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GOVERNMENT OF ESWATINI  
MINISTRY OF NATURAL RESOURCES AND ENERGY  
SURVEYOR GENERAL'S DEPARTMENT

**SUSTAINABLE LAND ADMINISTRATION AND  
MANAGEMENT**

# **LANDHOLDING INFORMATION MANAGEMENT SYSTEM**

USER GUIDE

FINAL



## SUSTAINABLE LAND ADMINISTRATION AND MANAGEMENT

### LANDHOLDING INFORMATION MANAGEMENT SYSTEM

#### USER GUIDE

Final

July 2019

This manual has been prepared by **COWI A/S** of Parallelvej 2, Kongens Lyngby, Denmark on behalf of the Ministry of Natural Resources & Energy, Surveyor General's Department, for a project of Technical Assistance Support to the Government of Eswatini in Sustainable Land Administration and Management, funded by the European Union.

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## Acronyms and Abbreviations

App	Application (software program)
CRS	Coordinate Reference System
ECW	Enhanced Compression Wavelet
EPSG	European Petroleum Survey Group
ESWADE	Eswatini Water and Agriculture Development Enterprise
EU	European Union
FAO	Food and Agriculture Organisation (of the United Nations)
GIS	Geographic Information System
GOE	Government of (the Kingdom of) Eswatini
GPS	Global Positioning System
IT	Information Technology
LIMS	Land Information Management System
LMB	Land Management Board
LUP	Land Use Planning
MEPD	Ministry of Economic Planning and Development
ODBC	Open Data Base Connectivity
ODK	Open Data Kit
SGD	Surveyor General's Department
SLAM	Sustainable Land Administration and Management
SNL	emaSwati Nation Land (formerly Swazi Nation Land)
TA	Technical Assistance
TDL	Title Deed Land
<i>Tinkhundla</i>	Electoral and administrative areas; a division of regions, similar to 'districts.
TOR	Terms of Reference

# 1 Introduction

This user guide on the SLAM Landholding Information Management System (LIMS) is a one-source technical reference for the system that collects, stores, edits, delivers and maintains information about homestead landholdings on emaSwati Nation Land (SNL).

The LIMS is a product of the Sustainable Land Administration and Management (SLAM) project that operated, as a pilot, between October 2016 and May 2019. The key stakeholders in the SLAM project include:

- > Ministry of Natural Resources and Energy / Surveyor General's Department (SGD)
- > Ministry of Agriculture / Land Use Planning Department & Eswatini Water and Agriculture Development Enterprise (ESWADE)
- > Ministry of Tinkhundla Administration and Development
- > Pilot area chiefdoms
  - > Hhohho / Ndzingeni
    - > Ludlawini
    - > Nkamanzi
    - > Ndzingeni
    - > Mvuma
  - > Lubombo / Dvokodvweni
    - > Malindza
    - > Mdumezulu
  - > Manzini / Mkhiweni
    - > Dvokolwako
    - > Mbelebeleni
    - > Ekutsimuleni
  - > Shiselweni / Sandleni
    - > Ngololweni
    - > Nkhungwini
    - > Kanzameya
    - > Nkalaneni
    - > Gasa
    - > Lomfa
- > Delegation of the European Union in Eswatini
- > Ministry of Economic Planning and Development / Aid Coordination Management Section
- > COWI A/S (technical assistance advisers)

The LIMS is largely managed, operated and maintained in the Surveyor General's Department (SGD) in Mbabane.

## 1.1 Landholding Information Management System Overview

The architecture for the land information management system (LIMS) consists of the following main components: **mobile devices** with a data collection app, a **server** receiving and storing the collected information, and **office equipment** to check, handle and visualise the collected data.

The use of mobile devices and technologies for collection of (geo) information in the field has grown popular in the last decade, avoiding the use of pen and paper-based surveys. The challenges associated with these paper-based methodologies, such as transcription errors in data entry from handwritten forms, lost forms, linking copies of supporting documents to the appropriate record are non-existent in a digital approach, and a full audit trail from data capture in the field, quality control in the office, to record completion can be achieved.

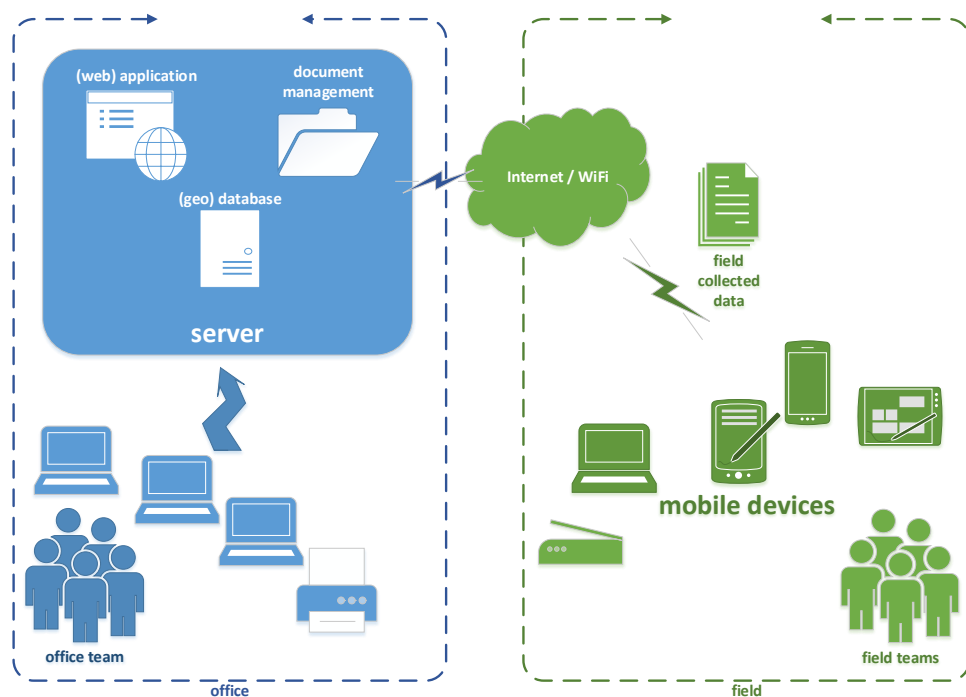


Figure 1: SLAM LIMS architecture

An evaluation of various alternatives for system components was made before the choice of specific software tools. Limiting factors in the decision-making process included the project budget, technical assistance input, existing capacity, and short- and medium-term sustainability. A SLAM LIMS website (cloud access) is envisaged but has not yet been implemented.

### 1.1.1 Field Data Collection App

The data collection app can record geographical information, e.g. **geometries** such as points of interest, roads, parcels, fields as well as alphanumeric attributes describing these geometries. The data collection app can guide field teams in performing structured and predefined digital **questionnaires**, and even facilitates the recording and storing **photos, videos, barcodes, audio**.



The data collection app is able to **work offline** under conditions where internet connectivity and speed are limited and unstable. The mobile devices will have supporting offline spatial data available, such as world imagery, other ortho(aerial) photos, supporting vector information, such as downloaded open street map data.

The GeoODK Collect<sup>1</sup> app was selected as data collection application on the mobile devices for the SLAM project. GeoODK is suitable for an android operating system and is based on the open source Open Data Kit (ODK Collect<sup>2</sup>) software with added spatial/geographic functionality.

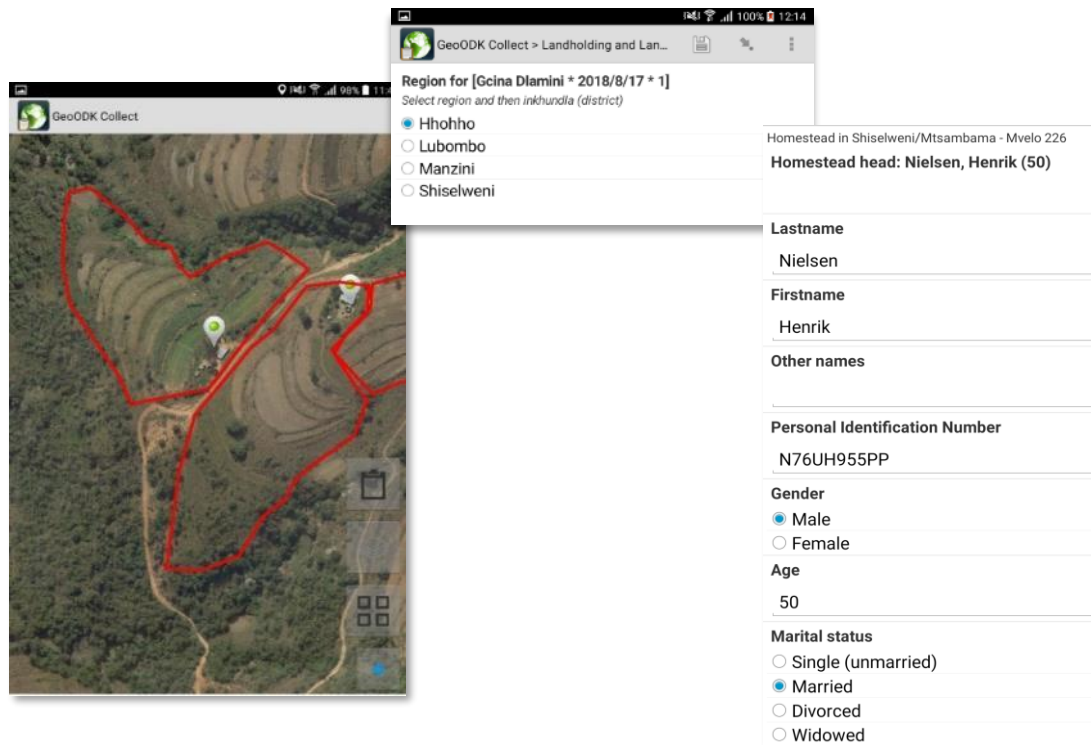


Figure 2: impression of GeoODK Collect

### 1.1.2 Office Processing

The server holds the definition of the desired information (i.e. a data model of attributes, geometries, and questionnaires) captured in a "form"<sup>3</sup> which can be loaded and used on the mobile device. The collected data will be **synchronised** between mobile device and server via Internet or Wi-Fi connection and stored in a **geodatabase** with all collected information.

The server facilitates further handling, supervises **quality control**, analysis and completion of the collected information by the office team, as well as **sharing** and **visualisation** of the results with stakeholders (chiefdom landholding data on chiefdom laptops).

<sup>1</sup> <https://play.google.com/store/apps/details?id=com.geoodk.collect.android>

<sup>2</sup> <https://docs.opendatakit.org/collect-intro/>

<sup>3</sup> Landholding & Land Use Data Form, version F: d.d. 13-08-2018

A Dell PowerEdge R730 rackserver has been deployed with MS Windows 2012 R2 operating system and a PostgreSQL database. The server operates in a small local area network (LAN). The server has a 250GB SSD and should have two hot-swap 1TB hard disk drives but problems with procurement means that only one 1TB external drive provides the data storage. The network is not connected to the Internet, nor to the government computer network.

Office Equipment that is available to perform quality control, updates, visualisation is available:

- > Desktop computers with Geographic Information System (GIS) software for data editing, querying and viewing spatial and textual data; QGIS<sup>4</sup> geographic information system (GIS) software.
- > Office productivity tools for data distribution and dissemination; MS Office.
- > A0 map plotters and A4 printers.

GIS desktop software is QGIS (version 2.18 and 3.4), which has robust links and compatibility with server-based PostGIS databases.

Microsoft Office Word and Excel software with ODBC links to the PostGIS database are used for preparing and printing registers and lists.

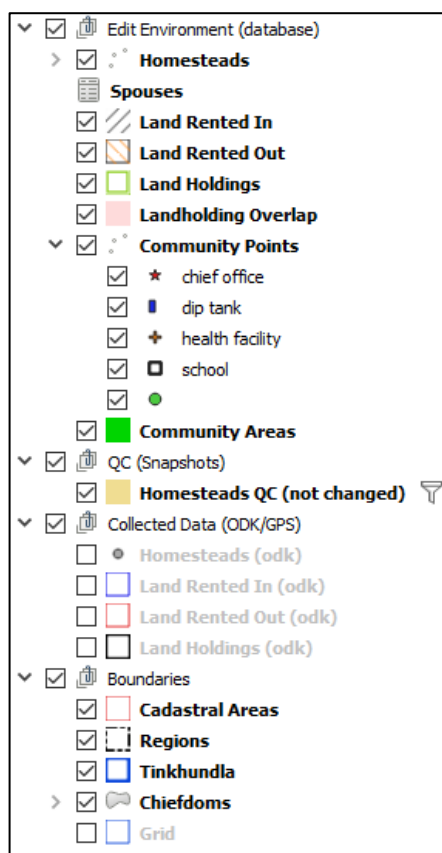


Figure 3: QGIS LIMS data layers and views

## 1.2 Data Structure

Both attribute and spatial data are stored within LIMS's central PostgreSQL `odk_prod` database. Daily backups of the `odk_prod` database are made using Windows Server's TaskScheduler (see Appendix D). Data are distributed across numerous related database tables. The tables and `views` (or 'snapshots') of one or more tables are made available in QGIS as `layers`.

The data in LIMS comprises of the following information stored in its geo-database or as files on the server:

- > Editable layers/tables
  - > Homestead (points)
  - > Landholdings / fields (polygons)
  - > Land borrowed in/out (polygons)
  - > Community features (points and polygons)
- > Quality Control layers/tables
  - > Checks on overlaps
  - > Original collected ODK/GPS data
- > Administrative boundaries
  - > Cadastral areas
  - > Regions, tinkhundla and chiefdoms

<sup>4</sup> <https://www.qgis.org>

- > Raster image files (orthophoto maps)
  - > Images in ECW format
  - > A grid visualising location of image files

## 1.3 Coordinate Reference Systems

A coordinate reference system (CRS) is a combination of:

- > Geographic position (datum)
- > Map projection


A geographic location is defined by a geodetic datum (e.g. Cape datum) and latitude and longitude east or west of the Greenwich meridian. A map projection is defined by parameters for the shape of the earth (major axis, minor axis, e.g. Lo31). A coordinate reference system is a combination of a datum and map projection.

This user guide discusses coordinate reference systems in the context of the SLAM LIMS software environment; it does not cover the subject generally. A brief overview of coordinate reference systems in QGIS is provided here; more information can be found in any technical text on the subject<sup>5</sup> and in the QGIS user manual.

When starting QGIS with a new empty project, the default CRS will be EPSG:4326, where EPSG means 'European Petroleum Survey Group'<sup>6</sup> and '4326' is the code for a the WGS84 CRS.

When starting any new task in QGIS, the QGIS program is started (not an existing project file with the extension .qzs) and usually QGIS will start with **Recent Projects** window. For a new task, create a new QGIS project.

For SLAM data, QGIS can be set up with the right **environment** that defines the coordinate reference system, layers and layer styles. This environment is set using a **plugin**, which is a software extension to QGIS. To load QGIS plugins, see Appendix C0.

The SLAM environment plugin  configures QGIS with the appropriate coordinate reference systems. Three coordinate reference systems are loaded by the SLAM environment.

- > EPSG: 4326 – this is WGS84 datum and no projection i.e. geographical coordinates.
- > EPSG: 32736 – this is WGS84 datum and UTM zone 36S projection.
- > ESSG: 22291 – this is Cape datum and Lo31 projection.

The table below lists these, and other relevant CRS codes used in the SLAM LIMS.

---

<sup>5</sup> [https://en.wikibooks.org/wiki/Coordinate\\_Reference\\_Systems\\_and\\_Positioning](https://en.wikibooks.org/wiki/Coordinate_Reference_Systems_and_Positioning)

<sup>6</sup> [www.epsg.org](http://www.epsg.org)

<i>Code</i>	<i>Description / Coordinate Reference System (CRS)</i>
<i>Standard</i>	
EPSG:3857	WGS84 ellipsoid, pseudo Mercator projection (used by Google maps, OpenStreetMap, Bing, etc.)
EPSG:4326	WGS84 ellipsoid, no projection – geographical coordinates (latitude / longitude)
EPSG:22291	Cape datum, Clarke 1880 ellipsoid, Lo (zone 31) projection (based on a generic 5-point transformation, with accuracy of 9-15m)
EPSG:32736	WGS84 datum/ellipsoid, UTM projection zone 36S
<i>User defined</i>	
USER100001	Cape datum, Clarke 1880 ellipsoid, Lo (zone 31) projection. This CRS is based on SGD geodetic data and is very close to but not exactly the same as EPSG:22291. However, for most practical purposes in SLAM, either USER10001 or EPSG:22291 may be used.

By default, QGIS starts with the default CRS (EPSG:4326), and it automatically changes to the CRS of the first vector or raster data set layer added to a new project.

If the SLAM edit environment is loaded the default CRS will also be EPSG:4326 and all the SLAM data layers will be presented in this CRS. Adding a raster (image) layer may result in a CRS inconsistency if the image file is not in EPSG:4326. However, in most cases, but not all, QGIS will recognise the CRS of the image file and automatically apply an “on-the-fly” reprojection. Where the image file does not include CRS metadata that QGIS recognises, the image will appear in the wrong location. It can be ‘brought’ back into consistency with SLAM data by manually setting the projection.

- > Right-click on the image layer > Properties > Source

Set the source coordinate reference system to EPSG: 22291- Cape/Lo31. If the image file has the CRS EPSG: 102478 – Cape\_Lo31, this is wrong. Change it to EPSG: 22291.

Although EPSG: 22291 Cape datum Lo projection zone 31 is the official CRS for Eswatini, QGS works by default in EPSG: 4326 and re-projects automatically all other data into this default CRS. Furthermore, spatial data captured in the field is also in EPSG: 4326.

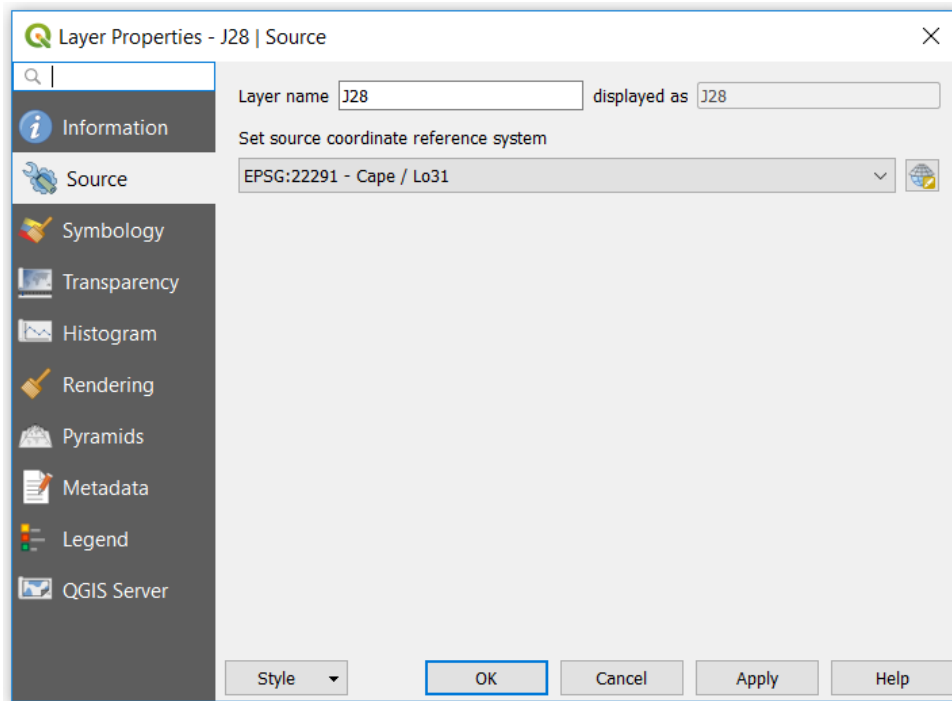


Figure 4: QGIS raster layer CRS properties

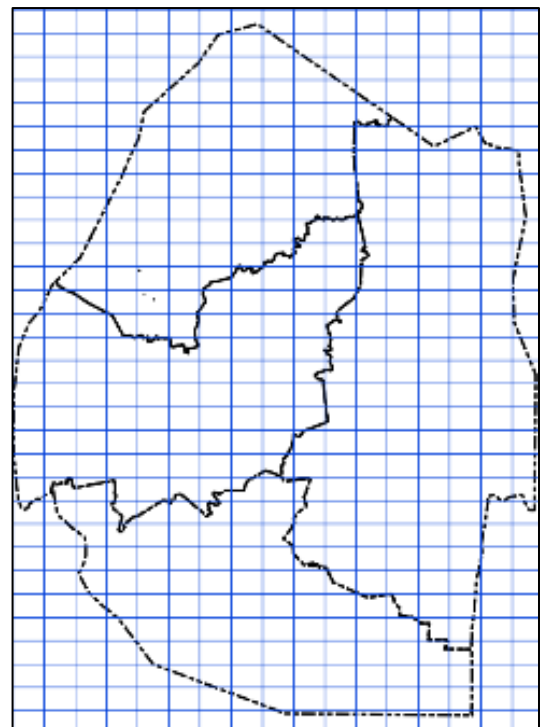
Refer to the QGIS manual for more on projections and transformations.

If a data set is used without a CRS or a standard conversion is available, it may be necessary to 'georeference' the image to bring it into the project CRS. Refer to Appendix E for more information about georeferencing.

## 1.4 Orthophoto Image Files

The image files, or orthophoto map files, used as a backdrop for homestead landholding data are provided by the SGD. These 'ortho-rectified' images, which means they are distortion free and scale accurate, have a ground resolution of 0.25 metres (pixel size). The image files are arranged in a grid of map tiles 8km by 4km. The CRS for these raster image files is EPSG: 22291 – Cape/Lo31. However, some may have a 'user-defined' CRS which for all mapping purposes is the same as EPSG: 22291.

The map tile or sheet is identified by a letter and number, starting with A01 in the top left and ending S31 in the bottom right. Note that the "grid" layer is available in QGIS to provide an overview of these map tiles.



The files are stored in a directory in the fileserver at:

> D SLAM EXDR02 Geodata (\\192.168.8.2) [mapped drive letter]\Geodata\Imagery\ECW\_SGD\_2015

The file formats are Enhanced Compression Wavelet (ECW) that is supported directly by QGIS.

**For performance reasons: Do not use the files directly from the above directory on the fileserver. Copy the files needed to the local computer.**

The format is not supported by GeoODK for use in data collection, so the format must be converted to MBTiles for use on the tablet computer in GeoODK.

MBTiles is a raster file format. The files are compressed and hold geographic location and projection information. The format is specifically designed for use in web or mobile applications. MBTiles is an open source specification and based on SQLite. Refer to Appendix B about how to create MBTiles.

## 1.5 Attribute Data

Attribute or text data is collected in the field by a questionnaire form. There are a series of questions, and sub-questions that depend on answers given.

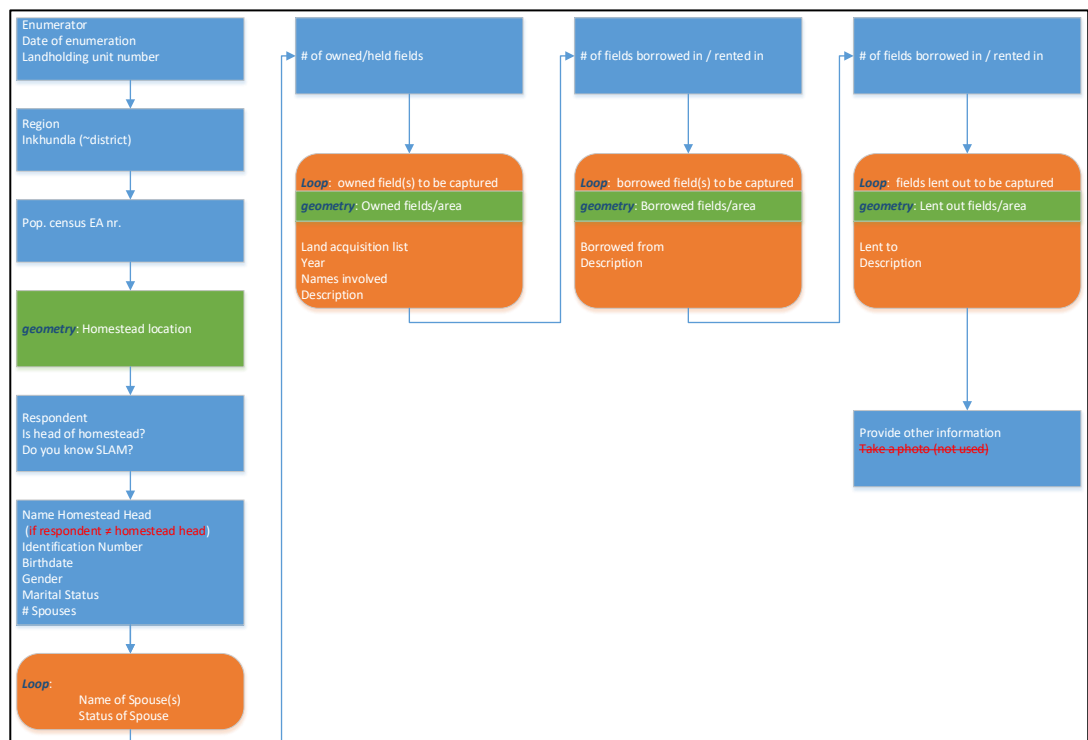


Figure 5: Field data collection form structure and flow

The form collects the following attribute data items:

Homestead landholding id; region; district; chiefdom; landholdings id; land use; allocation year; population census number; homestead head name; homestead head id; homestead head birthdate; homestead head gender; homestead head alive/deceased; homestead head marital status; number of spouses; spouse names; chiefdom disputes; other disputes; type land dispute; year dispute start; land dispute status; other relevant information; enumeration date; number parcels; amount land rented in; amount land rented out; area land holdings; area land rented in; area land rented out.

