Validation applied	Yes	100	25	25
Grand Total Confidence Score				82.8

Summary

In the above exercises, you learnt which factors are typically involved when WorldCereal moderators are evaluating the quality of a reference dataset and how to perform a quality assessment of point data. The steps for polygon data are similar, with the addition of more detailed analysis of polygon geometry, the heterogeneity of mapped polygons within cropland, and performing an intersection analysis with roads.