The data are held in a 4 core linked tables:

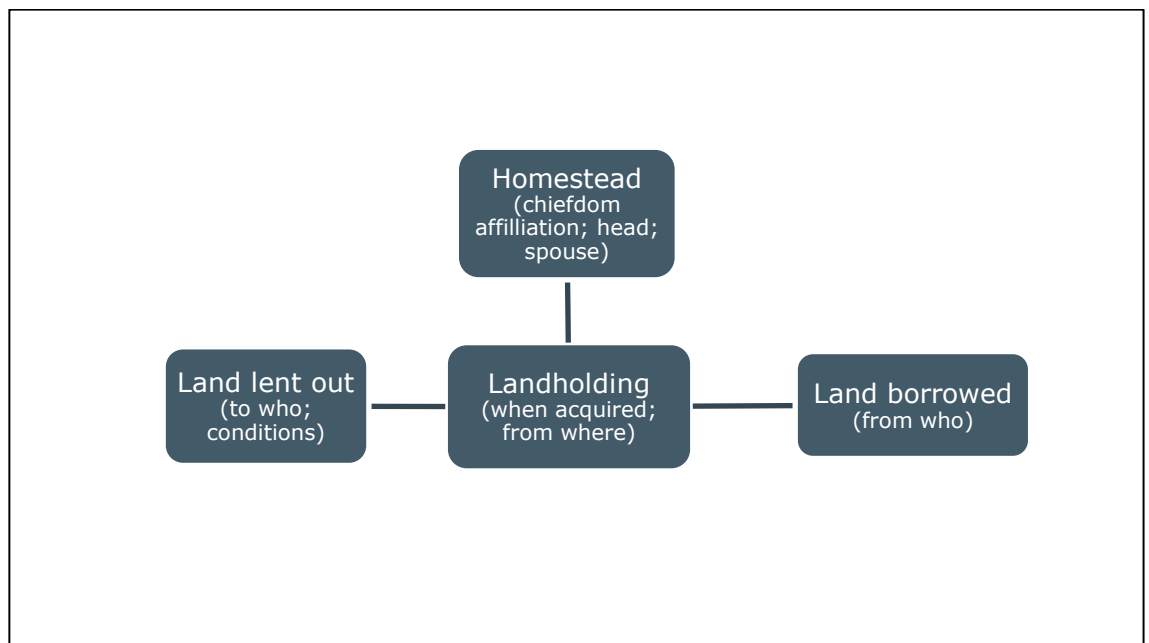


Figure 6: Attribute database tables

## 1.6 Key Fields

Each of the tables shown in Figure 6 above are linked by a key field. These key fields may be arbitrary with only the purpose of providing linkages but in may also be an important identifier of a land object. The SLAM database uses three key geospatial object identifiers:

- > Homestead\_id
- > Landholding\_id
- > Landholdings\_id

The **homestead\_id** is a unique number for all homestead point records (the location of the homestead houses) in the range 1-n for all chiefdoms where n is the last homestead record in the table for all homesteads in the Kingdom. During data collection, homesteads are labelled with **homestead\_id**, which is a system generated sequence identification number, unique within the whole database, assigned in the order of the homesteads records arriving from the field and being loaded into the server.

The **landholding\_id** is a unique number for all homestead polygon records in the range 1-n for all chiefdoms where n is the last landholding record in the table for all landholdings in the

Kingdom. Note that two polygons may have the same **landholding\_id** if they are landholdings belonging to the same homestead. Landholding polygons may be uniquely identified by their **homestead\_id** plus an ordinal number in the form 1234\_1 for field 1 and 1234\_2 for field 2 both belonging to the same homestead.

The **landholdings\_id** is a unique identifier only in each chiefdom in the range of 1-n where n is the last landholding in a particular chiefdom; i.e. the number is not unique and is duplicated in each chiefdom. The purpose of the **landholdings\_id** is to provide an easy to use identifier for chiefdom landholding records, registers and maps.

Two examples are shown below. Figure 7 shows **homestead\_id** and **landholding\_id**, both unique for the whole Kingdom. Figure 8 shows **landholdings\_ids** which are unique only in a chiefdom for both the homestead and homestead landholdings.

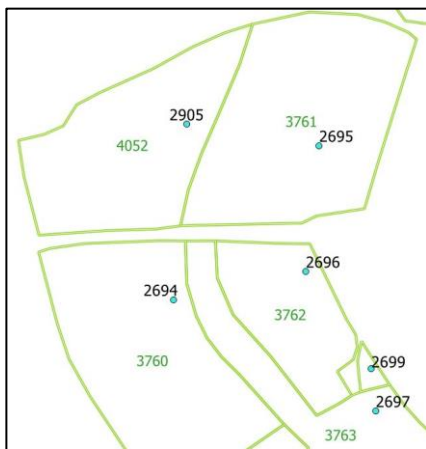


Figure 7: Homestead\_id and landholding\_id

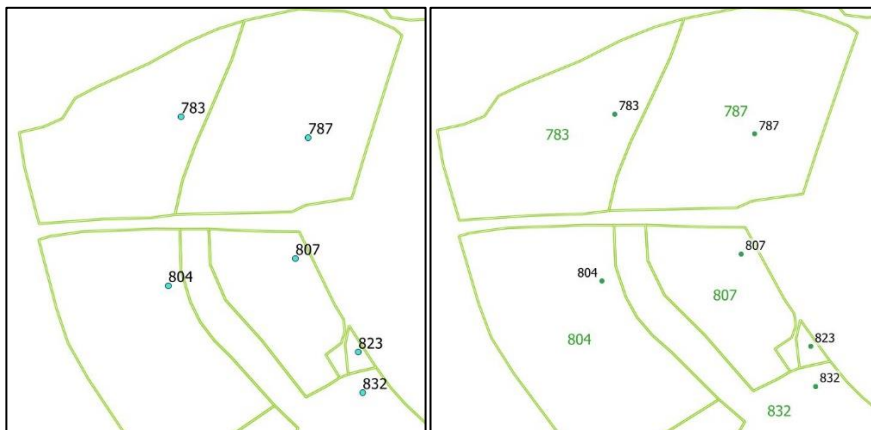


Figure 8: Landholdings\_id for both homestead and land (fields)



## 2 Data Collection

Landholding data are collected or captured in the field using tablet computers. This section of the LIMS user guide explains how to collect data using a tablet computer.

For instructions on setting up a tablet computer and troubleshooting problems with the tablet computer, data collection and data transfer issues, refer to Appendix A.1.







### 2.1 GeoODK – Field Data Collection App

The software used for landholding data collection is called GeoODK Collect. The GeoODK user interface may start with the main menu:



Figure 9: GeoODK main menu

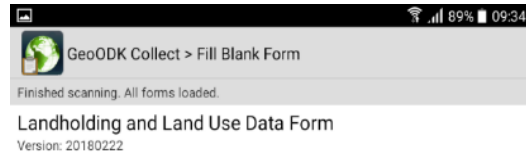
The main screen icons are described below...

 Collect Data	Form to collect data about the landholder etc.
 Send Data	Send collected data from the tablet to the office fileserver database.
 Edit Data	Edit collected data.
 Map Data	Select and show orthophoto maps and collected polygon data.
 Delete Data	Delete data (do not use except when tablet memory is full).
 Settings	Setting (not normally used).

## 2.2 Collect Field Data

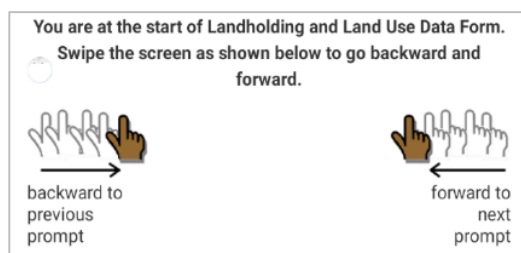
To start collecting data at a homestead:

- > Tap the [Collect Data] icon. "
- > This will provide a list of forms. In most cases select the Landholding and Land Use Data Form.



You are now ready to start data collection.

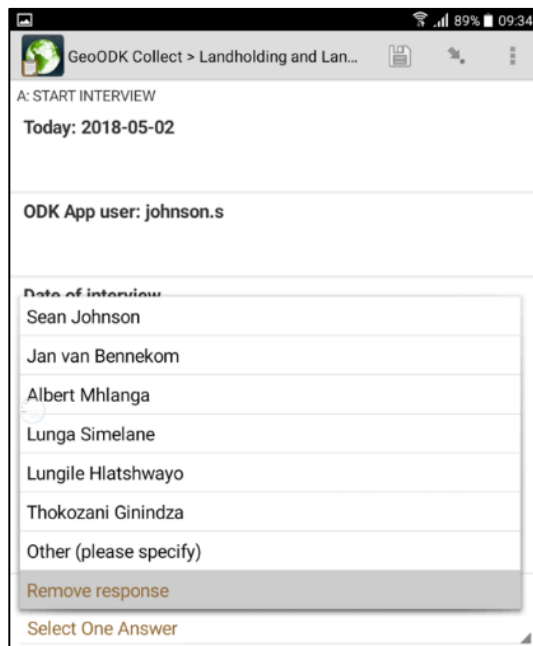
- > The Landholding and Land Use Data Form contains multiple pages. To move from the first page to the second, swipe right to left...



The first page is for the date. The default is today's date.

- > Next select the enumerator (name of person doing the interview to collect data) and chose your name.

If your name is not listed, select [Other] and type it in. Type it in carefully and use your name with exactly the same spelling for each form.



GeoODK Collect > Landholding and Lan...

A: START INTERVIEW  
Today: 2018-05-02

ODK App user: johnson.s

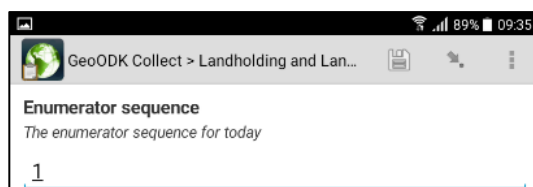
Date of interview

- Sean Johnson
- Jan van Bennekom
- Albert Mhlanga
- Lunga Simelane
- Lungile Hlatshwayo
- Thokozani Ginindza
- Other (please specify)

Remove response

Select One Answer

- > Again, swipe left to go to the next page, which is the Enumerator sequence.



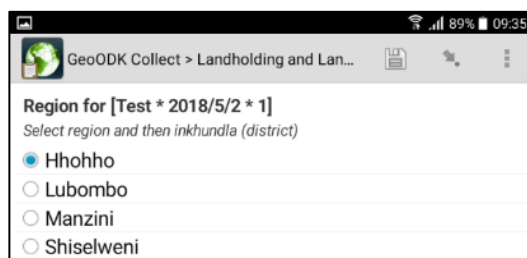
GeoODK Collect > Landholding and Lan...

Enumerator sequence  
The enumerator sequence for today

1

The enumerator sequence for each day usually always starts at [1].

- > Next select the region in which data are being collected.



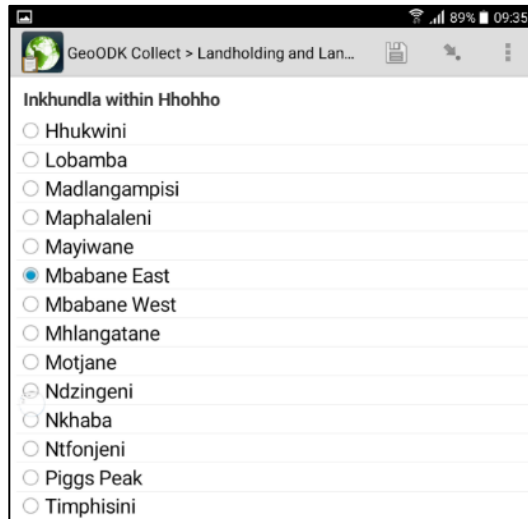
GeoODK Collect > Landholding and Lan...

Region for [Test \* 2018/5/2 \* 1]  
Select region and then inkhundla (district)

- Hhohho
- Lubombo
- Manzini
- Shiselweni

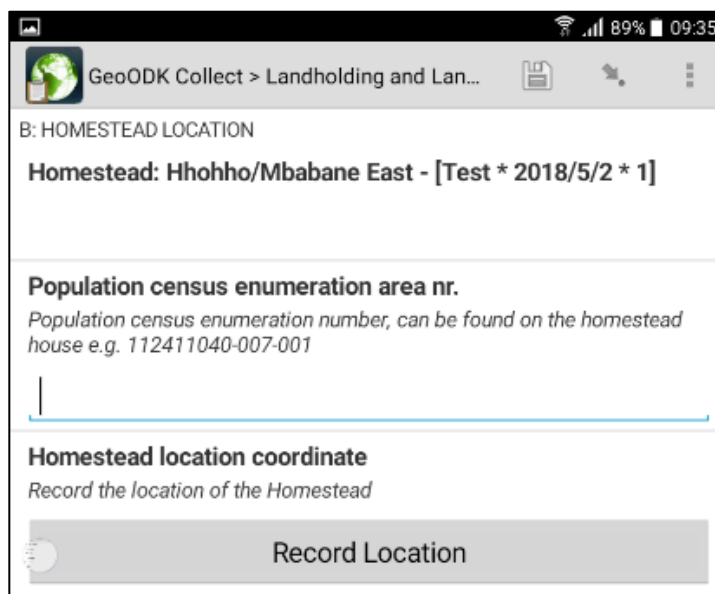
- > Then select the *inkhundla*.

Note that only the tinkhundla in your chosen region are listed.

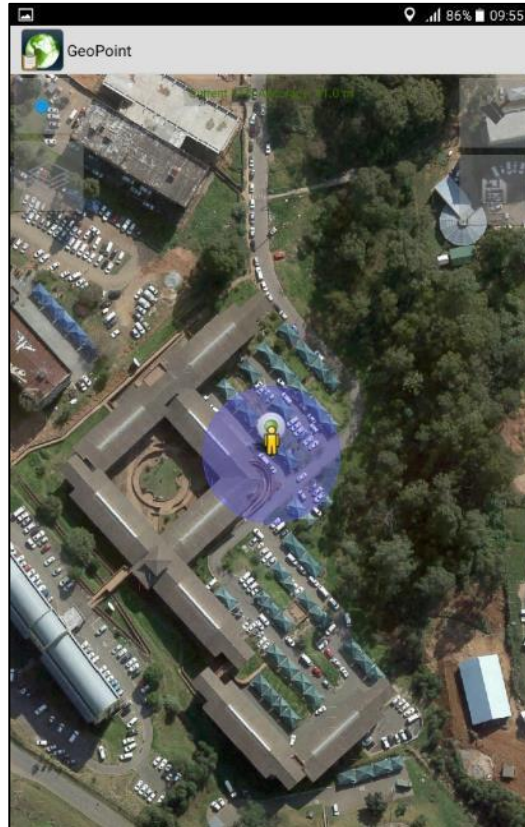


- > Swipe left to reveal the page to enter the population census number.

This is usually written on a sticker above the homestead door.





- > Then tap the [Record Location] bar that will capture a position coordinate of where you are standing, which is should be next to / in front of the homestead dwelling.



Your location is then shown on the orthophoto. The blue circle represents the region of positional uncertainty, which depends on the GPS satellite signal. You can also manually select a point on the orthophoto to be captured as the homestead location.



In the top of the orthophoto are two (faint) icons.

- > Select  to identify and centre your location in the orthophoto.
- > Select  to save your current geographical position in the form.

## 2.3 Data Upload

Uploading the collected field data is done in the office when the tablet is connected via Wi-Fi to the server.



- > Tap  to send data to the server.
- > Tap [Toggle All] to select all the forms to upload
- > Tap [Send Selected] to upload all those marked with  ; the results of the upload will be displayed.



## 2.4 Delete Data

Do not delete data immediately after upload. Keep data on the tablet. The system administrator will periodically delete the data on all tablets after upload has been verified at the server.

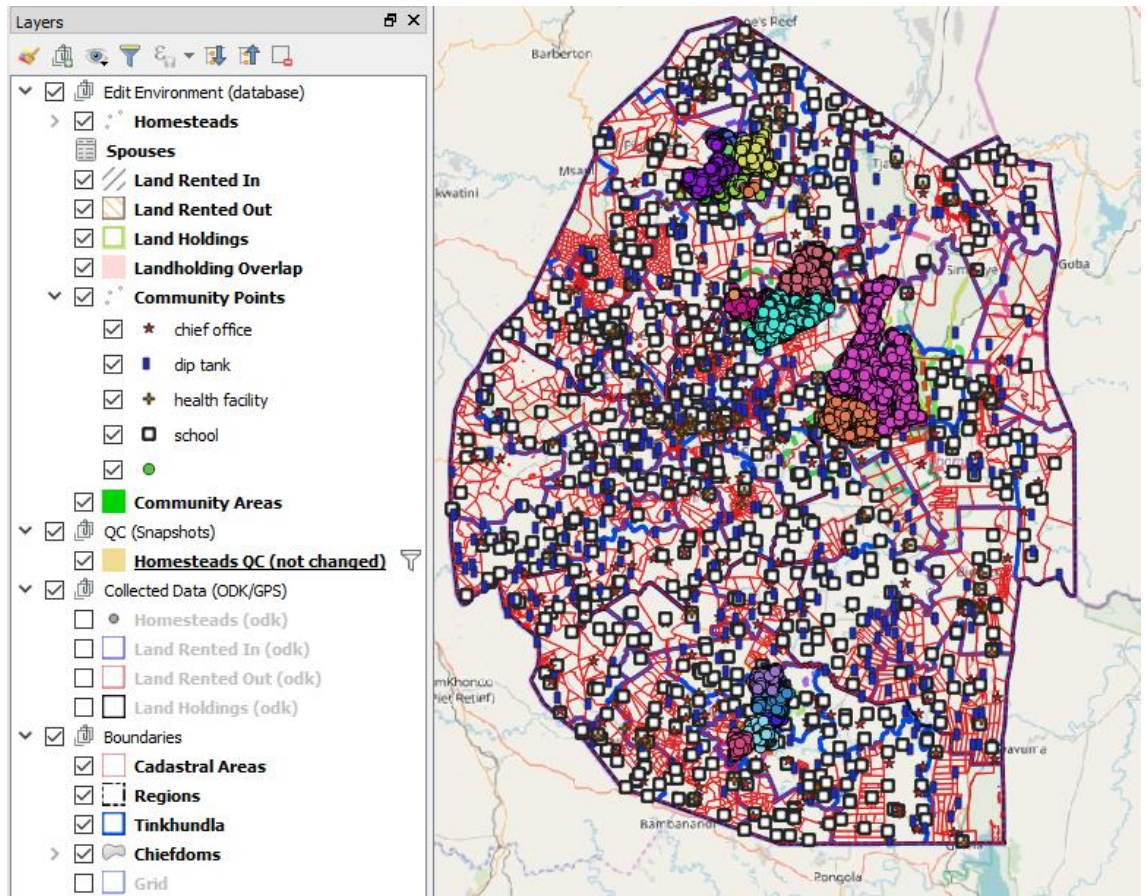
## 2.5 Troubleshooting GeoODK Problems

If there is a problem uploading data from the tablet to the server or the tablet runs very slow, refer to Appendix A.2 Troubleshooting GeoODK and Data Collection.

### 3 Data Processing

Data collected in the field are uploaded in the office to the SLAM database `odk_prod`. The database comprises numerous tables and those that hold the field collected data are identified by a suffix (`odk`).

The field data are uploaded via a Wi-Fi connection (`SlamDataCollection`) from the tablet computer to the SLAM database, after which an automatic process will load the data from the `odk` to the `edit` tables in the database.



Data are processed in the `edit` environment in two stages:

- > Editing of field data geometry (homestead points and field polygons) to eliminate gaps, overlaps, etc. and to make the features consistent with the underlying orthophoto base map.
- > Quality control and editing of all textual data.

### 3.1 QGIS Set Up

Refer to Appendix C QGIS Set Up, for installing and set up of QGIS for the SLAM **edit** environment.

Editing can be done with the whole dataset displayed in the QGIS map window. However, if you want to edit data within only a particular chiefdom then filters to the layers must be applied (see section 3.3).

Note that data can only be edited in the SLAM **edit** environment. Data in the SLAM **chiefdom** environment is read only.

### 3.2 Data Editing

The layer “**Homesteads QC (not changed)**” is available in the Edit environment with a filter on field **total\_changes =0**. This will indicate homestead (and their fields/landholdings) records that have not been checked/edited. Obviously, not all homestead records need changing after data collection, but the layer will identify areas where most homesteads have or have not been changed, thereby identifying areas that still need to undergo editing.

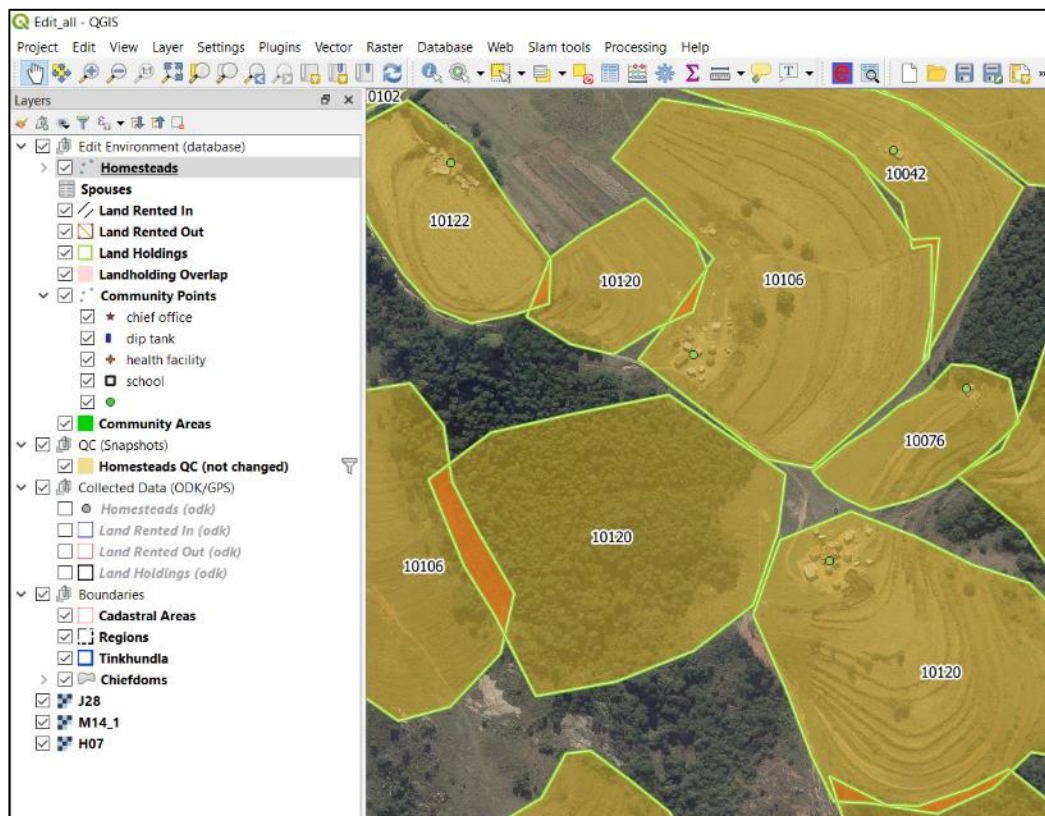


Figure 10: Homestead landholding polygons not edited

Note that after a polygon is edited, the highlighted (filled) polygons in **Homesteads QC (not changed)** layer will not clear immediately. This is because the layer is a ‘materialised view’ of the database, which updates every 6 hours, then clearing the highlights for edited polygons.



### 3.3 Filtering Layers

Filters can be applied to layers to show only data from one chiefdom, highlight the layer to filter:

- > Layer > Filter (or right-click > filter)

To filter (show only) records from one chiefdom in the **Homestead** layer

- > Scroll down the list of fields and select / double click **chiefdom\_list**

Note that **chiefdom\_list** appears in the box below. Next, select the *Operator*, which for text should be [ILIKE].

- > Then, under the values box click [All] which will reveal all the chiefdom names. Double-click to select the chiefdom (see Figure 11).

The results will hide all homestead points not in the chiefdom of interest.

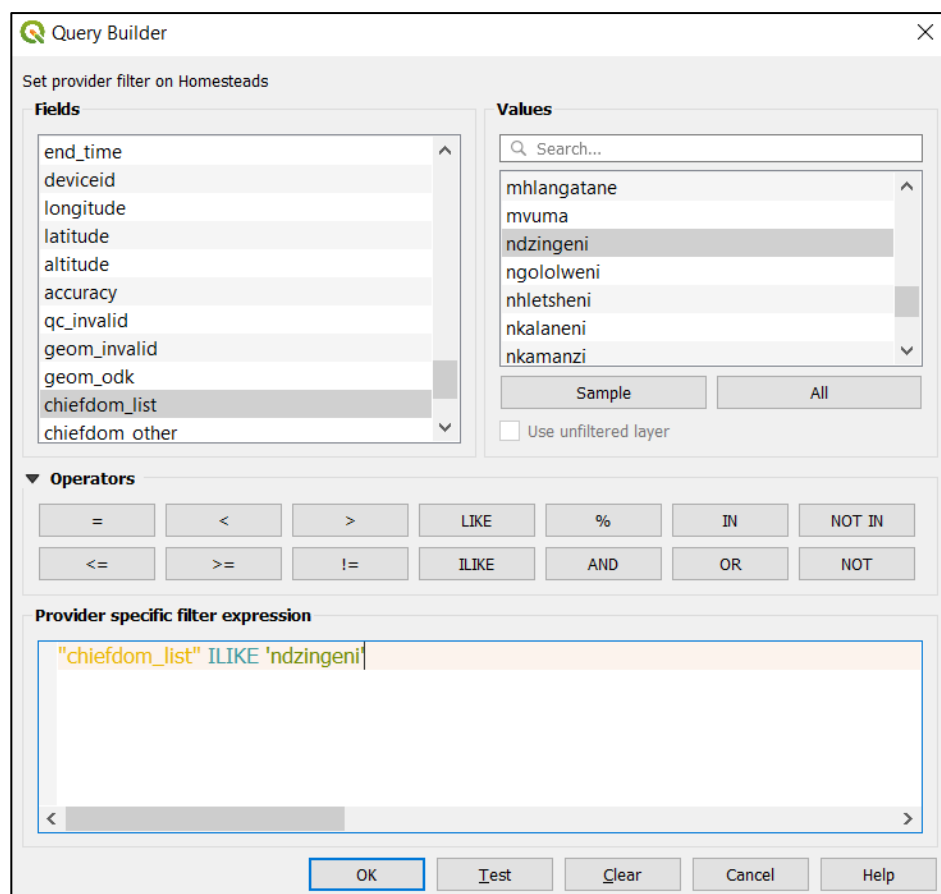


Figure 11: Filter Homesteads by chiefdom

Next, we must filter the **landholdings** layer. Note that this layer does not have a chiefdom name or **chiefdom\_list** field. Therefore, the filter must reference a linked database table. The easiest way to do this is to:

- > Copy and paste the following SQL expression into the query builder window:

- > `exists (select 1 from homesteads hs where hs.id = homestead_id and chiefdom_list = 'chiefdomname')`

Where `'chiefdomname'` is the name of the chiefdom. Note that the chiefdom name must be enclosed by quotation marks.

- > To make sure the statement is correct, click [Test], and if correct, a pop out window will reveal how many rows / records were returned by the SQL "where" clause.

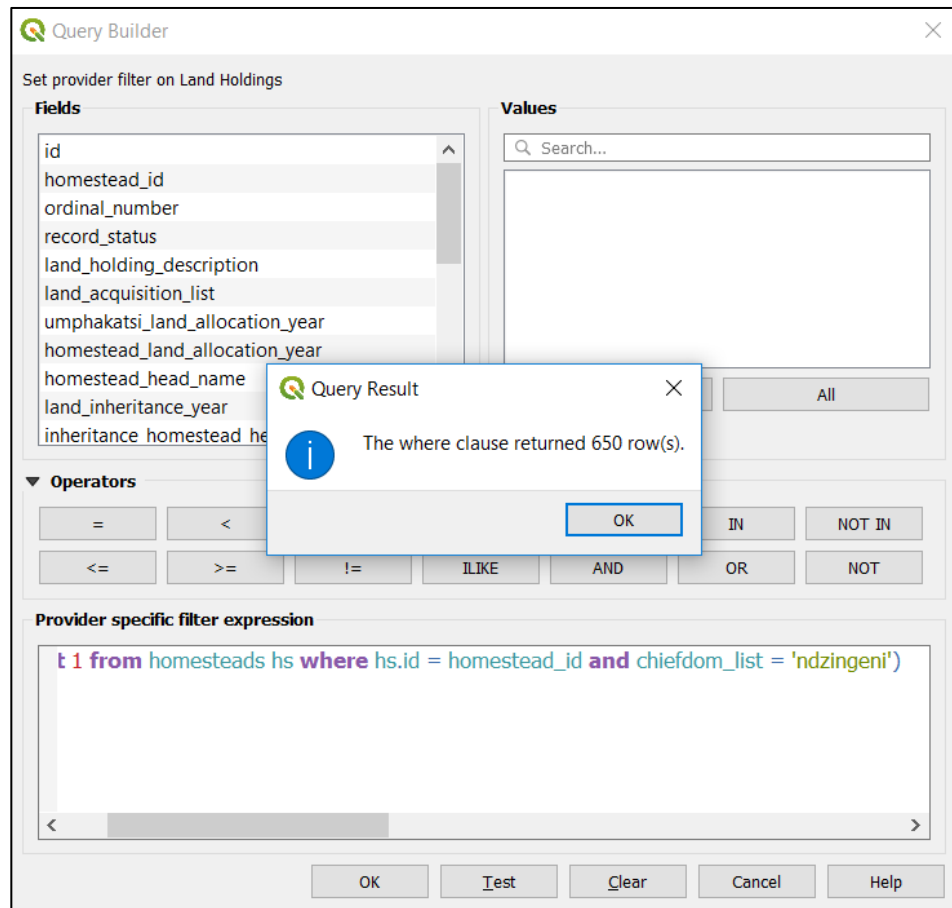


Figure 12: Filter Landholdings layer

To filter the `community_area` layer by chiefdom use the following SQL statement, where the percentage symbol `%` represents any characters, which means any name or words contained, for example, "Mbelebeleni" will be selected / returned:

- > `"community_area_name" LIKE '%Mbelebeleni%'`

For other filters and SQL queries, refer to the QGIS manual.

### 3.4 Landholding Polygon Edits

Spatial data layers available for editing include:

- > Homesteads (points)

- > Land rented in (polygons)
- > Land rented out (polygons)
- > Landholdings (polygons)
- > Community points (points)
- > Community areas (polygons)

The SLAM edit environment also automatically loads the (GeoODK) data collection layers as an aid to data editing (i.e. "Collected Data ODK/GPS").

### 3.4.1 Set Coordinate Reference System

Before starting to edit polygons, change the QGIS coordinate reference system for the project from EPSG:4326 (geographical coordinates) to EPSG:22291 (grid coordinates). The reason for this is that QGIS performs vector data editing when used with grid coordinates (X,Y) rather than geographical coordinates (lat., long.). To change the project CRS:

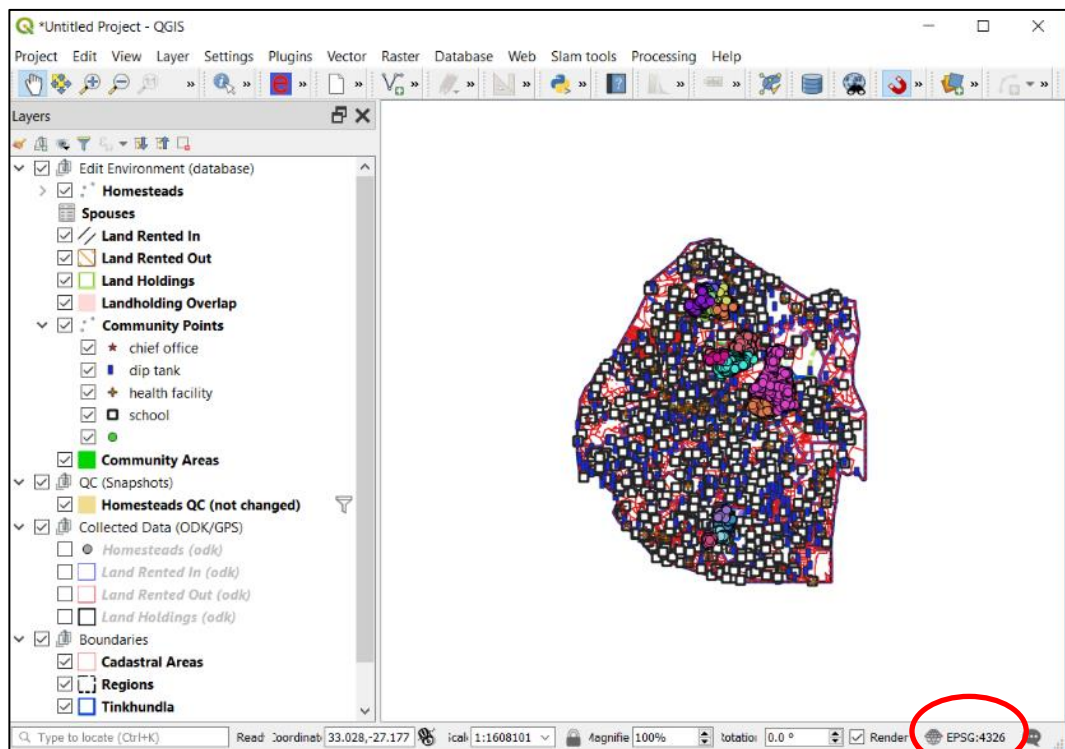


Figure 13: QGIS SLAM edit environment

- > In the bottom right corner of the QGIS window double-click on EPSG:4236, which will open Project Properties | CRS box, below.

If the local CRS Cape / Lo31 does not appear in the list of *Recently used coordinate reference systems*, type 22291 into the filter for the list of coordinate reference systems. This will reveal Cape / Lo31 for selection.

- > Click [Apply] and [OK].

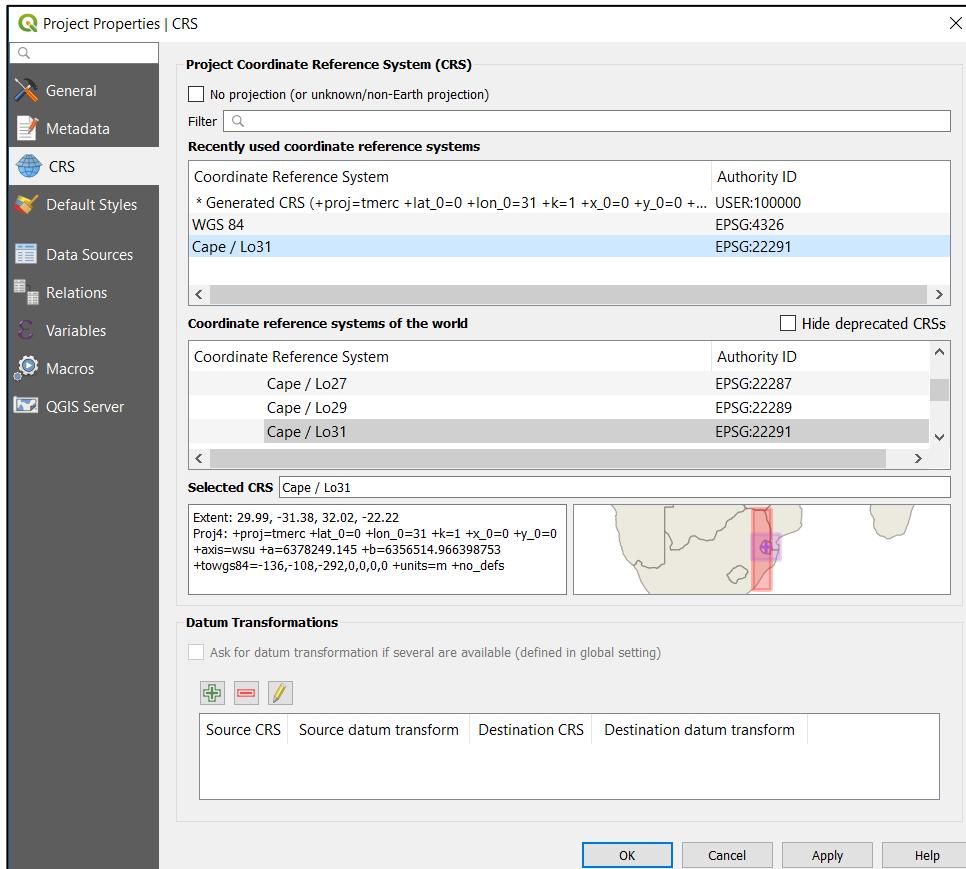


Figure 14: QGIS SLAM CRS

Changing the CRS from EPSG:4326 to EPSG:22291 in QGIS will result in data appearing upside down.

- > To correct this, change the Rotation from 0.0° to 180.0°.

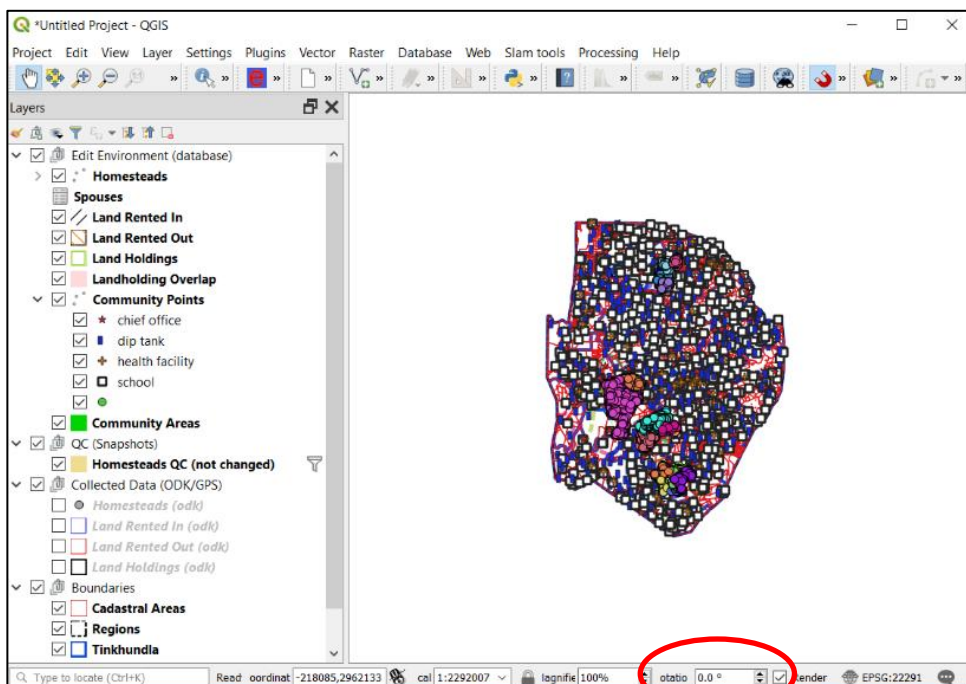


Figure 15; QGIS SLAM CRS re-orientation

### 3.4.2 Edit Overview

Usually, the first stage in data editing is to edit the landholdings polygon layer. Editing polygons consists of two steps:

- > Move the whole polygon to a best fit position.
- > Adjust / move / add polygon nodes and vertices to connect to adjoining polygons and to best fit the underlying orthophoto.

In both cases, the guides for moving and editing polygons are:

- > The orthophoto
- > Collected data (ODK/GPS)

Figure 16 below shows both the edit(able) polygons (green/white boundary lines) and collected data (black lines). The polygons are the same shape with the same gaps/overlaps but note the shift, which is due to difference coordinate reference systems – collected data (black) is WGS84 (EPSG:4326) and edit data (green) is Cape/Lo31 (EPSG:22291).



Figure 16: Unedited data

The edit task, as illustrated above, is to:

- > Move the green polygons to better fit the landholding fields as depicted in the orthophoto, and,
- > Move the polygon nodes and vertices for a best fit with the underlying orthophoto and adjoining polygons.

Figure 17 below illustrates a final result.

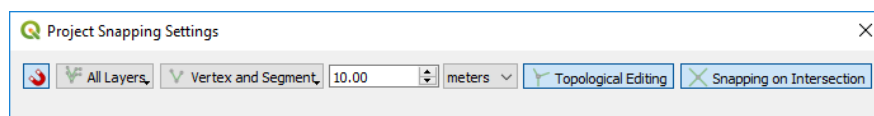


Figure 17: QGIS edited data (green lines) with unedited data (black line)


### 3.4.3 Snapping

Before editing any data, turn on *point snapping*. First turn on the project snapping options:

- > Project > Snapping options
- > Click on [Topological Editing] and [Snapping on Intersection]



Next, highlight the layer for editing, then:

- > Settings > Options > Digitizing > Enable snapping by default ✓
- > Alternatively, click the snapping icon  in the snapping toolbar.

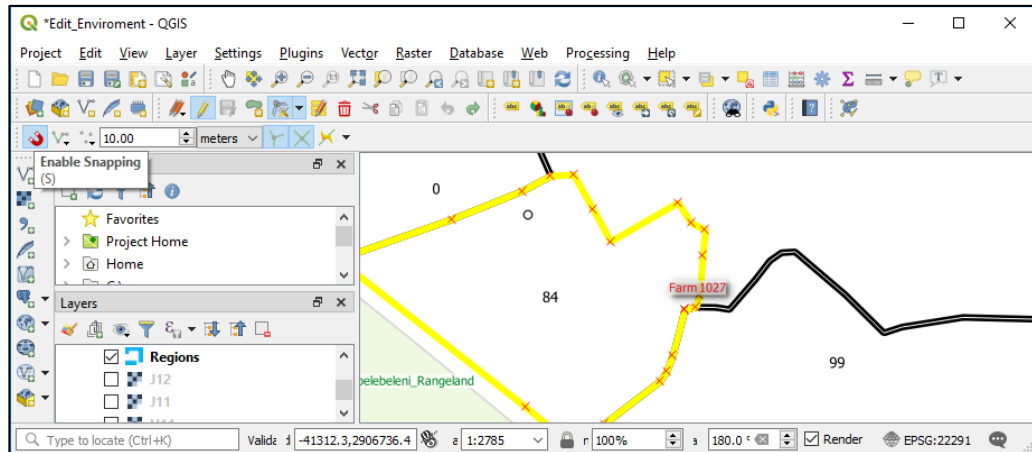


Figure 18: QGIS polygon in edit mode.

In most cases a snapping tolerance of 10 pixels (approx. 2 metres on the ground) is appropriate.

- > Enable both the topological editing and snapping on intersection options. This will allow moving a vertex shared by two polygon features as if it was a single vertex.

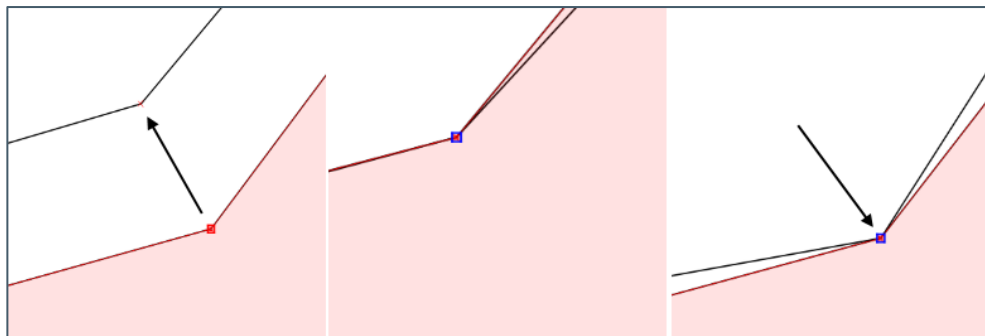


Figure 19: Move vertex with topological snap enabled

Vertices can be added to a polygon by double-clicking on the boundary line. Do not add vertices unless the polygon needs to be edited to better fit the orthophoto. When adjusting a polygon, bear in mind rule 1 (below), that landholding allocations are usually semi-regular geometric shapes unless they follow a physical feature or contour. Do not add vertices on a straight boundary line. Examples of too many and too few vertices are shown in the figures below.

### 3.4.4 General Rules

Some general rules apply in making decisions about the correct geometry of polygons and the boundary alignments of landholdings.

- 1 Landholdings, when first allocated, tend to be irregular geometric shapes, such as rectangles, with straight lines. But they can also *follow natural features*, such as a river or road, or the contours of a hillside. Examples are shown below.



Figure 20: Typical landholding polygon geometry

- 2 Landholding boundary lines must not cut through buildings and should not cross fields or cut off portions of fields. An exception to this rule is where a landholder is clearly encroaching into neighbouring land.
- 3 Landholding boundary lines do not cross other landholding boundary lines.
- 4 Landholdings do usually not cross roads. In such cases, two separate polygons are created on either side of the road. However, it is common to find *access tracks* crossing over landholdings.
- 5 Polygons sides should follow the general alignment of a boundary feature; they should not 'slavishly' follow every small deviation from the general alignment; but also consider rule 2.
- 6 Boundary features are not always clear on the orthophoto but in most cases there is some evidence of the boundary or corner point. Often, landholders plant trees at corner points and bushes along lines.
- 7 Where the ortho indicates no evidence of a physical boundary line, use the field collected polygon as a guide. Do not reduce the size of polygons significantly in order to make them fit with fields and apparent boundaries on the orthophoto (see Figure 20).





Figure 21: Incorrect use of orthophoto (left) and correct use (right) based on field data capture

### 3.4.5 Editing Examples

These are some 'before and after' examples that further illustrate the general rules for editing landholding polygons.



Figure 22: Edit example - incorrect (left), correct (right)



Figure 23: Edit example - incorrect (left), correct (right)



Figure 24: Edit example - incorrect vertex (left), correct vertex (right)



Figure 25: Edit example - incorrect (left), correct (right) aligned to orthophoto

### 3.4.6 Vertices

Editing requires moving and snapping of one polygon corner or join (vertex) to another. To ensure this happens correctly, *snapping mode* must be set on.



Figure 26: Incorrect (left) and correct (right) vertex definitions



Figure 27: Edit example - incorrect (left) too few vertices, correct (right) better fit to ortho

### 3.4.7 Deleting Landholding Polygons

As a general rule **do not** delete polygons unless you are absolutely sure it is a double data collection. Check if the polygon has the same homestead attributes (homestead head and spouses):

- > Right-click on Homesteads layer > Open attribute table

Compare the two homesteads for the two associated landholding polygons, for (a) the name and ID number of the homestead head, and (b) the name of the spouse. Note that if the spouse names are different and the homestead head name the same this may indicate a dispute rather than duplicate data collection. In this instance, and any instance where you are not absolutely sure that the polygons results from duplication, refer the overlapping landholdings back to the data collectors and the chiefdom.

A landholding polygon must be deleted from the attribute table, and not the map window.

When deleting a duplicate polygon, also delete the associated duplicate homestead point. Similarly, do not delete a homestead points unless you are 100% certain it is fieldwork duplication and not a dispute.

### 3.4.8 Editing Homestead Points

The most common edits for a homestead point are:

- > Move from outside to inside its related landholding polygon.
- > Move closer to the homestead as shown on the underlying orthophoto.

If a homestead point falls outside a polygon, this will be reported in one of numerous quality control checks.

## 4 Data Quality Assurance

The quality control of data collection and processing is achieved by:

- > Checks applied in QGIS
- > Validation of results by chiefdom

The QGIS checks should be performed after all the GeoODK collected data has been processed and edited and before any maps and lists are printed for chiefdom validation.

### 4.1 QGIS Data Quality Control

#### 4.1.1 Check Edit Status

First check that all the chiefdom landholdings have been edited. The edit environment will automatically load the layer **Homestead QC (not changed)** that will highlight those polygons not yet edited. Undertake a visual check that there are no polygons highlighted as unedited or unchanged.

#### 4.1.2 Check Overlapping Polygons

Any landholding polygon that overlaps with another (greater than a certain amount) is highlighted with a red fill in the **Landholding Overlap** layer. Visually identify each one and check them against the orthophoto and the data collected (ODK/GPS) layers.



Figure 28: Polygon overlaps resulting from misidentification of fields

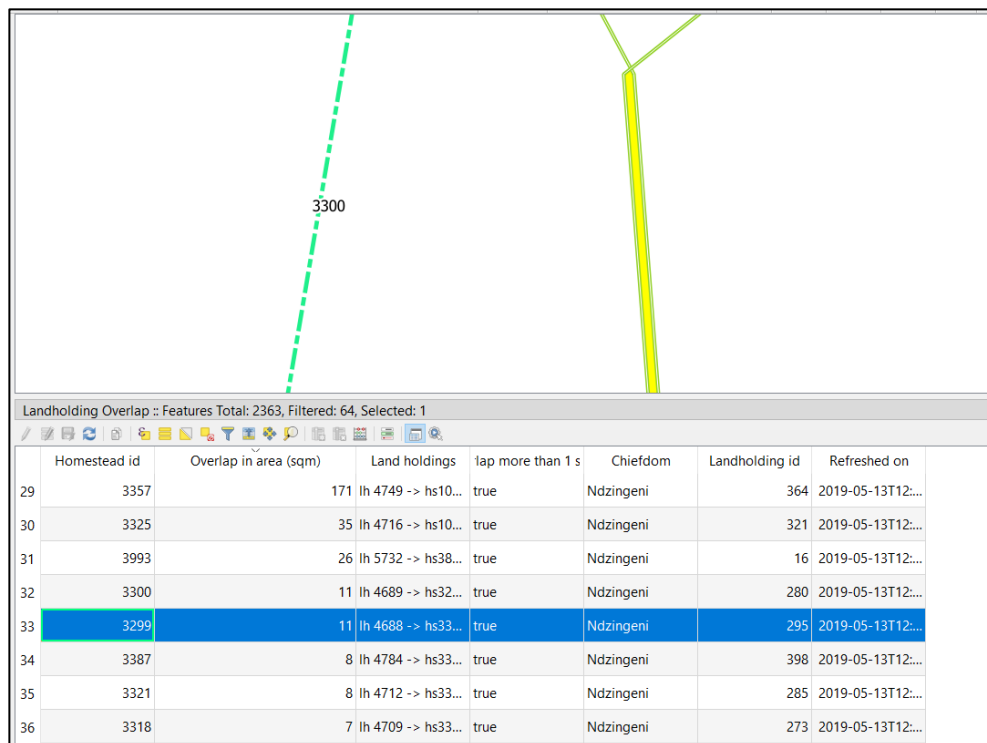
Overlaps may be the result of one or more of the following causes:

- > Data collection inaccuracies in defining the polygon shape and boundaries, resulting in small overlaps with neighbouring polygons.
- > Data collection error misidentifying the field polygons.
- > Disputes between two landholdings claiming the same land.

Many small overlaps can be fixed quite quickly. However, some of the smaller ones can be difficult to identify visually. In these cases, the attribute table can be used to identify them:

- > Right click on the Landholding overlap layer > Open attribute table

If necessary, filter the data in the table so that only records in one chiefdom are visible. Then order the records according to Overlap in area (sqm). Even the smallest overlap errors can be identified this way (and can be fixed), but QGIS can do this automatically (refer to the QGIS manual).



Landholding Overlap :: Features Total: 2363, Filtered: 64, Selected: 1

	Homestead id	Overlap in area (sqm)	Land holdings	lap more than 1 s	Chiefdom	Landholding id	Refreshed on
29	3357	171	lh 4749 -> hs10...	true	Ndzingeni	364	2019-05-13T12:...
30	3325	35	lh 4716 -> hs10...	true	Ndzingeni	321	2019-05-13T12:...
31	3993	26	lh 5732 -> hs38...	true	Ndzingeni	16	2019-05-13T12:...
32	3300	11	lh 4689 -> hs32...	true	Ndzingeni	280	2019-05-13T12:...
33	3299	11	lh 4688 -> hs33...	true	Ndzingeni	295	2019-05-13T12:...
34	3387	8	lh 4784 -> hs33...	true	Ndzingeni	398	2019-05-13T12:...
35	3321	8	lh 4712 -> hs33...	true	Ndzingeni	285	2019-05-13T12:...
36	3318	7	lh 4709 -> hs33...	true	Ndzingeni	273	2019-05-13T12:...

Figure 29: A small overlap identified using the Landholding overlap attribute table.

Note that the landholding overlap layer is a 'materialised view' of the database tables that is refreshed periodically. Fixing a small overlap will not result in the overlap fill disappearing immediately; it will disappear when next the view is refreshed.

Mis-identification of fields can be more difficult to fix but possible by deducing the correct location from patterns of land use. For instance, in the figures below, it is apparent that the two sets of fields are cultivated differently and therefore probably belong to different homesteads. But if not sure, refer the case back to the field teams for verification.



Figure 30: Before (left) where 2483-3 is too far east, and after (right) where 2483-3 moved west and over fields with similar cultivation.

Overlaps caused by exaggerated or mistaken claims or disputes are the most obvious and cannot be edited and must always be referred back to the chieftdom for resolution.

There may also be cases of overlapping polygons, but different homestead and landholding numbers, which may represent a duplicate rather than a disputed claim. This can arise where different enumerators visit the homestead on different days and interview different family members. This can be checked in the attribute tables, and if the name and ID number of the homestead head are the same in both cases then one of the two records (in both tables – homesteads and landholdings), usually the later one, can be deleted.

### 4.1.3 QGIS Checks

In addition, QGIS has a *Topology checker* function that also identifies where landholding polygons overlap but it also identifies gaps and other 'topological errors' (see QGIS manual).

The topology checker contains two useful rules – to check that homestead (points) fall inside landholding polygons, and to check that polygons do not have invalid geometries.

Before executing the topology checker, filter the layers to check only those records for checking. If the data is not filtered, the check will be run on the whole spatial database!

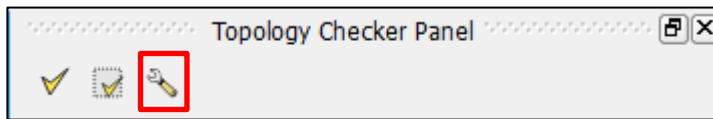
From the menu bar:



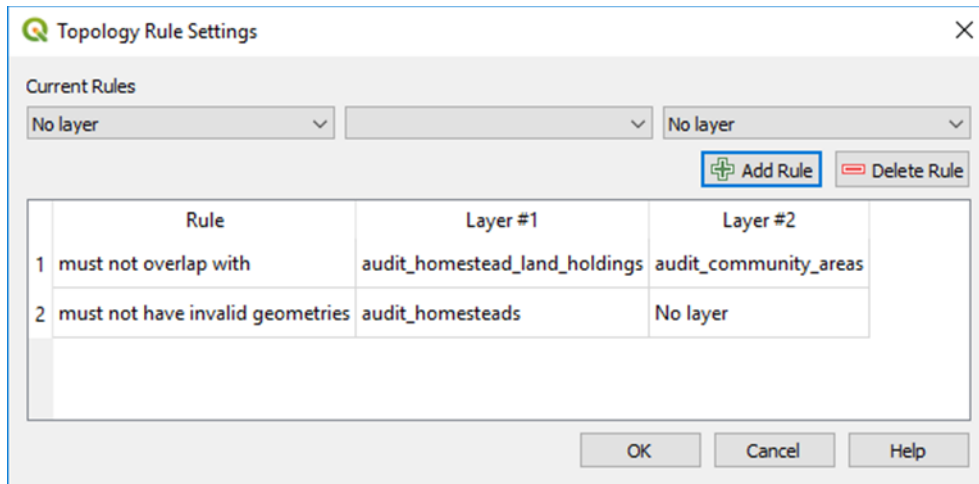
> Vector > Topology Checker > Topology Checker

The Topology Checker panel will appear.

- > Select the 'tool' icon to define the check.

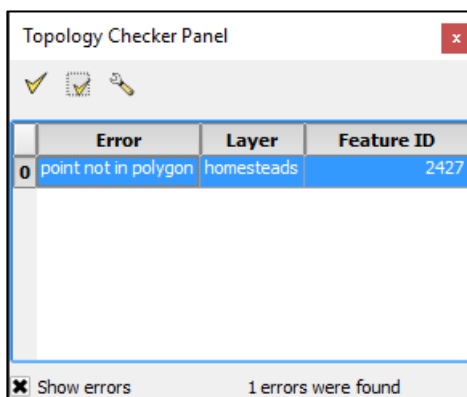


- > Configure the topology rule settings, by using the drop-down lists followed by [+ Add Rules] to include all the following:



- > Click [OK] to close the topology checker configuration box, then click on the large tick mark to run the check to validate all rules on the selected data layers and selected (filtered) records.

The errors found will be listed in the topology checker panel.



- > Check all the errors listed.

Highlighting the row in the topology checker panel will highlight the point or polygon in the QGIS window. To zoom to the features listed, use the relevant attribute table.

In addition, but probably 'overkill' is a vector geometry tool to check validity. The check validity function will duplicate both the QC and topology checks already done and identify even the smallest geometry errors. Usually it is not necessary to check validity if both the QC and topology checks and corrections are done.



#### 4.1.4 Visual Checks

Lastly, systematically scan across the area of interest to check for the following errors:

- > Polygon sides not aligned with orthophoto (see rule 2 above)
- > Small gaps between polygons of adjacent landholdings
- > Other errors not detected by topology or geometry checks

## 4.2 Chiefdom Validation

After field data has been collected and processed (edited) it must then be returned in two stages to the chiefdom for validation (correction and acceptance). The two stages are:

- > Correction and validation by the inner council
- > Correction and validation by the whole community

Data are reported, in the same way in both stages, in the form of:

- > Landholding maps
- > Landholding lists

Errors and omissions identified in the first stage are corrected and incorporated into the data before it is presented for *second stage* validation.

### 4.2.1 Landholding Maps

A map, or maps in larger chiefdoms, is prepared that shows the following:


- > Orthophoto map background
- > Landholding polygons, with homestead number and landholding field labels
- > Homestead locations, with homestead number label
- > Community land, such as grazing lands, schools and dip tanks, with name
- > Map title, scale bar and north arrow

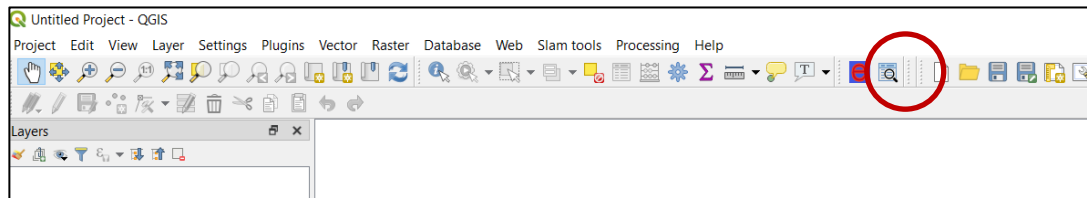
The map scale may vary, depending on the density and size of landholdings, but it should clearly show each polygon and the homestead and landholding labels within the polygon and without the text overlapping. 1/5,000 is often a suitable scale at A0 plot size.

### 4.2.2 Select Area of Interest (Chiefdom)

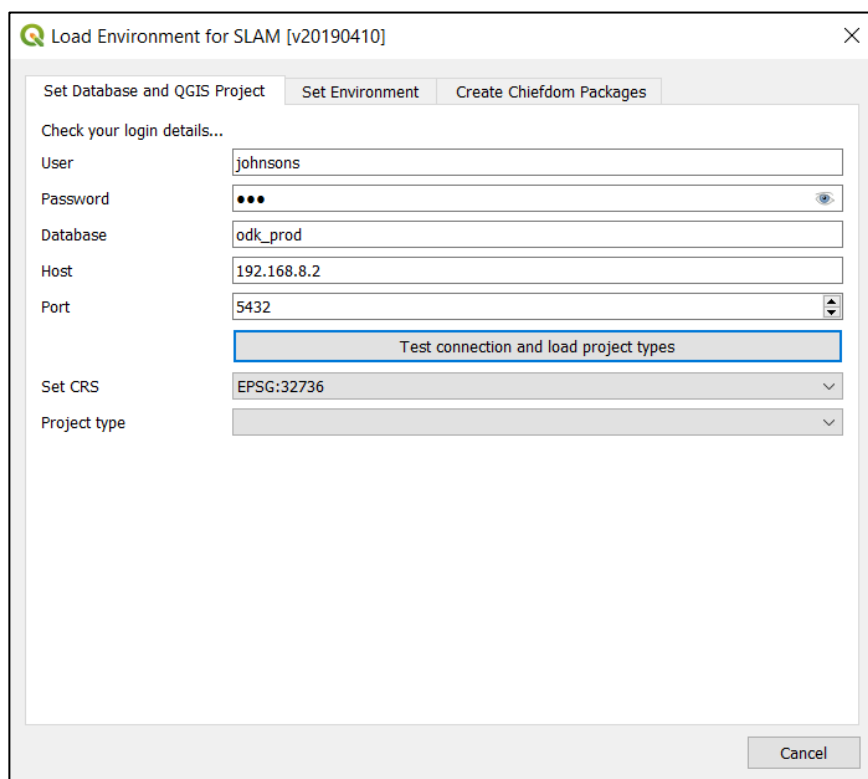
The preparation of landholding validation maps is done on a chiefdom basis. Therefore, the map must show only homesteads and landholdings related to one chiefdom.

Rather than use the homestead and landholding layers in the edit environment, which means having to filter the data, instead create a new QGIS project with a chiefdom data environment.

- > Start QGIS (do not open an existing project file) or close the existing project and create a new project.
- > Click on the SLAM Edit Environment icon. 



- > Enter your database credentials (user name and password).



- > Click [Test connection and load project types]
- > A message about a successful connection should appear. If not, check your connection, username and password (see figure below).
- > Note also that the **Project type** drop down list now has an entry. There are three options:
  - > **Edit** – this will load all relevant layers for the whole database and appropriate styles.
  - > **Chiefdom** – this will load only the data for a (yet to be specified) chiefdom with appropriate layers and styles for final data delivery.

- > **All chiefdoms** – this will load all the landholding parcels in the database in a styles that colour-codes parcels according to the chiefdom.

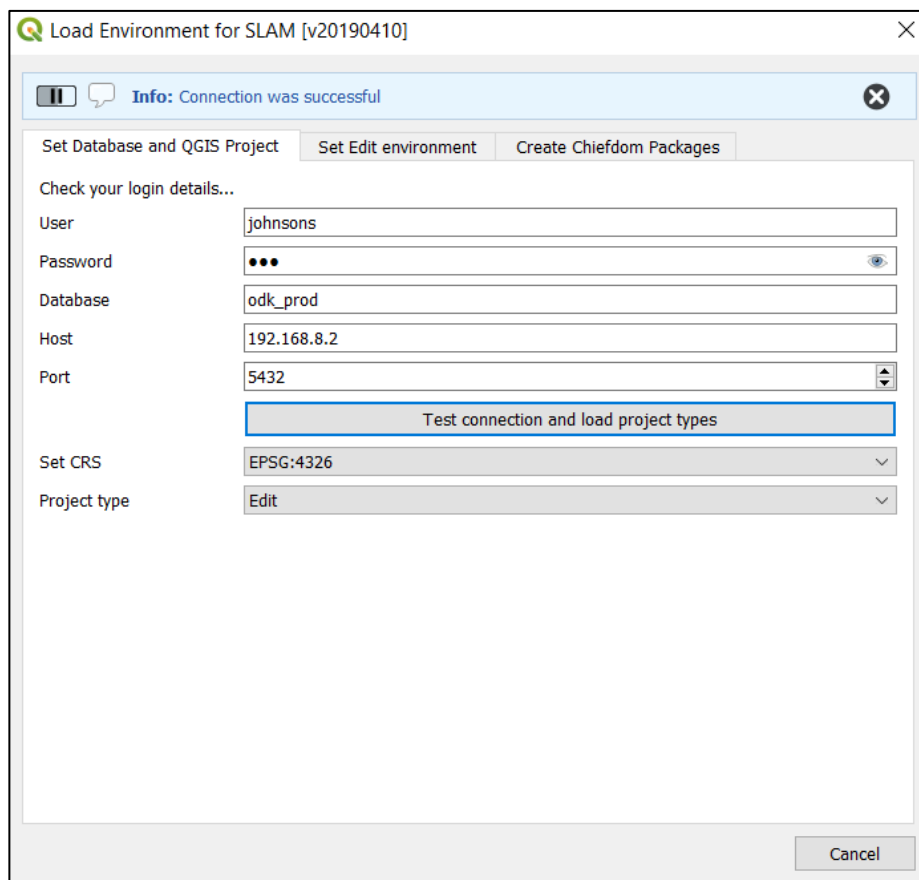


Figure 31: QGIS SLAM edit environment plugin

- > For chiefdom validation purposes, select **Chiefdom** from the **project types**.
- > With **Chiefdom** showing in the **Project types**, select the second tab **Set Edit Environment**.
- > Usually it is not necessary to **Refresh the list of edit layers**. However, nothing serious will happen if you do.
- > The drop-down list labelled **Chiefdom** contains an alphabetically order list of all chiefdoms. Choose the chiefdom name.
- > With the **Chiefdom** name showing in the drop-down list, click **Load Chiefdom Layers**.

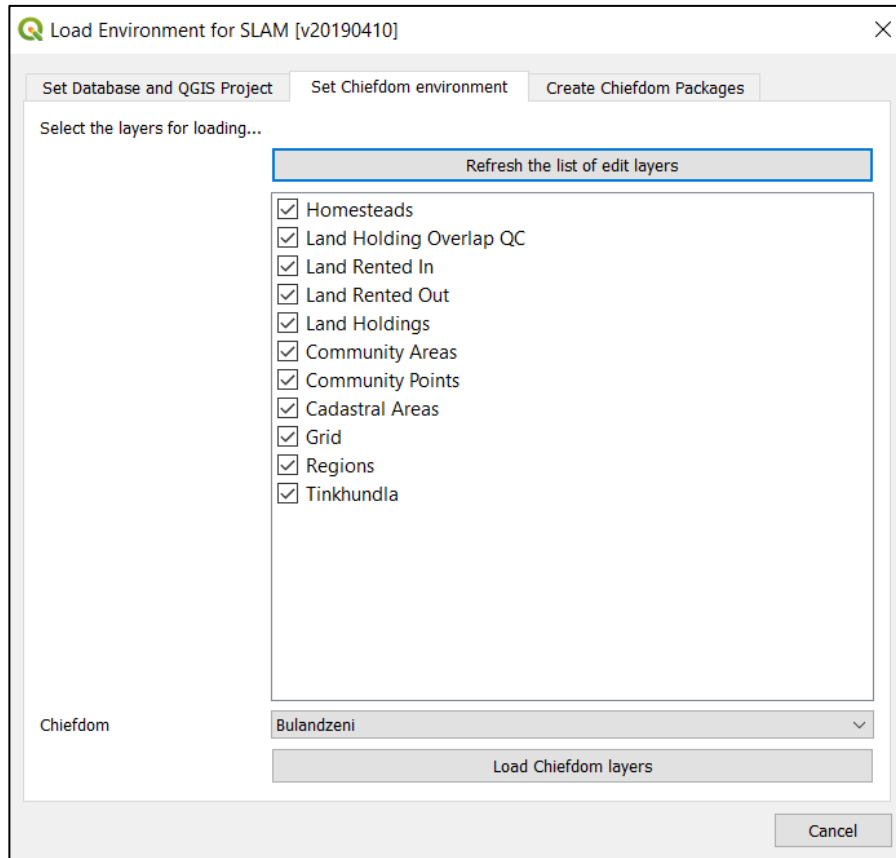
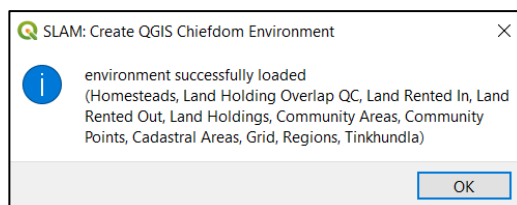


Figure 32: QGIS SLAM set chiefdom environment

- > A pop-up dialogue box should appear telling you that the environment was successfully loaded.



- > Click [OK] and the chiefdom data together with other layers will appear in the QGIS map window together with a confirmatory message that the environment was successfully loaded.

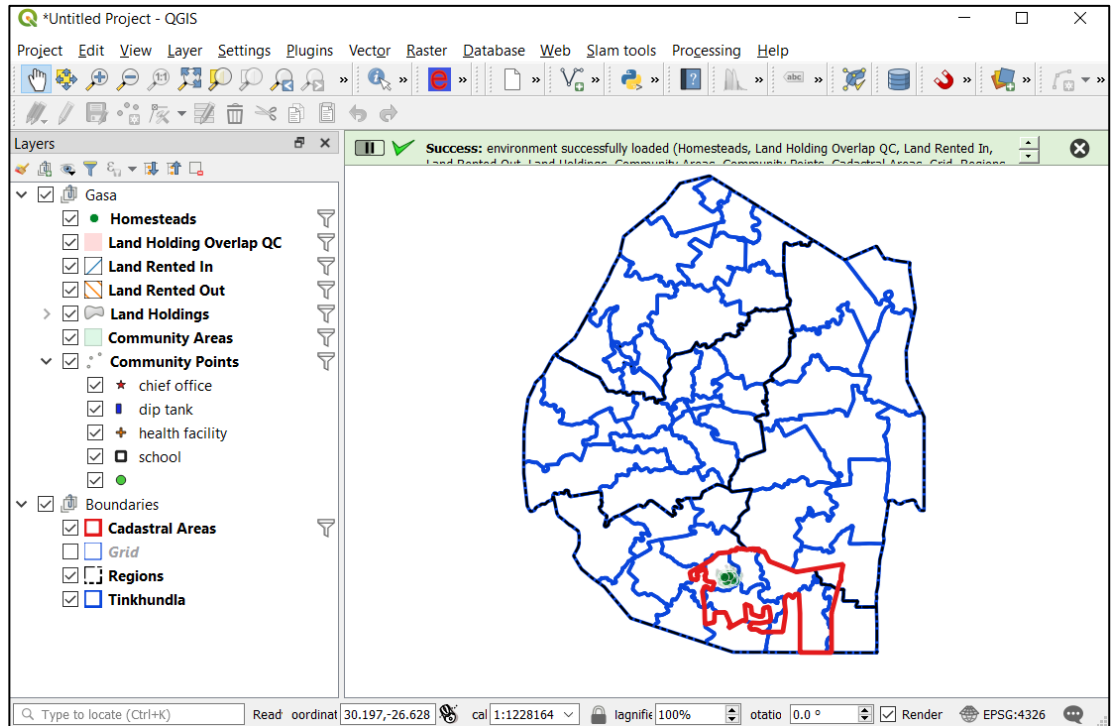
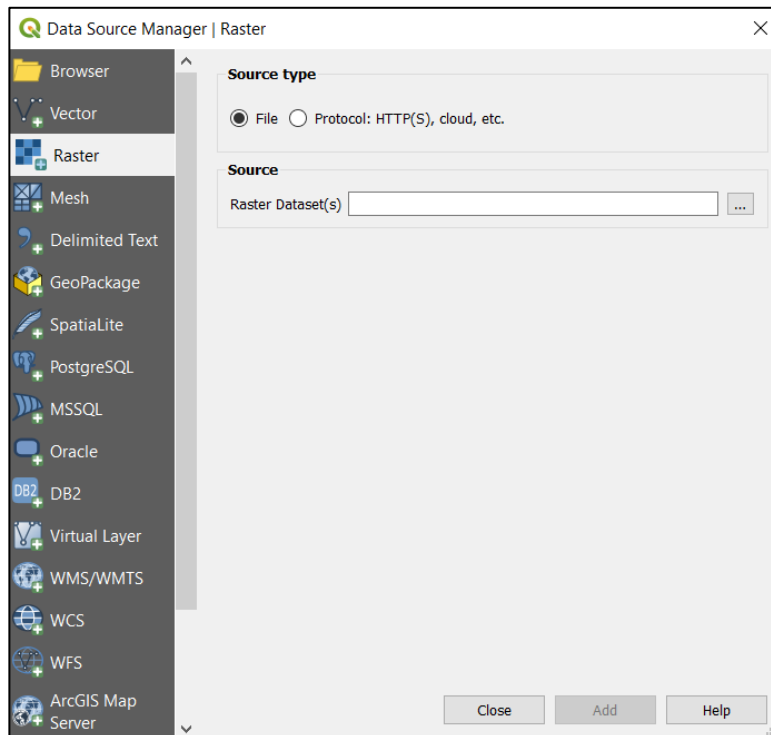


Figure 33: QGIS SLAM chiefdom environment

- > By default, the Grid layer is turned off. Turn it on to see the orthophoto map sheets needed to cover the chiefdom area.
- > Add each orthophoto via Layer > Add Layer > Add raster layer >



- > Click the [...] box to the right of the Source **Raster Dataset(s)** box and navigate to the folder containing the orthophoto. Load them at the bottom of the layers list.

- > If the ortho does not appear in the QGIS map window where you think it should, it is probably due to a coordinate reference system issue. To sort this out, refer to paragraph 1.4 *Orthophoto Image Files* to sort this out.



### 4.2.3 Map Production

Next select *Print Composer* and prepare one or more maps for printing. In most cases more than one sheet will be needed to cover a chiefdom, therefore an index map will also be needed.

Start by producing an overview map of the whole chiefdom that will be used as the basis of the index map.

- > Project > New Print Layout > Create print layout Title
- > Provide a suitable name for the title, e.g. *chiefdom\_name Index*

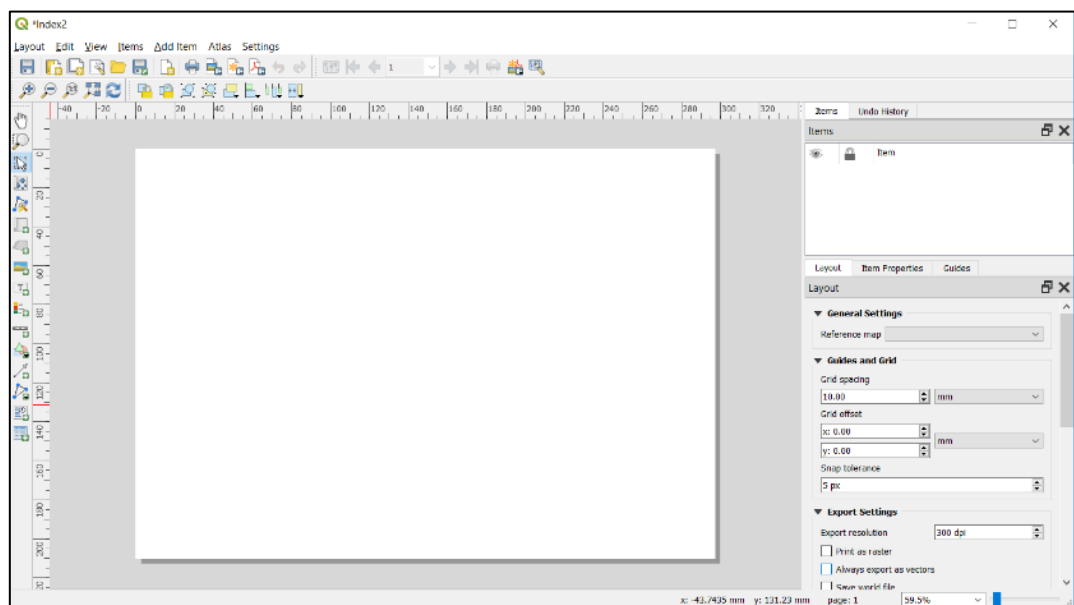


Figure 34: Empty map layout window

- > Right-click anywhere on the map layout canvas to open a **page properties** dialogue box.
- > Change the page size to A0

To add a map view to the layout...



- > Add item > Add map > (click top left of canvas and drag box to bottom right)
- > Alternatively, use the **Add a new map to the layout** icon.

The QGIS map window will now appear in the map layout canvas.

The scale of the map will now reflect the size of the map on the layout canvas. Change the scale to something appropriate so that all the chiefdom polygons fill the whole map canvas.

- > Item properties > scale = 10,000 (for example)

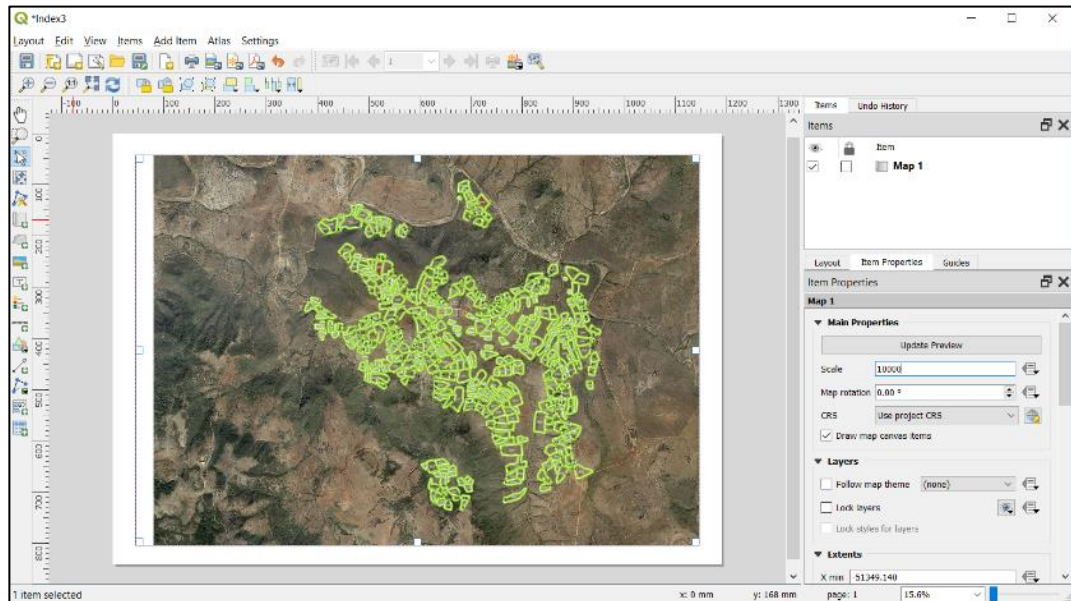


Figure 35: QGIS map composer

The map extent can be moved to make final adjustments to the map layout.

- > Layout > Move contents (click on map and drag to position)

Using the index map as a 'frame' for larger scale maps that show landholdings in more detail. The area and size of landholdings will dictate the scale of the maps. Typically, the detail maps will be between 1/5,000 and 1/7,000 scales.

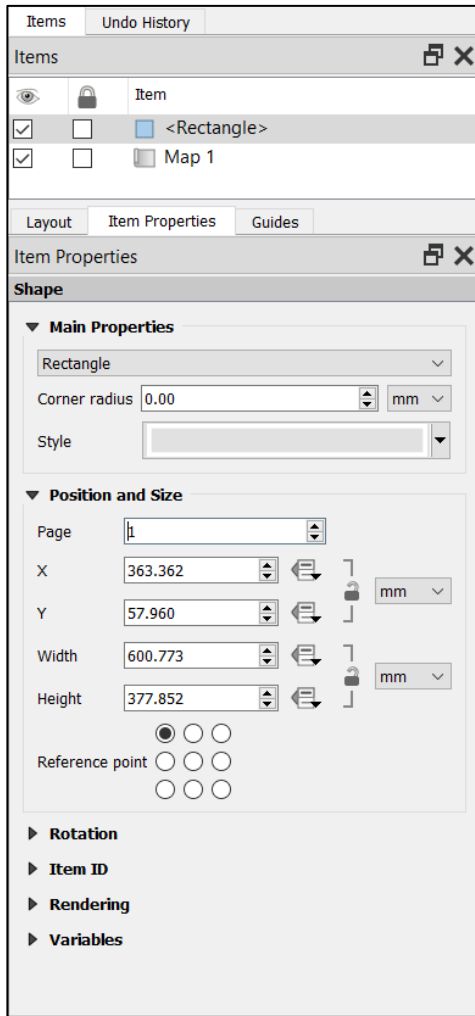
Using the index map in map composer, add a map frame:



- > Add items > Add shape > Add rectangle
- > Draw rectangle with approximate size for map frame that covers a part of the index map.

Adjust the size of the rectangle corresponding to your map frame for the plot sheet size. For example, an AO plot of 1/7,000 scale will have a rectangle size of 400mm wide by 300mm high.

- > In the items panel > select rectangle > position and size (width = 400mm, height = 300mm)



- > Position the frame to cover the area of the detail map.

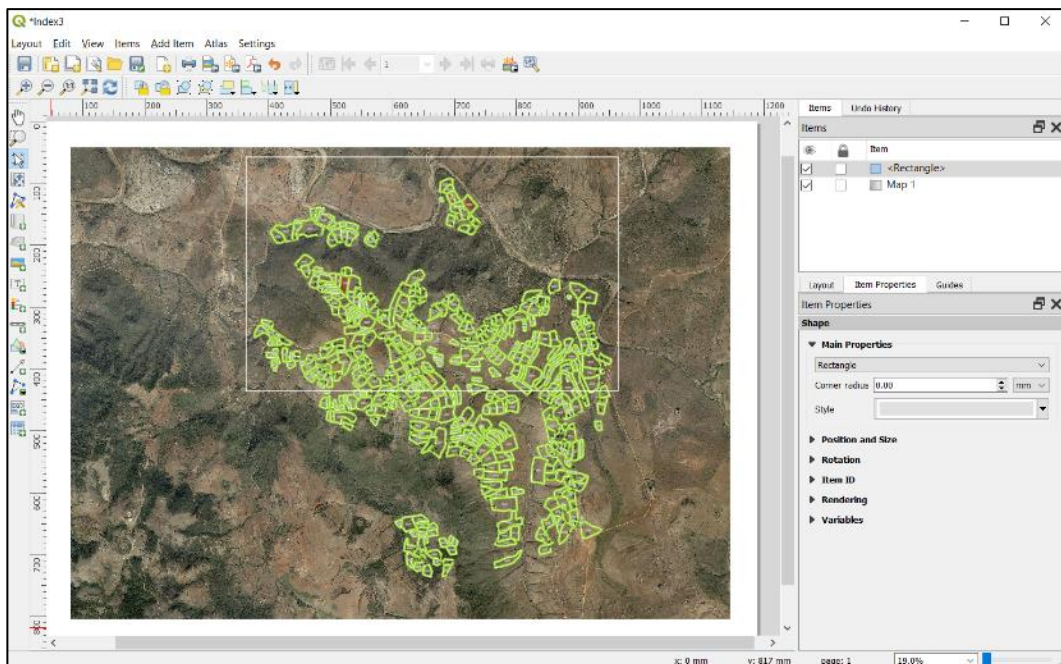
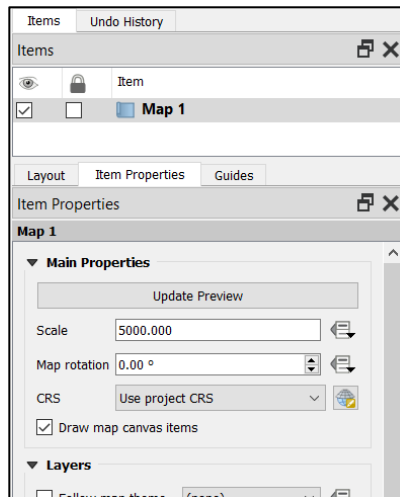


Figure 36: Index map showing the (white) rectangle representing the detail map frame



The next step is to create a new map based on this frame. To do this a new map is created.

- > Layout > Duplicate Layout
- > By default, the current map name is added to the title box. Type in a new name of your new map (e.g. *chiefdom\_sheet\_1*).
- > In the new map layout window, delete or unselect the rectangle(s) and change the scale of the map to the required scale.



- > Move the window to cover the area of the index that corresponds with the area covered by the detail map frame / rectangle. Switch between the two map layouts to verify the new map frame corresponds to the rectangle (frame) in the index map.



- > Layout > Move Content

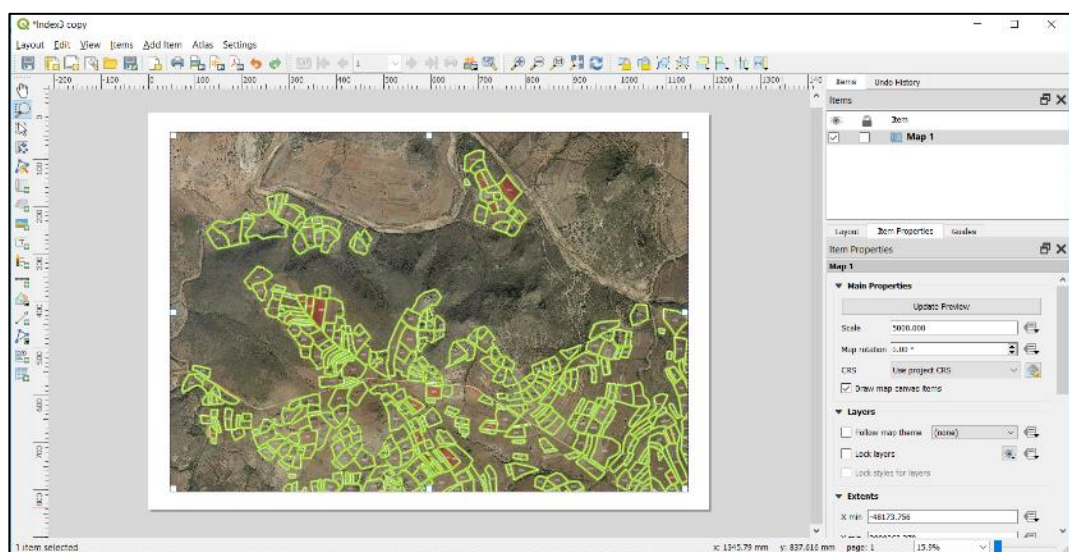


Figure 37: Layout window showing new map of the area within the rectangle on the index map

- Repeat the creation of frames/rectangles and detailed maps that correspond to these frames until the all the landholdings shown on the index map are covered by detailed maps.

The index map should now a series of white rectangles, each overlapping the next by a small amount. Add an index number to each rectangle corresponding to each detailed sheet number.



Figure 38: Example of a sheet index map

## 4.3 Landholding Lists

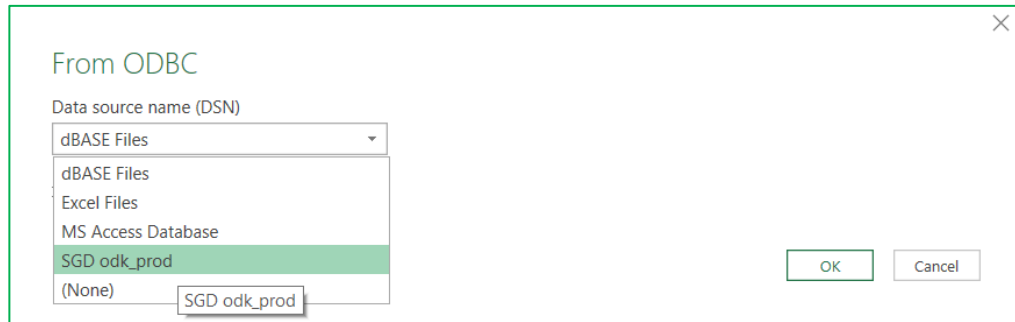
Two lists of all landholding data captured in the chiefdom containing the same data but indexed differently, are required:

- By homestead number
- By homestead head name

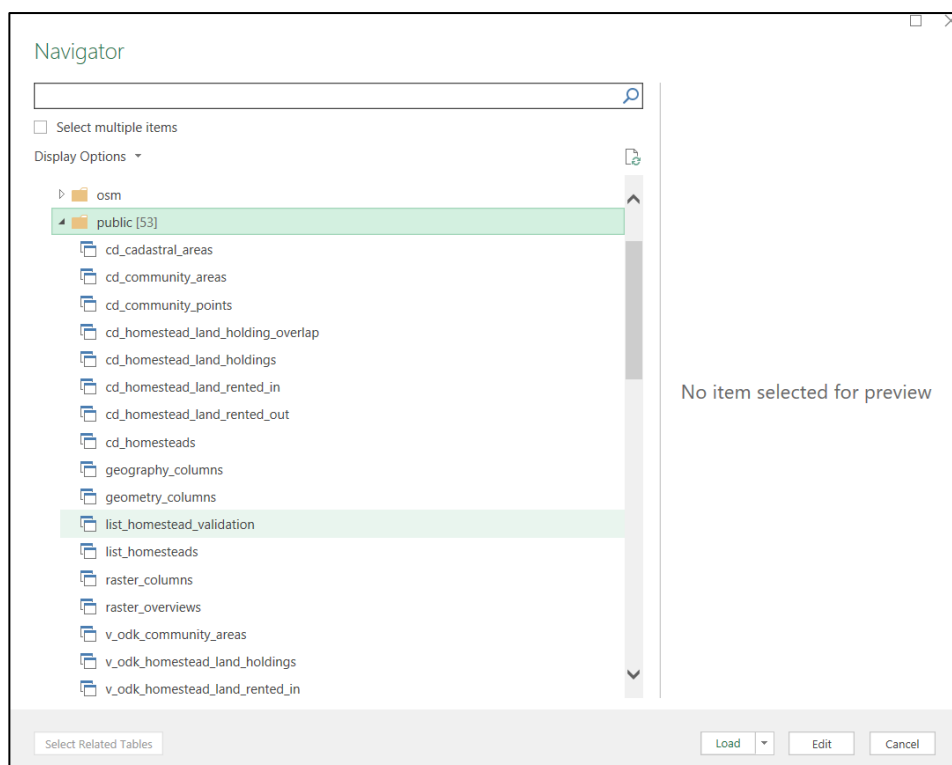
### 4.3.1 Connecting to the Server Data

The data is held in PostGIS tables on the server, but the list can be produced using Microsoft Excel on the desktop computer.

- Start Excel and begin with a blank, empty worksheet.
- Data > Get Data > From Other Sources > From ODBC



- > From the ODBC dialogue box select **SGD odk\_prod**
- > Select [OK] and the ODBC Navigator box appears (below)
- > Click on the arrows to **open odk\_prod** and **public**.
- > Select **list\_homestead\_validation** from the list of database tables and views. Note, do not choose list\_homesteads (which is for the final lists).
- > A preview of the view appears...



- > Select [Edit] to open the database table. Note: in later versions of Excel the [Edit] button will be named [Transform Data].
- > Refresh the view.
- > Click the down arrow for **chiefdom\_list** to open the filter and sort box > Load more to show the complete list of chiefdoms.

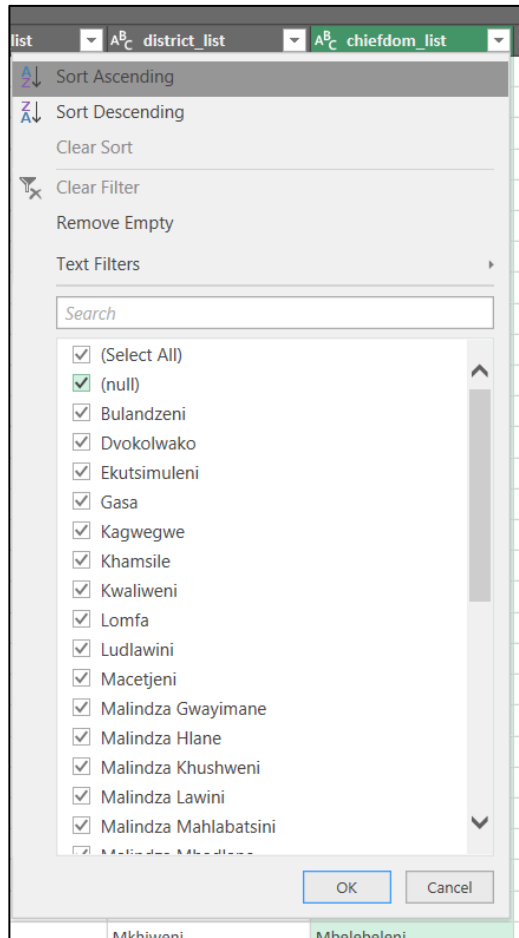


Figure 39: Sort list of all chiefdoms

- > Unselect all > Select the box for the chiefdom > [OK]

Only the chiefdom records will now appear, sorted by homestead\_id. Note that the homestead\_id is used for validation lists whereas the landholdings\_id is used for the final lists.



- > Click the [Close & Load] button to load the filtered records into the worksheet.

Either the worksheet can be saved and printed for the chiefdom validation lists or the data copied and pasted into the validation list template (ValidationList\_template.xlsx). The template is already set up with the page headings, column headings, etc. If the template is not used, set up the page size, print area, column headings, etc. in the list\_homestead\_validation worksheet.

Save worksheet with the chiefdom name and 'validation list' as both an Excel spreadsheet and a PDF file for printing.

### 4.3.2 Printing Validation Lists

Validation lists are usually printed on A3 size paper. This can be problematic when printing directly from Excel, so it is recommended to print from a PDF file copy.

Two sets of validations lists are required – one listed by homestead number and the second by homestead head name.

## 4.4 Results of Data Validation

The maps and lists are delivered to the chiefdom for their scrutiny and any corrections needed. These corrections will be made on the printed maps and lists.

### 4.4.1 Polygon edits / corrections

Correcting the landholding map is made by editing polygons in QGIS in the usual way (see 3.4). If a homestead landholding polygon is to be deleted completely, for example in the case of a double claim or unauthorised household divisions of a homestead, delete the homestead and landholding using QGIS attribute table views and not the map view. The map view will update automatically on deletion of a record in an attribute table.

### 4.4.2 Attribute data edits / corrections

Using QGIS, edit the polygons to capture the corrections and changes made by the chiefdom.

For corrections and changes to the attribute data lists, QGIS is also used.

- > Start QGIS in **edit** mode, either a new project or existing edit environment project.
- > It is not necessary to filter the homesteads according to chiefdom, but it may help to locate the record for editing more quickly. See 3.3 on how to filter records.
- > Right click on **Homesteads** > Open attribute table

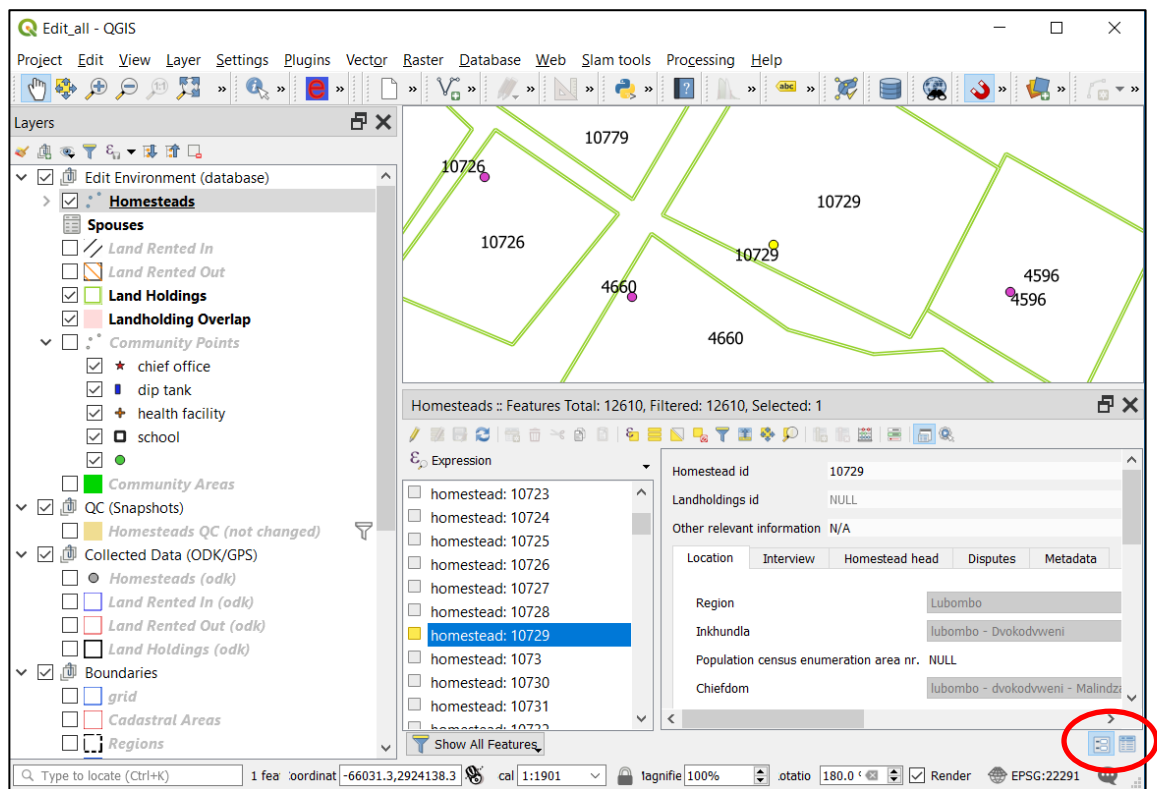


Figure 40: QGIS attribute table edits

The **homesteads** attribute table will open in a docked window below the map window. It is **important** to ensure that, **for editing purposes**, the attribute table is in **form view** and not **table view**. To switch between form and table views, use the buttons in the lower right corner of the attribute table dock window.

- > Either scroll down to the homestead number to edit or use the [Select/filter features using form] button to input the homestead\_id to edit. Click the [Zoom to feature] button to show the polygon in the map window.
- > To edit, for example, the name of a homestead head spouse, in **form view** select the **homestead head** tab, scroll down to the **homestead\_spouses\_relation** box and to edit the spouse details, select to highlight the number in the relation box. If there is more than one number, this means there is more than one spouse.

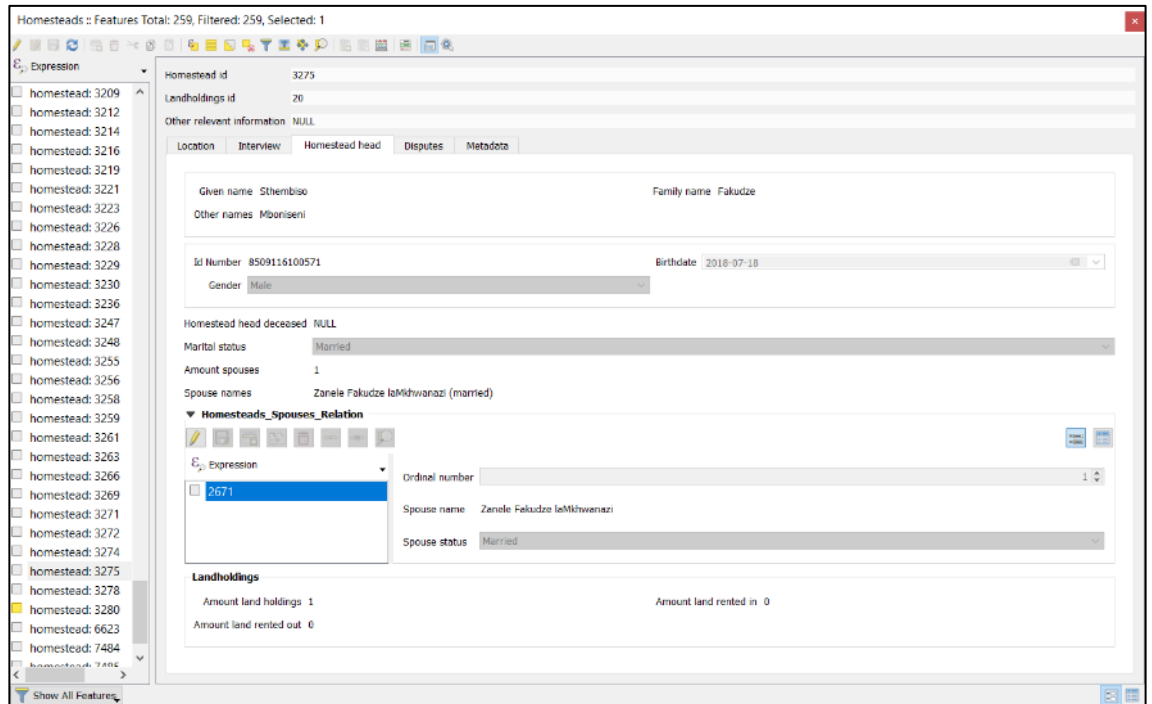


Figure 41: Homestead spouse name edit example

## 4.5 Generate Landholdings Id

At the time of initial data collection, homesteads are labelled with a system generated identification number, the **homestead\_id**, which is a sequence number, unique within the whole database, assigned in the order of the homesteads records arriving from the field and being loaded into the server.

After the quality control and any editing and updating of the homestead records, a **landholdings id** will be assigned. The landholdings id is a *unique number within the chieftdom* to identify a homestead with all its fields (used or borrowed in/out).

Assigning the **landholdings id** is not automatic but a database administration function that works in the QGIS SLAM edit environment (see Figure 42 below).

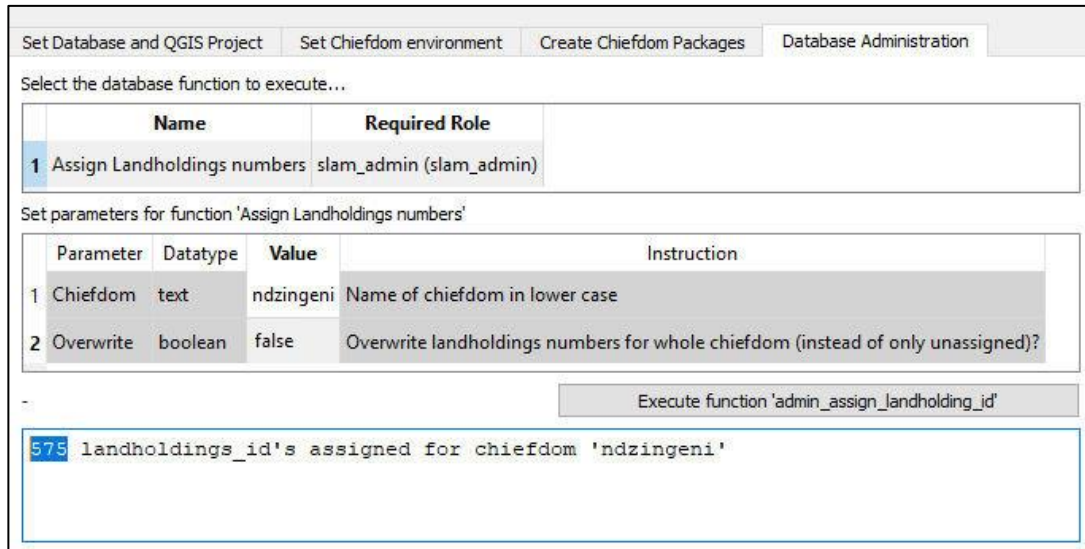


Figure 42: QGIS edit environment database administration

A database stored function `admin_assign_landholding_id` is available to generate and assign landholdings id's, with a parameter for the **name of the chiefdom**. The numbering starts at the north-west corner to the south-east corner. The QGIS plugin (sheet Database Administration) facilitates the use of this function.

Note: The parameter to overwrite the landholdings id's is by default set to `false`, which means that homesteads already assigned with a landholdings id will not be renumbered; only the new/unassigned homesteads will be assigned a landholdings id. Setting this parameter to `true`, will re-assign all homesteads within the chiefdom.



## 5 Data Delivery

SLAM data delivery includes the following:

- > Set up laptop computer
- > Prepare the **chiefdom geopackages**

### 5.1 Hardware Set Up

The computer hardware for SLAM data delivery comprises a laptop computer. No other hardware is involved. The laptop must be configured using Microsoft Windows 10 Home (or better) operating system. SLAM or the [chiefdom name] is the only user account and has administrator privileges. Refer to Appendix A for more on hardware set up.

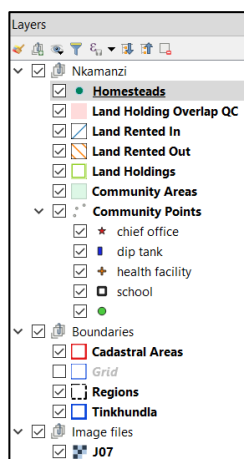
### 5.2 Software Set Up

Delivery of SLAM data requires software to be installed and set up on a laptop computer.

- > Establish a connection to the SLAM server.
- > Install QGIS
- > Configure QGIS

Refer to Appendix C for instructions on how to set up and configure the necessary software.

### 5.3 Chiefdom Data Set Up



Each chiefdom receives a copy of the SLAM database comprising the layers shown in figure. Note that the data layers do not include the chiefdom. This is because the chiefdom dataset was collected by the Elections and Boundaries Commission and **the SLAM project cannot and must not distribute chiefdom boundary information.**

Creating a sub-set of the SLAM database for each chiefdom can be done on the chiefdom laptop or another computer and copied across. However, if the changed user interface has already been applied, it will not be possible to create the chiefdom data packages. Therefore, either create the chiefdom data packages on another computer or start QGIS with no customization as described in Appendix C.

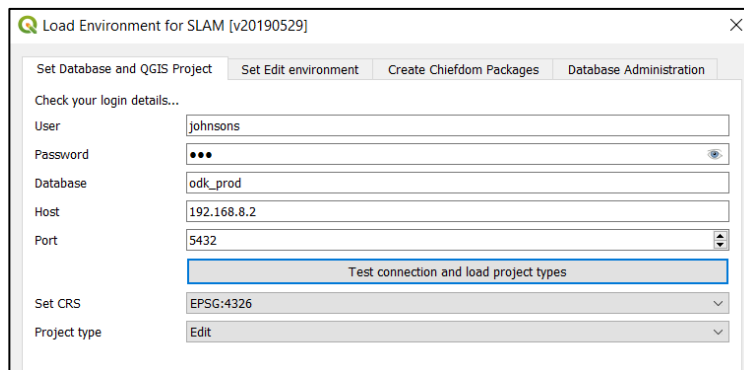
Figure 43: SLAM chiefdom data set layers

#### 5.3.1 Chiefdom Data Packages

- > Start QGIS with a new / blank project.
- > Start the SLAM plugin:
- > Provide your database credentials (i.e. username and password).



The tool should remember credentials after completing the setup of the edit environment. The tool can only be used by users that have user authorisation in the PostGIS database.



- > After entering the password, click [Test connection and load project layers].

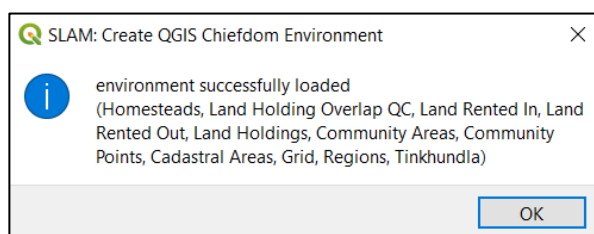
A message should appear that the connection was successful. The project types also now appear in the bottom selection field.

- > After successfully connecting, do not set the CRS (this can be left unchanged), but choose the **project type**.
- > Click on the menu bar, which by default will show [Edit], to select the option [Chiefdom].
- > After selecting **Chiefdom**, select the **Set Edit Environment** tab, which enables a review of the layers that the tool will load. Usually, there is no need to deselect any of these layers. Occasionally it may be necessary to [Refresh the list of edit layers] if any changes have been made in the SLAM database.
- > Next, choose the **chiefdom name**, then [Load Chiefdom Layers].

**Note, it may take a minute or so for all the layers to load and then appear/render.**

A message window will open saying the environment was successfully loaded.

- > Select [OK] to continue.



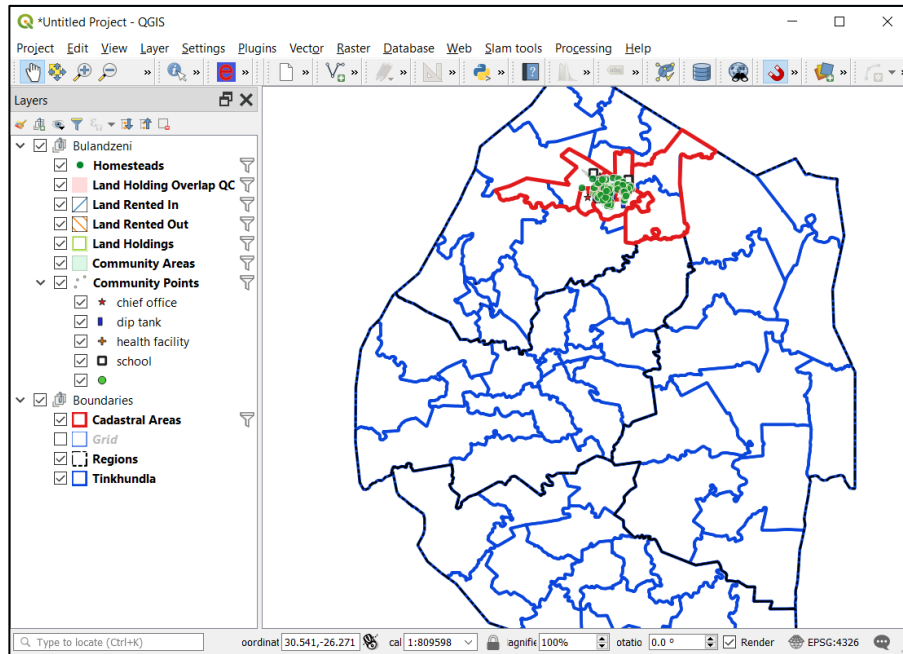

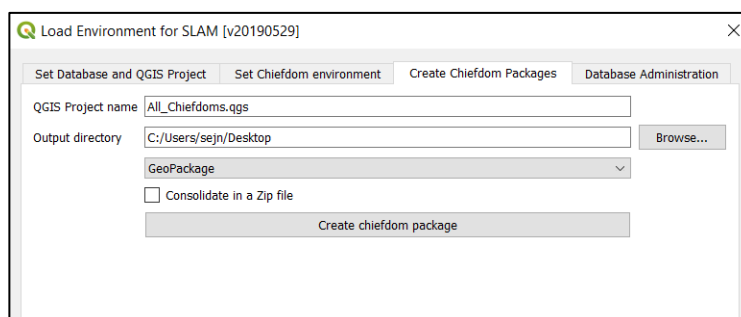


Figure 44: QGIS SLAM chiefdom environment

Although the data may initially appear upside down in the process, it will at the end be the right way up.

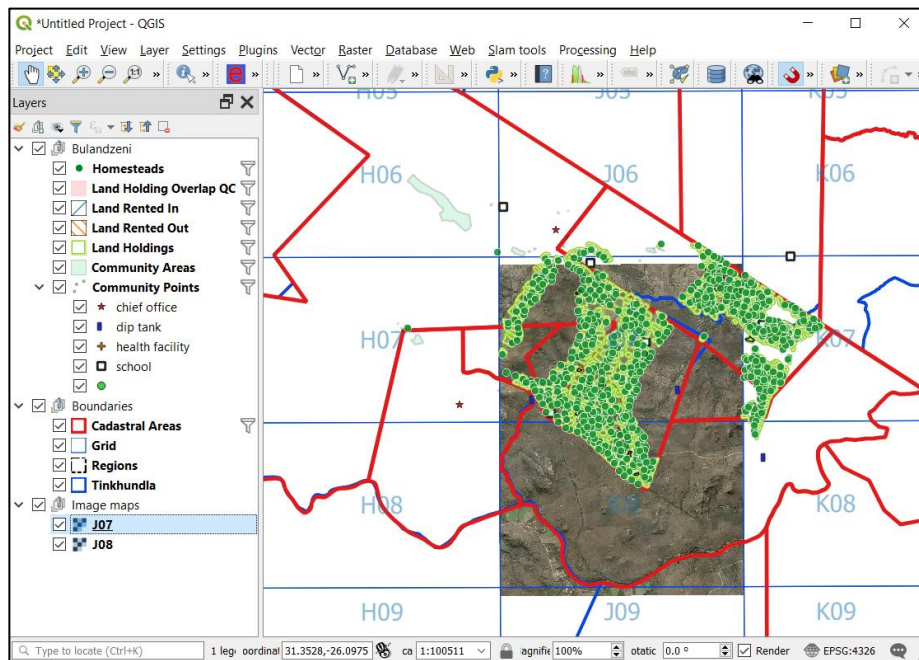
Usually, the point and polygon text, line and fill styles will load by default from the database. However, if there is a need to change the style definitions this can be done now (before the chiefdom package is created). Either load a style from the database (PostgreSQL) or define them manually.

- > After the layers have loaded, the next step is to create or copy the layer on or to the laptop. Create folder on the laptop in the user directory.
  - > This PC > Windows (C:) > Users > SLAM > SLAM
- > Select the  plugin again and select the **Create Chiefdom Packages** tab.
- > Browse to the Output directory



- > Select **Geopackage**. The consolidated zip file is not needed when creating the geopackage directly on the chiefdom laptop.
- > Then click **Create chiefdom package**.

- > Next, the orthophotos that cover the chiefdom area need to be identified and copied manually on to the chiefdom laptop. Use the **grid** layer to identify which orthophotos to copy. Copy them to same folder as the other layers.
- > In the QGIS **layers panel** create a **group** and name it **Image maps**.



- > Highlight the Image maps group and add the orthos:
  - > Layers > Add Layer > Add Raster layer >

## 5.4 Chiefdom Register

In addition to SLAM QGIS data, each chiefdom laptop will have, as PDF files, the following:

- > Landholding register
- > Landholding lists
- > Landholding maps

These are all Adobe Acrobat PDF files that are readable with Adobe Acrobat Reader software.

### 5.4.1 Creating the Landholding Register

The landholding register is produced with Microsoft Excel and Word software using an ODBC<sup>7</sup> connection to the SLAM odk\_prod database.

<sup>7</sup> Open Data Base Connection (ODBC)

An ODBC driver must be installed, otherwise the option to select SGD odk\_prod database (below) is not available. Refer to Appendix A.4 on how to install an ODBC driver for MS Excel.

- > Start Excel and create a blank spreadsheet. Save the spreadsheet now or later as [Chiefdom\_name] Landholding Register.xlsx.

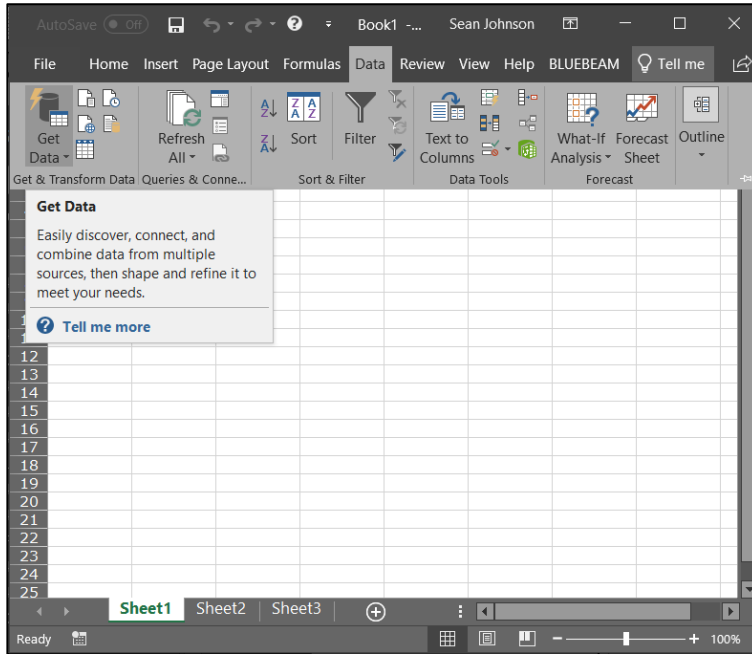
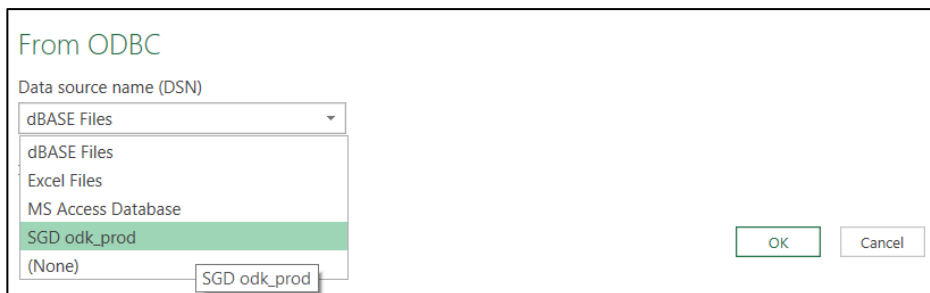


Figure 45: Excel > Data > Get Data (from external source)

- > Data > Get Data > From Other Sources > From ODBC > SGD odk\_prod



- > Select odk\_prod > public > View\_homesteads

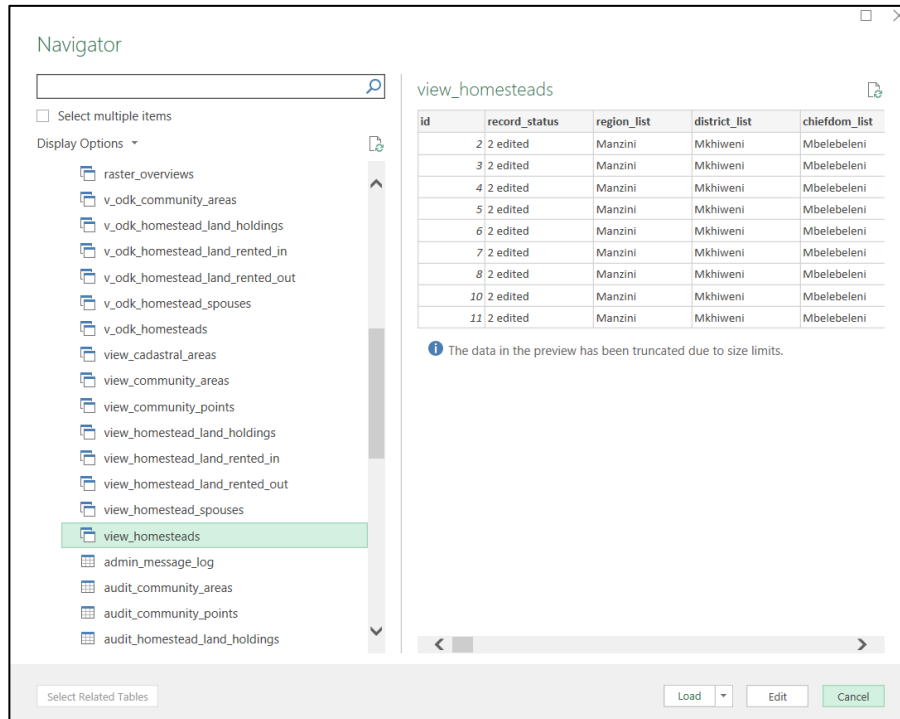
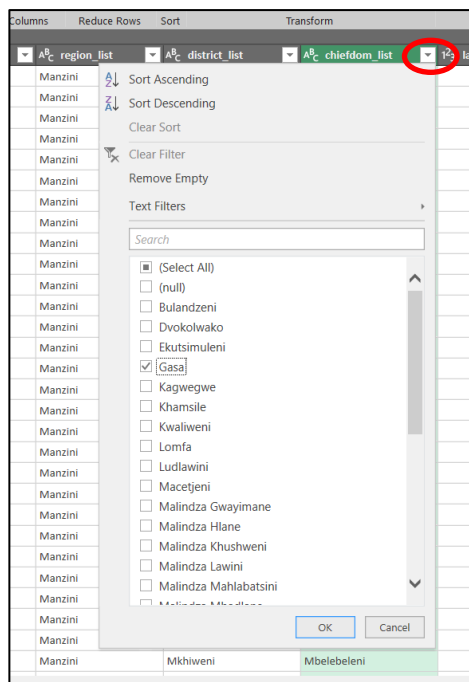


Figure 46: Excel ODBC connect to odk\_prod and View\_homesteads table

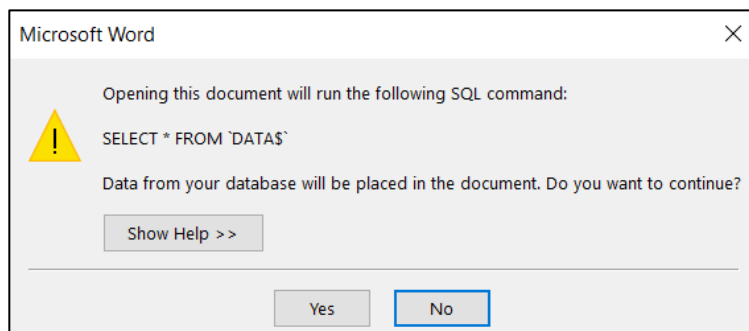
- > Click [Edit] (or [Transform Data] in later versions of Excel) to filter and select only the needed chiefdom data. Refresh the view if necessary.
- > The view of the database contains all records for all chiefdoms. Click the down arrow in the chiefdom\_list column and select the chiefdom name.



- > Click Load more options (chiefdom names) to the list if necessary.
- > Uncheck the box (Select All) and check the box for the chiefdom, then [OK].

- > The chiefdom records will not be sorted according to the `landholdings_id`, so click the down arrow on the column heading `landholdings_id`, and **Sort Ascending**.
- > If the `landholdings_id` shows zeros ('0') this means the landholdings ids have not yet been assigned (see 4.5).
- > Next, select [Close & Load]. It may take a few seconds for the data to load and appear in the worksheet. A side panel will display how many rows / records were loaded.
- > Rename the worksheet to **DATA**. Note: an error will appear later if the worksheet is not renamed to 'DATA'.
- > Save the spreadsheet with the chiefdom name and exit.
- > Make a copy of the **Chiefdom Landholding Register TEMPLATE.docx** file and open it. There is no need to rename the file (template) at this stage; it will be saved with a new name after the records are merged (imported).

A dialog box **may** appear asking to run an SQL command embedded in the file. If so, select [Yes]. If the above dialogue box appears, another dialog box will open asking for the location of the source data; this is the Excel file just created earlier.



- > A Word document opens showing the <<place holders>> for the data.


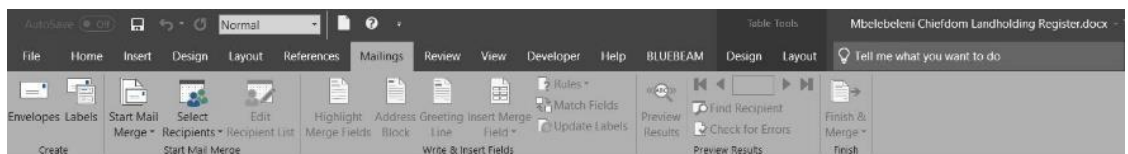
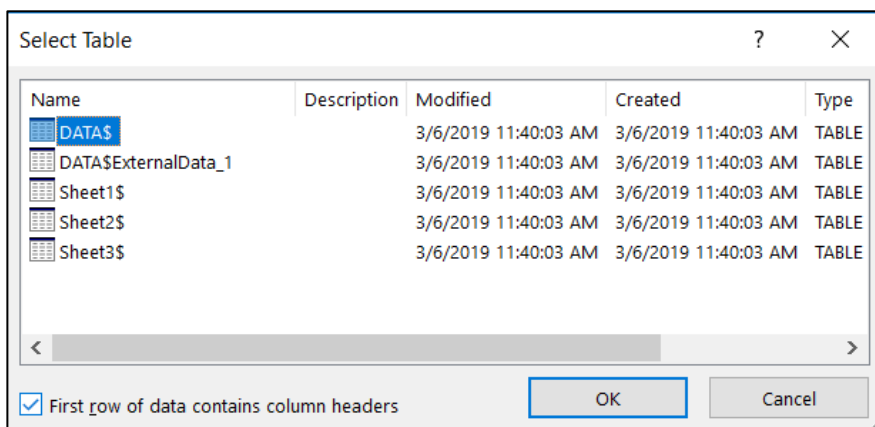
Region:	<<region_list>>	 <b>CHIEFDOM LANDHOLDING REGISTER</b>	Year of allocation:	<<allocation_year>>
Inkhundla:	<<district_list>>		Area (sq. metres):	<<area_sqm_land_holdings>>
Umphakatsi:	<<chiefdom_list>>		Number of parcels:	<<amount_land_holdings>>
Landholding nr:	<<landholdings_id>>		Land use:	<<land_use_list>>
			Page 1      Date:	<<enumeration_date>>
#	Name of homestead head:	Gender:	ID no:	Date:
1	<<homestead_head>>	<<homestead_head_gender>>	<<homestead_head_id>>	<<enumeration_date>>
#	Name(s) of homestead head's spouse(s)			Date:
1	<<homestead_head_spouse_names>>			<<date_spouses>>
#	Notes (additional information, e.g. household allocations):			Date:
1	<<clr_info>>			<<date_clr_info>>
#	Land lent out (name, terms & conditions):			Date:
1	<<land_rented_out>>			<<date_rented_out>>
#	Land borrowed from (name, terms & conditions):			Date:
1	<<land_rented_in>>			<<date_rented_in>>

Figure 47: MS Word chiefdom landholding register template

- > To import data: select > Mailings > Select Recipients



- > Of the three options, select > Use an existing list
- > Select the Excel file created with the chiefdom name > [Open]



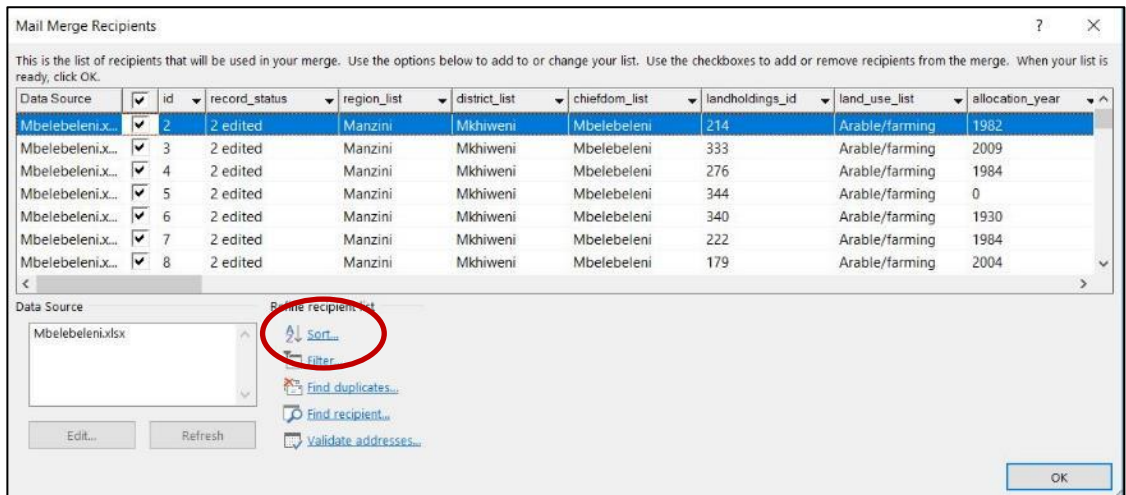
- > Select the table named 'DATA\$'
- > Nothing will appear, so click on <<Preview Results>> to see the records inserted into the template.



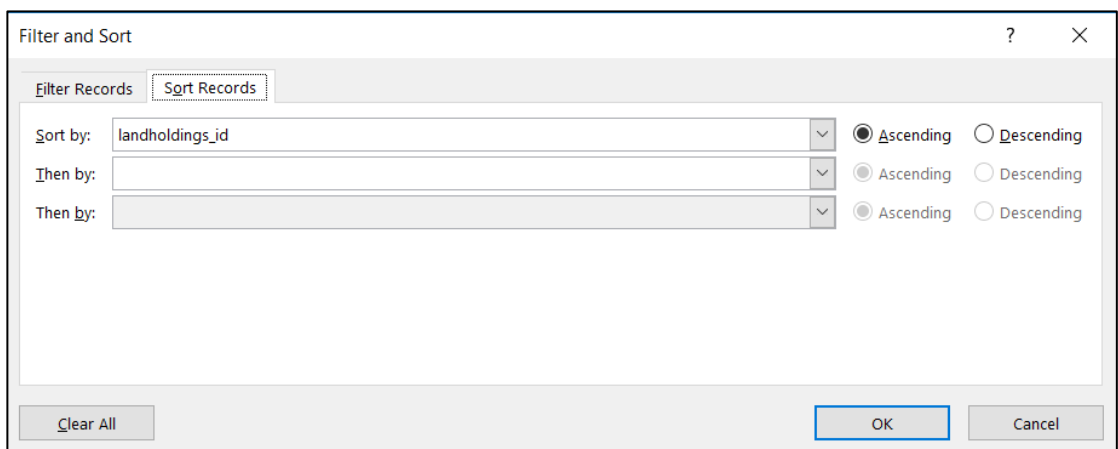
- > The first record in the Excel worksheet will appear on the first page of the register. This should be landholding number 1 in the chiefdom, and if so, skip the next step.

If the records appearing in the word document do not start with landholding 1 then:

- > Select > **Edit recipient list.**




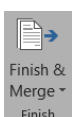
- > In **Mail Merge Recipients** box click [Sort].



- > In the box [Sort by] click the down arrow and select **landholdings\_id** from the list. Check that the button shows [Ascending].
- > Close the box by clicking [OK].

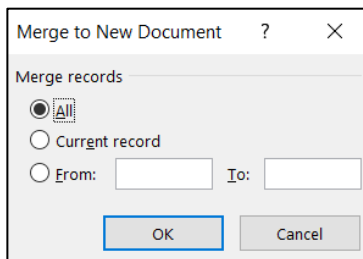
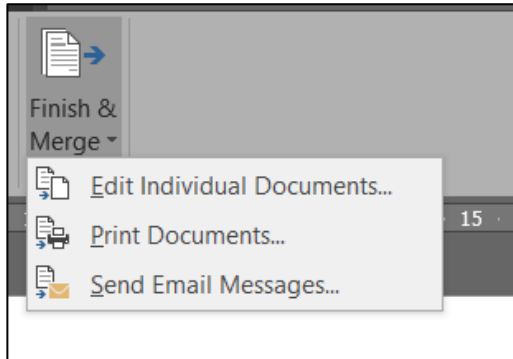


The chiefdom register word document should now contain all the records starting at landholding 1. Select **Preview the results** and navigate  to display each record in turn. To end:



- > Select > **Finish and Merge.** A dropdown menu appears with 3 options...

- > Select > **Edit individual documents ...** to create a MS Word document (preferred option). Alternatively, print documents can be used to send the register directly to a printer (not recommended) or to print a PDF file.



- > All records must be merged, so select [OK] to merge to New Document.

Note: it may a few minutes to create the DOCX or PDF file, depending on the number of records (homestead landholdings) in the chiefdom.

- > Save the file with the chiefdom name and "landholding register".

The register can be printed from the DOCX file, but a PDF copy will also be provided to the chiefdom on their laptop.

- > Save the file with the chiefdom name "landholding register" as a PDF file.

After the PDF file is created (either by saving the DOCX as PDF or printing direct to PDF), pages must be inserted to complete the landholding register ready for delivery. The following pages must be added:

- > Title page (chiefdom name, 'landholding register' and date register was created)
- > Example page (immediately after the title page)
- > Blank pages (10, 20, 30, depending on the size of the register)

A template is available for the title page as a DOCX file. Edit it and save as a PDF. Insert the PDF page as the first page of the register.

- > Insert the example page PDF file as the second page of the register.
- > Insert the blank pages at the end of the register.

## 5.4.2 Creating Other Chiefdom Documents

In addition to the landholding register, each chiefdom must receive the following documents:

- > Copy of landholding maps
- > List of all landholdings (A3 size)
- > Index lists – by new landholding number, old homestead number, and by name.
- > Copy of chiefdom LIMS manual
- > Copy of chiefdom land records maintenance manual

Refer to section 4.2.1 for guidance on the production and printing of landholding maps.

The need for index lists is because a different set of identification numbers is used for the final data – landholding numbers – whereas the data collection and validation used homestead numbers. Landholding numbers are in the range 1-n for each chiefdom whereas homestead numbers are 1-n for the whole database / country.

To prepare the final results list of all landholdings:

- > Start Excel with a blank spreadsheet
- > Connect to the database
- > Data > Get Data > From Other Sources > From ODBC
- > Select the SGD odk\_prod source from the dropdown list. [OK]
- > From odk\_prod open the public folder and select List\_homesteads, then [Edit]
- > From the umphakatsi column select only the records for the relevant chiefdom. Load more chiefdom names if necessary.
- > With only the relevant chiefdom records showing, select Close and Load.
- > Use either the list homesteads template for printing or set up the page size, header, column headings etc in the current worksheet,

To prepare the index, connect to the SLAM database using Microsoft Excel.

- > Start Excel with a blank spreadsheet
- > Connect to the database
- > Data > Get Data > From Other Sources > From ODBC
- > Select the SGD odk\_prod source from the dropdown list. [OK]
- > From odk\_prod open the public folder and select View\_homesteads, then [Edit]

- > From the **chiefdom\_list** column, select only the records for the relevant chiefdom. Load more chiefdom names if necessary.
- > With only the relevant chiefdom records showing, select **Close and Load**.
- > Delete all the columns not needed, i.e. leaving only the homestead number (id), landholdings number, surname, given name and other name columns.
- > Sort the data 3 times, by homestead number, landholdings number and surname, and each time copy the records and paste them into a DOCX file as separate tables.

### 5.4.3 Copy and Complete

The final step is to copy the chiefdom geopackage layers, the maps and the lists to the laptop.

## Appendix A IT Technical Guide

### A.1 Tablet Computers Set Up

These notes refer to the tablet computer *Samsung Galaxy Tab Active (SM-T365)*.

After switching on, the tablet will require input on:

- > Language = English (United Kingdom)
- > SIM card = skip
- > Wi-Fi = Provide a Wi-Fi that is connected to the Internet
- > User agreement = ✓
- > The tablet will check for and download updates – this may take a while
- > Tap & Go = skip
- > Google sign in = slamcowisd@gmail.com & password = slamcowi101
- > Date & time = Harare GMT+02:00
- > Google services = uncheck all the boxes
- > Samsung account = skip
- > Dropbox = skip
- > Device name = SLAM# (where # is the next number assigned, see inventory list)
- > Note the serial number and IMEI number (Device > About > Status)

The tablet is now ready to use. Suggest that unused apps and icons are removed from the home screen and the tablet.

Recommend that some settings are changed to make the tablet easier to use:

- > Device > Display > Smart stay = ✓
- > Device > Display > Screen timeout = 5 minutes

The data collection software is called **GeoODK Collect** and can be downloaded from the Internet.



- > Connect to the Internet
- > Sign in to Google using [slamcowisd@gmail.com](mailto:slamcowisd@gmail.com) with current password (credentials)
- > Go to The Play Store, search for and download GeoODK

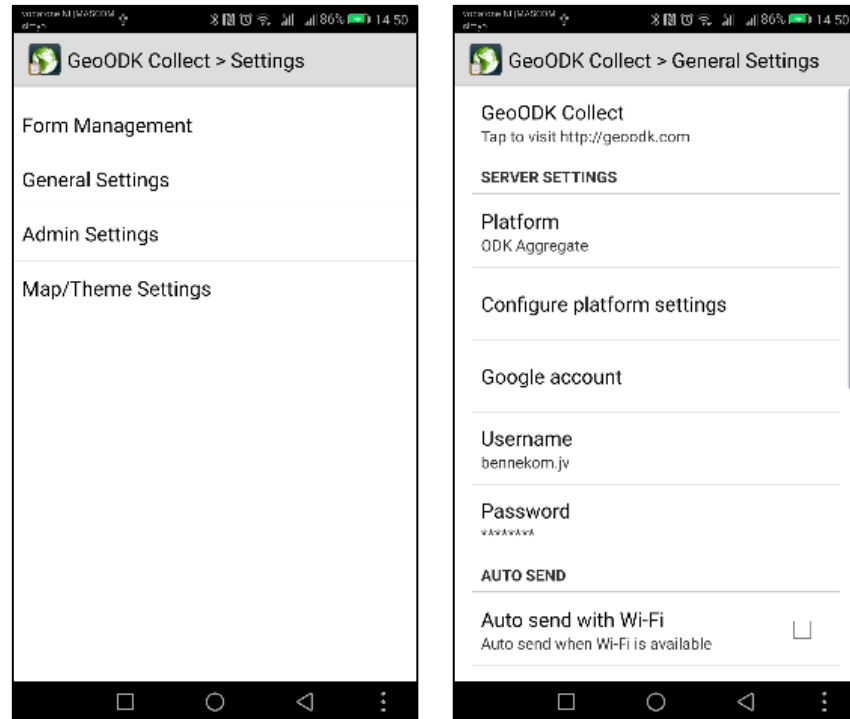
#### A.1.1 Configure GeoODK

The GeoODK<sup>8</sup> app is used for field data collection. Before using the app for the first time, it needs to set up or configured, for example with regard to connection to ODK Aggregate web application, running on the server, and required for receiving and storing data collected in the field.

- > Go to Settings > General Settings.

---

<sup>8</sup> <http://geodk.com>



- > Go to Server settings > Configure platform settings.

Use the following data to configure ODKAggregate server settings:

URL = <http://192.168.8.2:8580/ODKAggregate/>  
 Username = [data\_collector]  
 Password = [password]

- > Go back to GeoODK > General Settings

The remaining options in *General Settings* can remain as default.

- > Go back to GeoODK > Settings

No changes are required to *Admin Settings*.

- > Go to Map/Theme Settings
  - > Uncheck Online Maps (so that maps are offline)
  - > Theme options > Set default theme = classic

Next, a data collection form needs to be copied from the server:

- > Go to Form Management

If not already provided, the server will require authentication:

**Server Requires Authentication**

Please enter username and password for server:  
 http://192.168.8.2:8580/ODKAggregate/formList

Username  
 data\_collector

Password  
 ....

Cancel OK

- > Got to GeoODK Collect > Get Blank Forms

The following forms/questionnaires can be used in field data collection:

- > Capture Community Area (201808)
- > Landholding and Land Use Data Form (201808)

GeoODK Collect > Get Blank Forms

Capture Community Area (201808) Version: 20180813 ID: community_area	<input checked="" type="checkbox"/>
Landholding and Land Use Data Form Version: 20180222 ID: landholding_landuse	<input type="checkbox"/>
Landholding and Land Use Data Form (201808) Version: 20180814 ID: landholding2	<input checked="" type="checkbox"/>
Point of Interest ID: poi_20171229	<input type="checkbox"/>
Test Spatial Widgets ID: test_spatialwidgets_draft_a	<input type="checkbox"/>

Toggle All Refresh Get Selected

- > Press "Get Selected"

**Download Result**

Landholding and Land Use Data Form  
 (201808) (Version:: 20180814 ID: landholding2)  
 - Success

Capture Community Area (201808) (Version::  
 20180813 ID: community\_area) - Success

OK

Forms are now loaded and ready to use!

## A.1.2 Copy Image Files

Prior to fieldwork, the necessary orthophotos covering the area of interest must be copied to the tablet computer.

These orthophoto are specially formatted for use on a tablet, and orthos in other formats such as JPG, TIFF or ECW formats cannot be used. The format is called MBTILES<sup>9</sup> and image files have the mbtiles suffix.

- > Identify the required MBTILES files on the server at:
  - > Z:\192.168.8.2/geodata/imagery/MBTiles/
- > Copy the subdirectory containing the mbtiles file, and not just the file itself, to the following directory in the tablet computer:
  - > Internal storage\geoodk\OfflineLayers

The naming convention is the same as for other orthophoto files, but they may be divided into four (because of file size limitations in GeoODK software). The file name also indicates the resolution (i.e. zoom level<sup>10</sup>) of the ortho image. For example:

- > K11\_z19.mbtiles (ortho index tile K11 with a resolution of zoom 19)
- > J06\_z20 (ortho index tile J06 with a resolution of zoom 20)

A zoom 20 file is a higher resolution than z19. For most areas a zoom 20 file provides sufficient resolution. A zoom 19 may be appropriate in less densely populated or farmed areas.

Refer to Appendix B for guidance on creating MBTiles using TileMill software.

## A.2 Troubleshooting GeoODK and Data Collection

### Slow Tablet Performance

If the tablet begins to 'slow down' restart the tablet.

- > Power off > Restart

This will clear the data cache freeing up memory for applications to run more quickly.

Also check that the device storage is not full or near full. If so, first try deleting any unneeded programs and files. If necessary, delete some GeoODK data that has been successfully uploaded to the server.

---

<sup>9</sup> <https://wiki.openstreetmap.org/wiki/MBTiles>

<sup>10</sup> [https://wiki.openstreetmap.org/wiki/Zoom\\_levels](https://wiki.openstreetmap.org/wiki/Zoom_levels)



### GeoODK App Crash

If GeoODK crashes or stops working, the issue is often the size of the orthophoto image or too many orthophoto images stored on the device and consuming memory.

- > Reduce the orthophoto image size (< 5GB; best between 2GB and 3GB)
- > Delete unneeded orthophoto image files

To recover from a crash, navigate to the tablet's android system settings:

- > Settings > Applications > GeoODK > [Force Stop]

Do not clear data or clear cache because this will delete all data on the tablet including data that has not been uploaded to the server.

- > Restart GeoODK

### Tablet Factory Reset

Sometimes it may be necessary, due to general problems with the tablet computer and its android operating system, to reset the tablet to its factory settings. This will delete all applications and data from the device, so only do this if you are sure all data are transferred to the server.

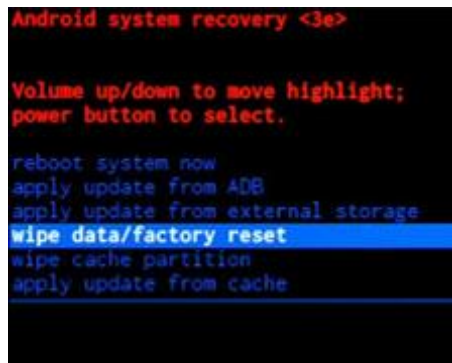
- > Power off the tablet
- > Press and hold together > Volume Up + Home button + Power button.



- > The android reset (robot) logo appears, followed by the system recovery menu.



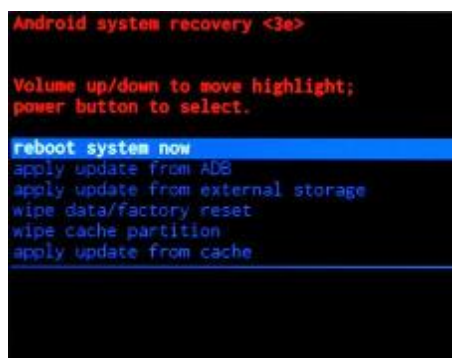
- > Using the volume down button, select [wipe data/factory reset]



- > Confirm that all data will be deleted:



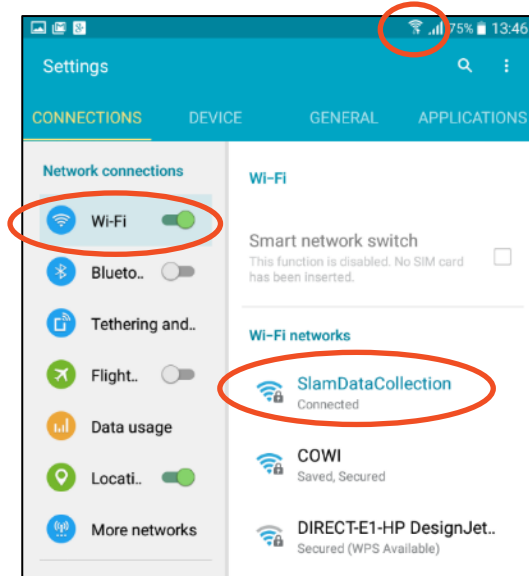
- > Then confirm the option to *reboot system now*.



### Data Does Not Upload or Transfer

If the Upload Results say 'Error: Network Connection Refused', then:

- > Check if the Wi-Fi is turned on?



- > Check if the server settings have been reset.
  - > Go to GeoODK > Settings > General Settings > Configure platform settings
  - > Check the setting for URL, Username and Password (see beginning of section A.1.1)

## A.3 Resetting Laptops

If and when necessary, the Lenovo Ideapad 310 laptop computers can be reset to their factory defaults. To do this...

- > Turn the laptop off.
- > Press the Novo button on the left side of the laptop case. The button is recessed in a small hole and a paper clip is needed to press it.
- > Select > System Recovery.
- > Restore form initial (factory settings) or user backup, as required.
- > If a restore to factory settings is chosen, then an Internet connection is needed to re-set up the computer.

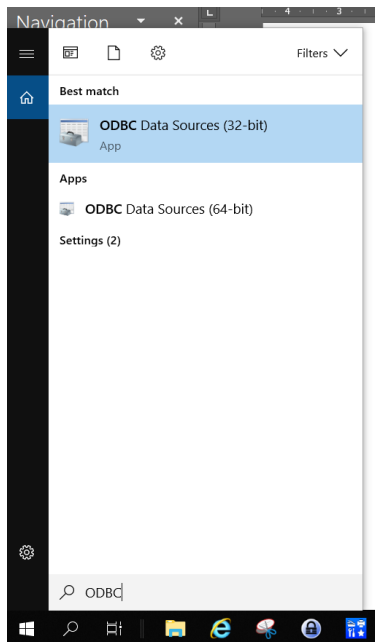
## A.4 Installing ODBC Driver for MS Excel

Note that a connection from MS Excel to the PostgreSQL database will be made via Open Database Connection tools. The psqloDBC<sup>11</sup> executables that need to be installed on a computer operating the MS Excel-PostgreSQL connection, are, in the order of installation:

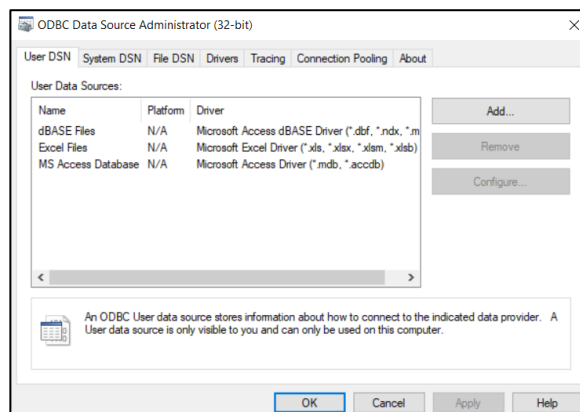
- > psqloDBC-setup.exe
- > psqloDBC\_x86.msi: for psqloDBC (32bit)
- > msipsqlodbc\_x64.msi: psqloDBC (64bit)

Both 32- and 64-bit programs are required to make a User DSN<sup>12</sup> named "SGD odk\_prod"; this has to be done on each computer.

- > In the Windows Search box type ODBC and choose ODBC Data Sources (32-bit).



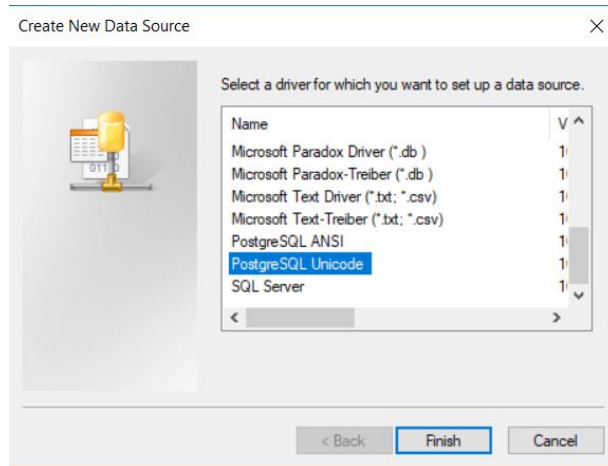
- > In ODBC Administrator, Add a new User DSN.



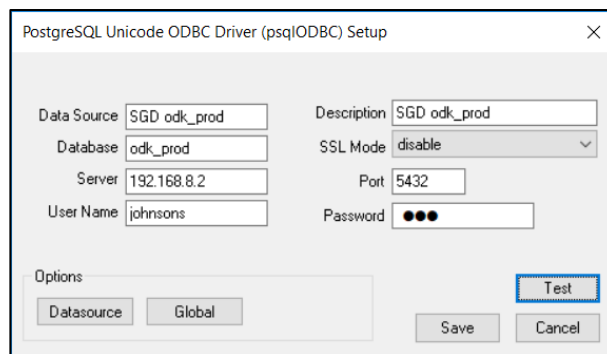
<sup>11</sup> <https://www.postgresql.org/ftp/odbc/versions/msi/>

<sup>12</sup> <https://support.microsoft.com/en-us/help/966849/what-is-a-dsn-data-source-name>

- > Scroll down the list and choose PostgreSQL Unicode. Click [Finish].



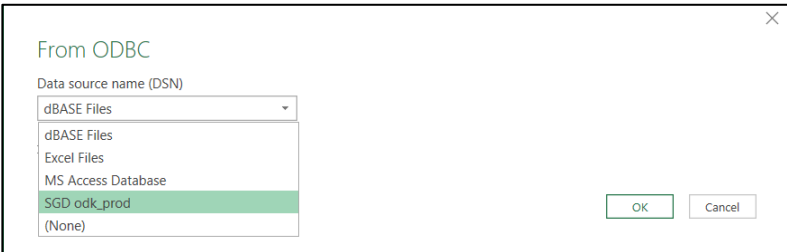
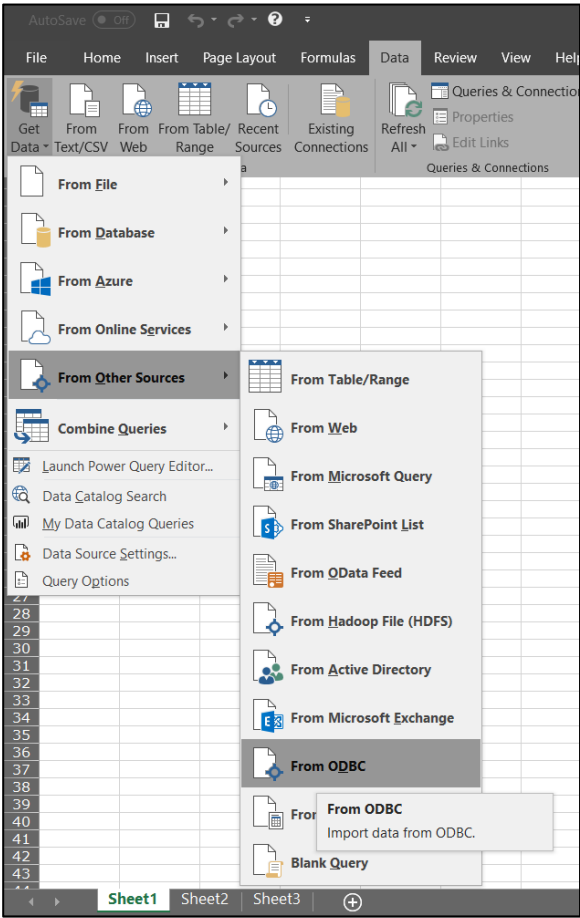
- > In the PostgreSQL driver set up box, type in the details as shown below:

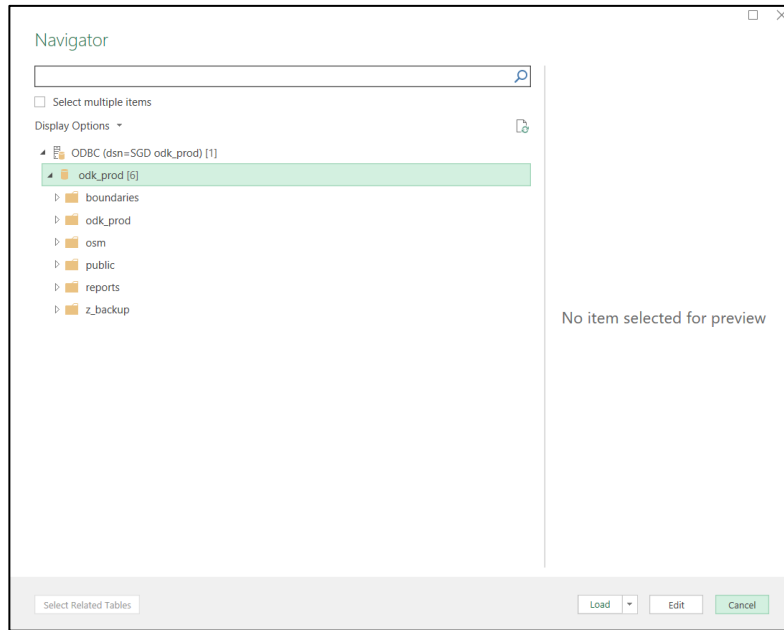


- > Data Source = SGD odk\_prod
- > Database: odk\_prod
- > Server: 192.168.8.2
- > User name: e.g. johnsons
- > Password: \*\*\*\*\*
- > [Test] the connection and [Save] the [OK] to exit the ODBC Administrator. The driver should now be installed and available in MS Excel.

To test the ODBC link and the connection to the SLAM database...

- > Start MS Excel.
- > Select the Data menu tab > Get Data > From Other Sources > From ODBC





- > Select [Load] for all data, or select [Edit] to choose columns and if required filter and sort order.
- > Close and load.

## Appendix B Creating MBTiles

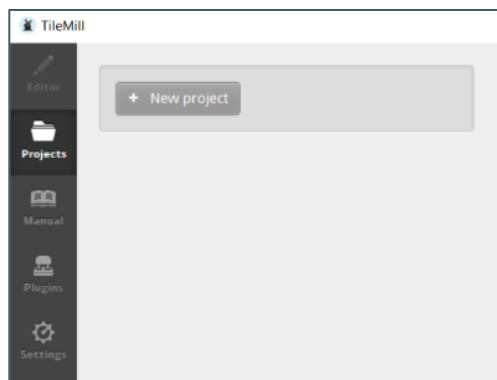
MBTiles is a raster image file format. The files are compressed and hold geographic location and projection information. The format is specifically designed for use in web or mobile applications. MBTiles is an open source specification and based on SQLite.

### B.1 Software

Various software can be used to create MBTiles files. The preferred application is called [TileMill](#)<sup>13</sup>. Information in addition to this training guide can be found in the software documentation at the mentioned URL.

### B.2 Create an MBTiles Format File

- > First make sure that [GeoTIFF](#) imagery is available. If necessary, convert the orthophoto file format into GeoTIFF using Global Mapper, QGIS or other software. TileMill only works with GeoTIFF format input files.

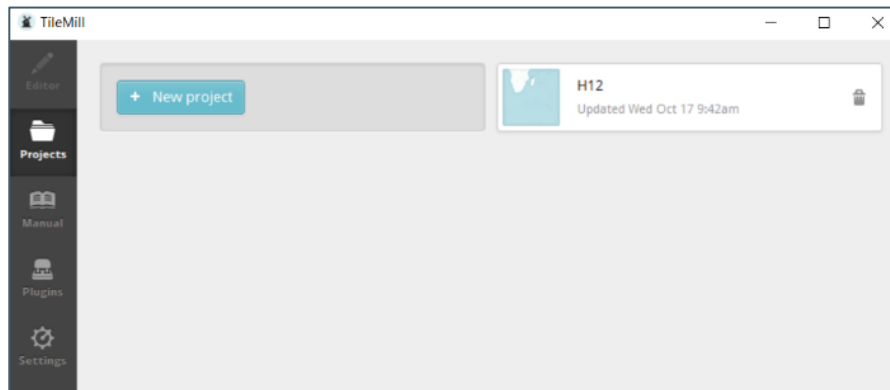


- > Start TileMill and create a new project. Include default data in the project – [world layer and styles](#) – as this will help to geo-referencing the image, i.e. to locate the orthophoto to be converted.

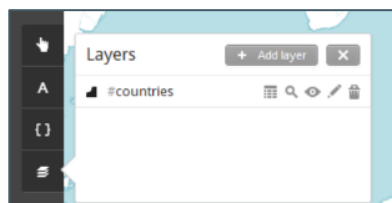
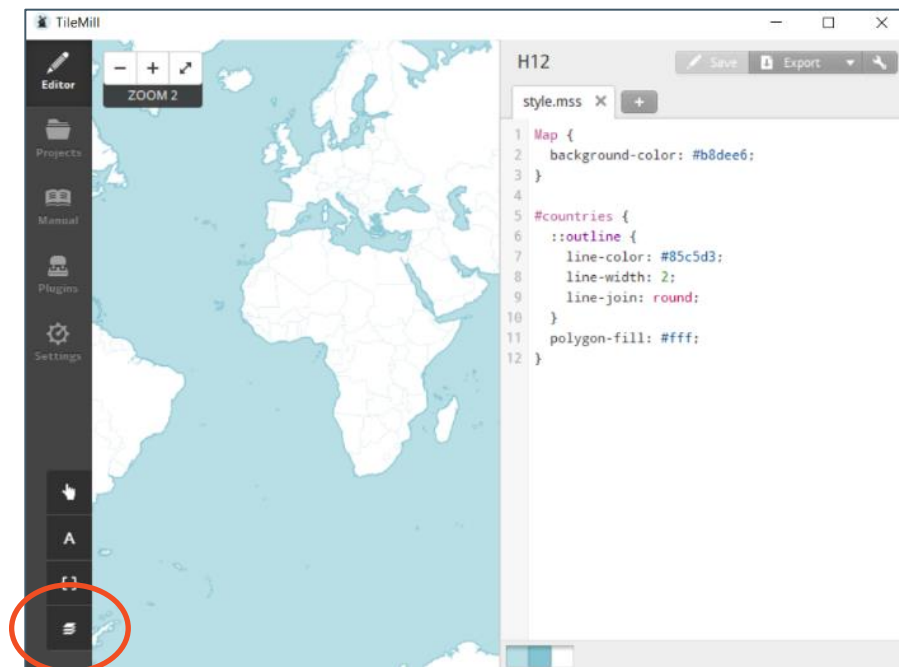
<sup>13</sup> <http://tilemill-project.github.io/tilemill/>



- > The new project is added to the projects window. Select the project...



- > Select the **Add Layer** to add the GeoTIFF image.



- > Use the [Browse] button to locate the GeoTIFF file that will be converted to MBTiles.

**Add layer**

File SQLite PostGIS

ID  select in Carto #id

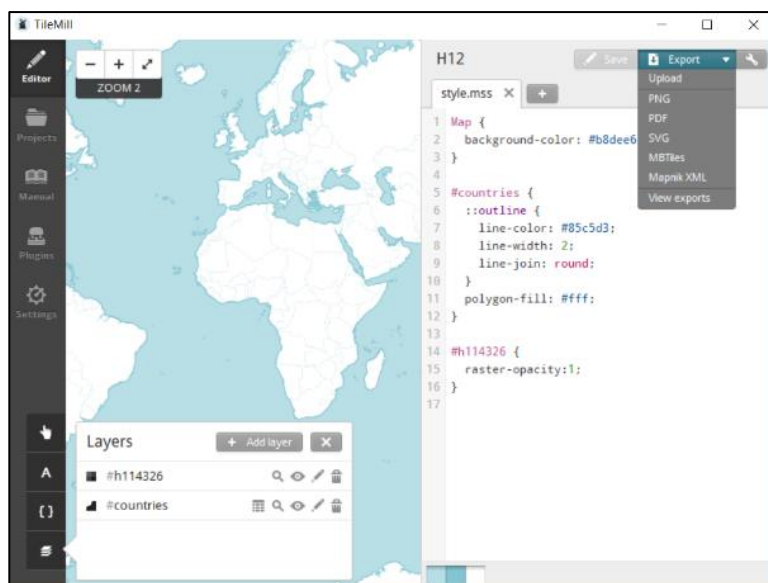
Class  select in Carto .class

\* Datasource

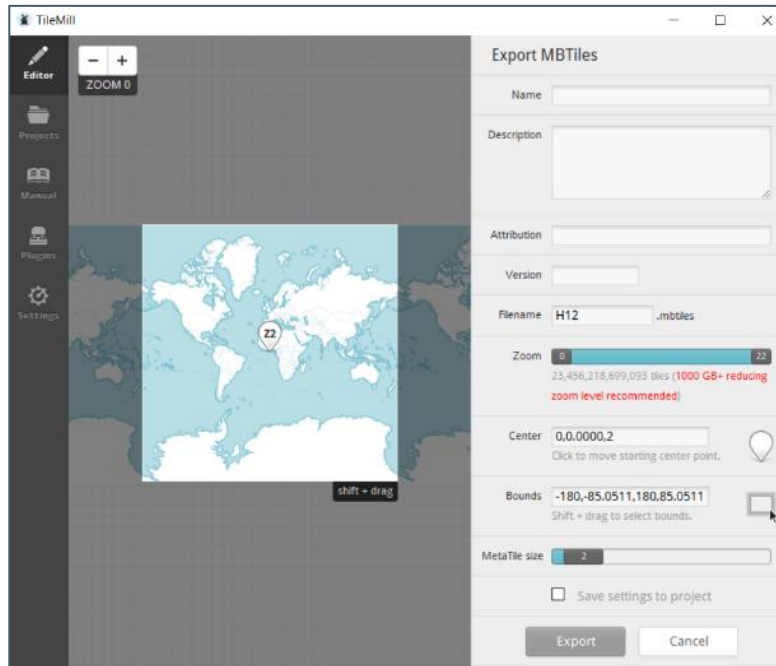
SRS     
SRS projection string for this datasource. TileMill can often autodetect this value.

Advanced  Optional, advanced arguments to pass to Mapnik.

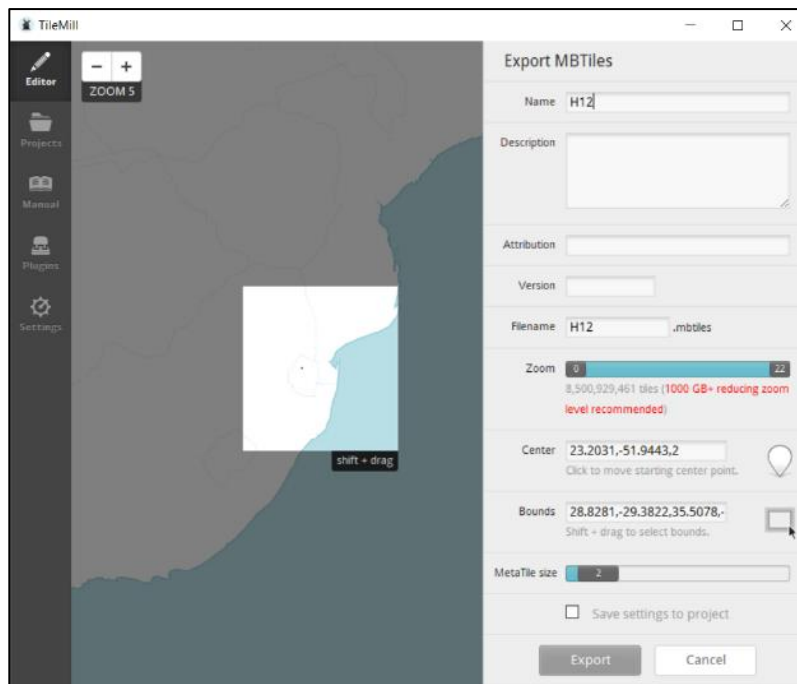
- > Set the **SRS** to WGS84.
- > **Save & Style** (the style is needed to depict the ortho)
- > The edit window will then reappear, with image file (H11) added to the project layers. Note that in this example the layer is named H114326. The '4326' added to the sheet number represents the ESPG coordinate reference system code for WGS84.



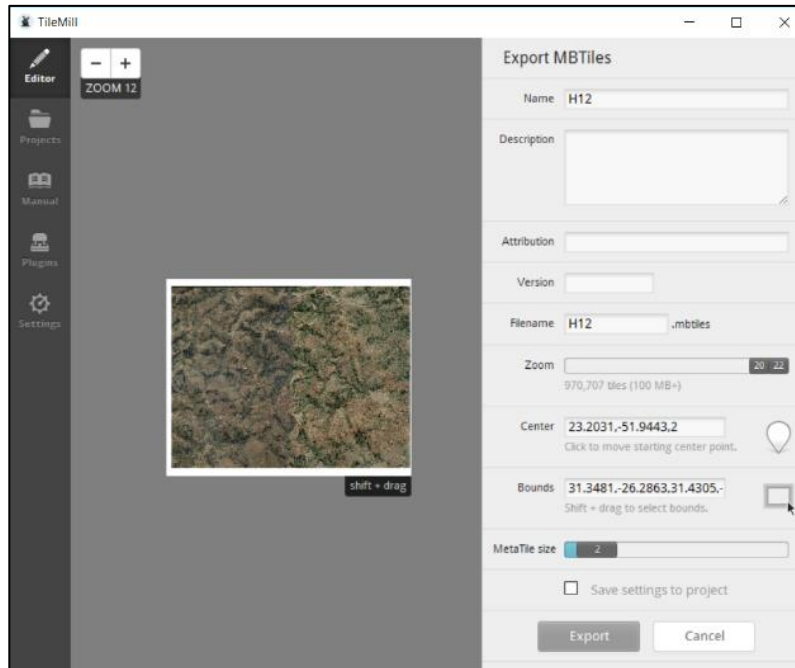
- > Click [Export] and from the from down list, choose MBTiles.
- > Then your TileMill window should be like that below:



- > Next, adjust the bounding box, highlighted above, to coincide with the image. To make this adjustment, select and drag the sides of the box to resize it. Click the [Zoom +] button to resize the box. Repeat and drag the box to locate the image in its geographic location. If you are prompted 'Delete this point', select [Yes].



- > Continue adjusting the size and zoom so that the box coincides with the image.



- > In the Zoom slider, move it until the desired zoom number appears in the slider bar. The zoom number represents the MBTiles image resolution. A zoom of 20 is usually used; sometimes 19 when a slightly lower resolution will suffice. A zoom of 21 or 22 will result in large image file sizes.
- > Centre: click somewhere within the bounding box to set centre.
- > Click "save settings to project" and press **Export**, a 48 km<sup>2</sup> ortho takes about 1.5 to 2 hours to process depending on the speed of the PC. The resource of the PC will be almost fully used, so use a PC dedicated to this task. Use **view exports** to view progress, multiple tasks can be run simultaneously.
- > When done, press **Save** (in view exports), this will load the MBTiles.
- > Store the MBTiles file in a folder for MBTiles for later copy/transfer to a tablet computer.

**Hint:** A full size GeoTIFF orthophoto tile will result in a large MBTiles file size, especially if Zoom 20 is needed. Large MBTiles file size can cause problems in tablet computers with limited memory. Two options are available. Use a lower resolution zoom setting, e.g. 19, or smaller image extents. For example, instead of creating one large MBTiles file for an orthophoto tile, create four smaller ones.

## Appendix C QGIS Set Up

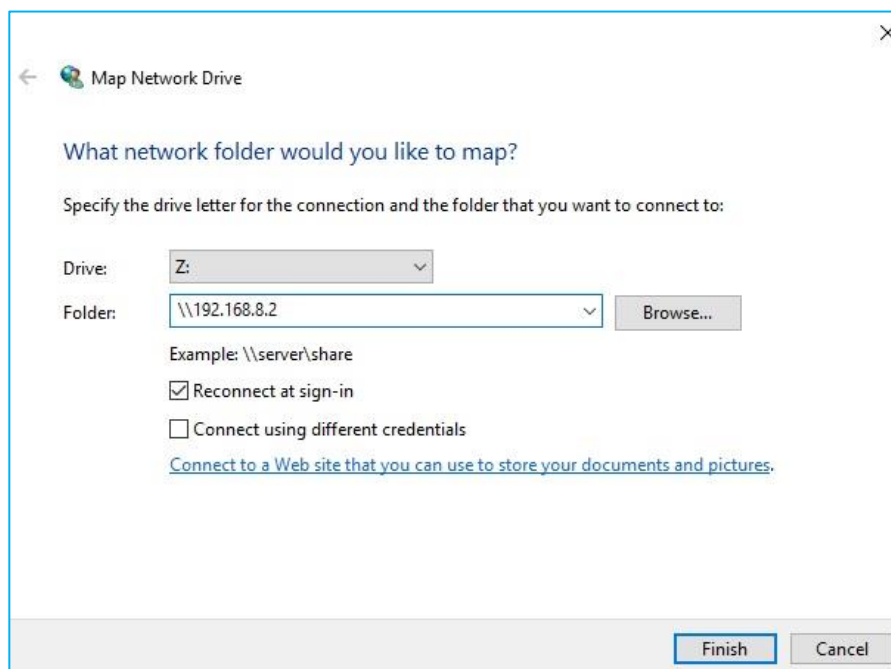
- > For setting up software, a temporary connection is needed to the server. Connect to the WiFi

Wireless SSID	SlamDataCollection
Password	slamWifi102
Server	\\192.168.8.2

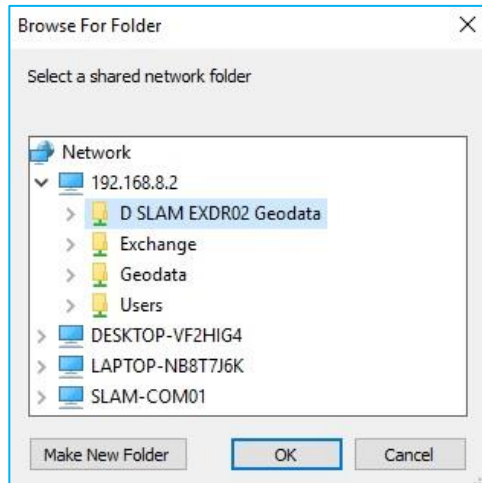
- > Make the laptop discoverable on other networks (turn on network discovery).

All computers connected to the wireless router, except for the server, will now be listed in the network.

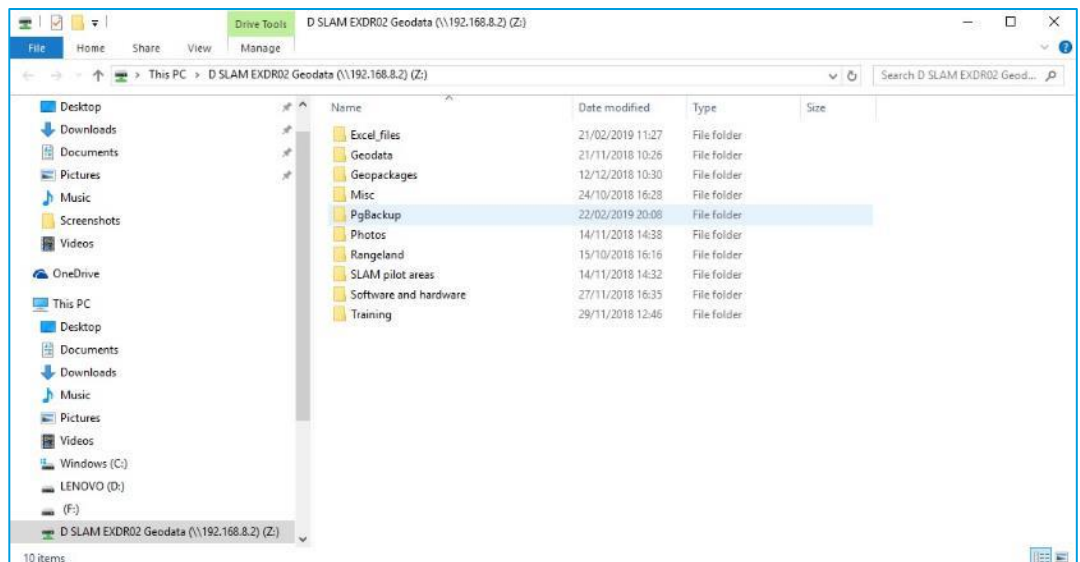
- > To connect to the server, a network drive must be defined / mapped. Use the folder IP address for the server specified above. The laptop may need to be restarted to finish the connection.



- > Click [Browse] to choose the network folder to map and connect to:
  - > D SLAM EXDR02 Geodata



The server folders will now be mapped to drive Z: as shown below.



- > Next, copy from the software and hardware folder to the laptop and double-click to install the following software:
  - > QGIS-OSGeo4W-3.4.0-1-Setup-x86\_64.exe (the QGIS Standalone Installer [64 bit]<sup>14</sup>)
  - > LibreOffice\_6.0.6\_Win\_x64
  - > Adobe Acrobat Reader

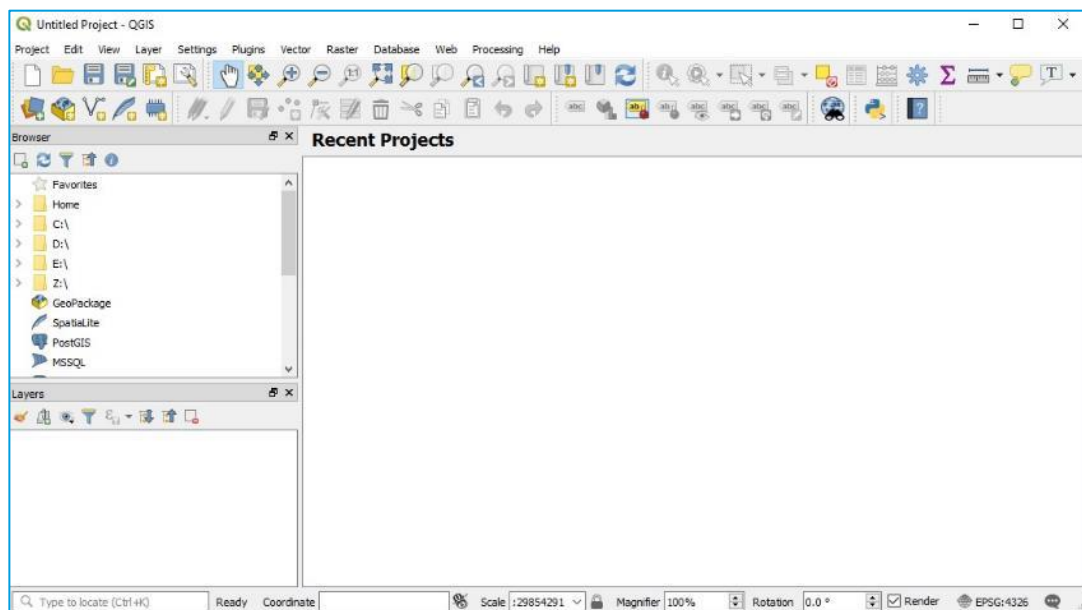
## C.1 Install QGIS

Version 3.4 'Madeira' (the April 2019 Long Term Release) can be found on the server at:

- > Z:\\192.168.8.2/D SLAM EXDR02 Geodata/Software and Hardware/QGIS

<sup>14</sup> <https://qgis.org/en/site/forusers/download.html>

- > Copy the file *QGIS-OSGeo4W-3.4.6-2-Setup-x86\_64.exe* (the so-called QGIS Standalone Installer [64 bit]) to the computer workstation. The computer **must** be using Windows 10 64-bit version.
- > Double-click the QGIS set file.
- > During the installation of QGIS, accept all the defaults during the installation process.
- > Copy the QGIS 3.4 Desktop shortcut to the start menu and desktop and delete the QGIS installation file and shortcuts folder.
- > After installation, start QGIS, which will open with an empty project window with a user interface, as depicted below.




### Configure User Interface

A simplified QGIS user interface is necessary for computers in use in/by the chiefdom. Only the functions that are needed are available in the QGIS menus; all other functions are hidden.

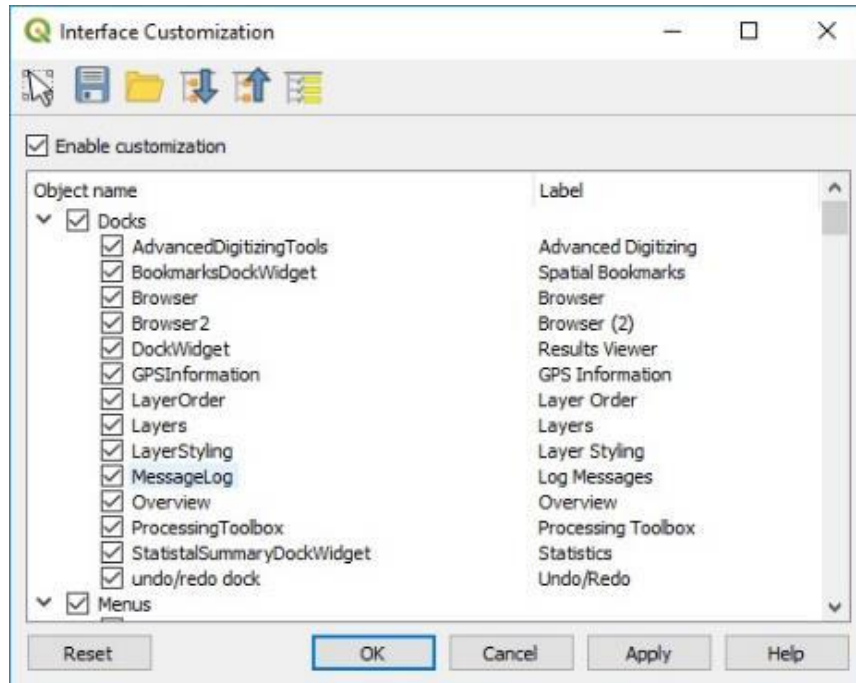
The QGIS user interface is customized using a \*.ini file (e.g. "qgis3 chiefdom.ini"). which can be used for setting up the chiefdom laptops with a simple user interface.

Customisation is enabled in the QGIS Menu:

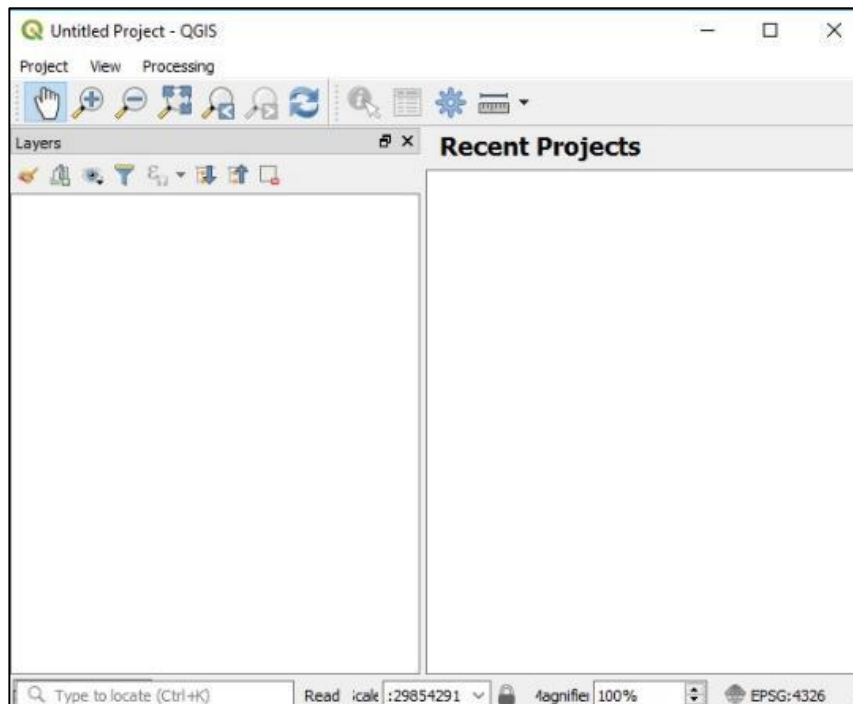
- > Settings > Interface Customisation > Enable Customisation
- > A dialog **Interface Customisation** is shown, with the option "Load from File" by clicking the folder  and the qgis3 chiefdom.ini can be loaded.

The dialogue window will now show how the customisation will be applied, as shown below. Additional adjustments to the customised interface can be manually made, if necessary.

- > Click [Apply] and [OK] to finish.



When restarted, QGIS will have the changed, stripped down user interface as shown below.





Applying the qgis3 chiefdom.ini file will strip away all but the most basic menu functions and therefore the process cannot easily be reversed. However, a full set of menus will be available if QGIS is started from the command prompt with the following command line:

- > cd c:\program files\qgis 3.4\bin
- > start "qgis" qgis-bin.exe --nocustomization

Tip: the minimal UI means access to some menu functions are hidden but they are nevertheless available via keyboard shortcuts. The following are some of the most useful:

Show the layers panel.	Ctrl+1
Show all layers	Ctrl+Shift+U

## C.2 Edit Environment

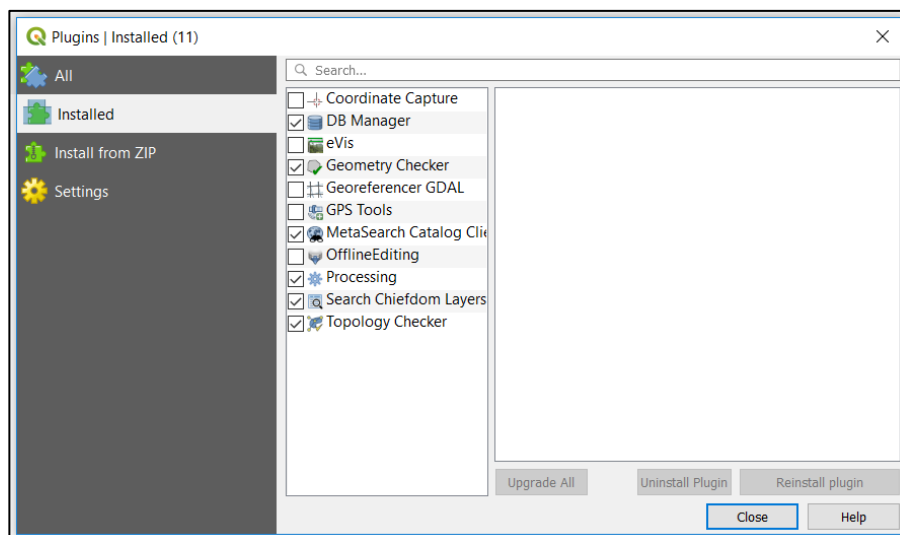
In previous versions of QGIS a manual connection would need to be established with the SLAM PostGIS server. However, version 3.4 uses a custom developed software extension or plugin (i.e. load\_edit\_env) to establish the connection and to set up the SLAM **edit environment** with all its layers automatically.

Copy the plugin in the form of a [load\\_edit\\_env20190326.zip](#) file to the desktop computer. All (later versions of) QGIS plugins can be found on the server in the QGIS custom\Plugins directory.

- > Z:\192.168.8.2\D SLAM EXDR02 Geodata/Software and Hardware/QGIS/SLAM Plugins

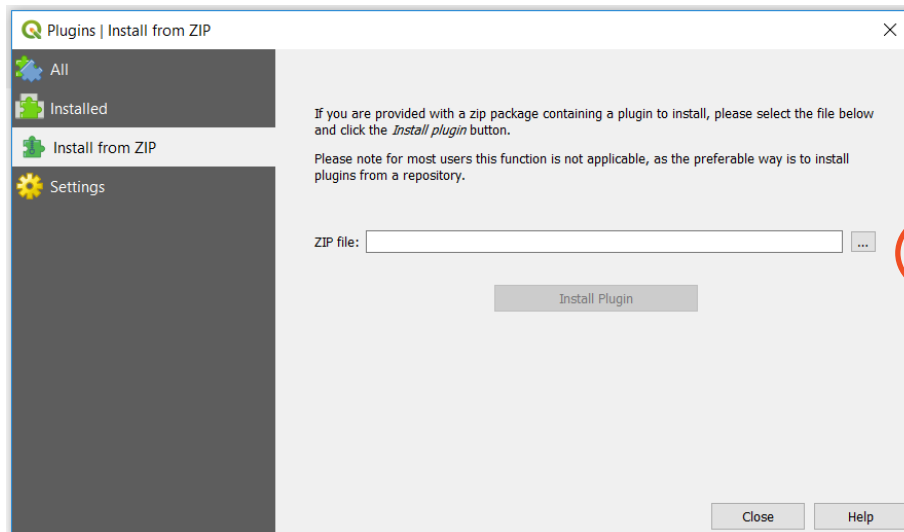
### To install the QGIS plugin:

- > In QGIS, go to Plugins > Manage and install plugins >



The list of installed plugins is shown.

- > Select **Install from ZIP**



- > Click on the [...] button and navigate to the .zip file in the plugin directory:
- > Click [Install Plugin].

A message will briefly appear informing that the plugin is successfully installed.

- > Close the Plugins | Install from ZIP window.

The plugin places a new icon  below the QGIS menus.

- > Note that another plugin "Search Chiefdom Layers" is available, primarily for the chiefdom equipment. The plugin is available in a similar ZIP file structure (searchchiefdomlayers20190308.zip) and can be installed in a similar fashion through "Install from ZIP file" (see Appendix E.1).

### To start the QGIS plugin:

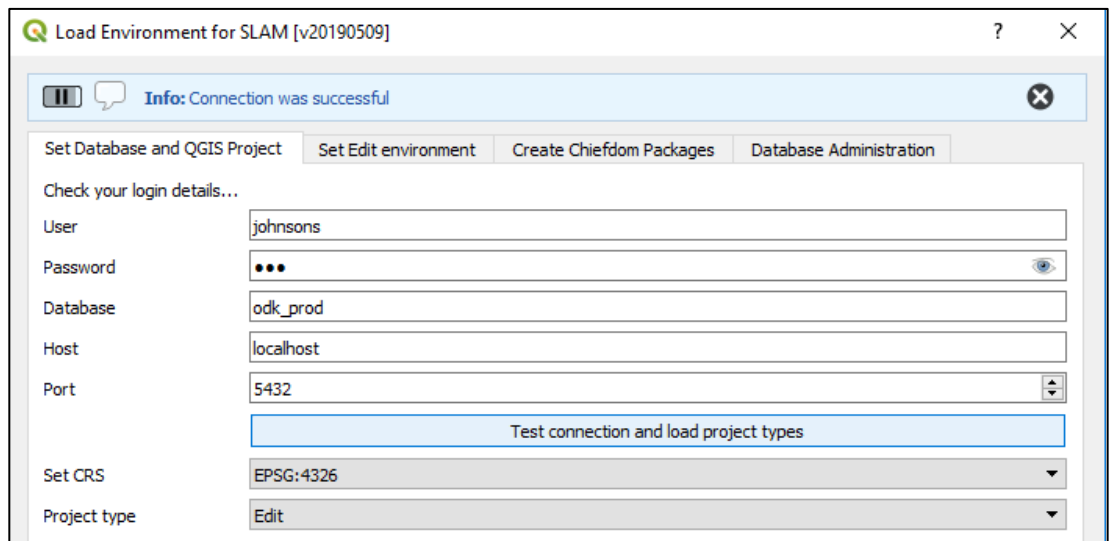


- > Start the plugin by
  - > Double-clicking this icon, or
  - > Go to Plugins > Load SLAM Edit Environment > Load SLAM Edit Environment

A Load Environment for SLAM window will open:

- > Provide your database credentials (i.e. username and password). The tool should remember credentials after completing the first setup of the edit environment. The tool can only be used by users that have user authorisation in the Postgres database.
- > After entering the password, click [Test connection and load project types].

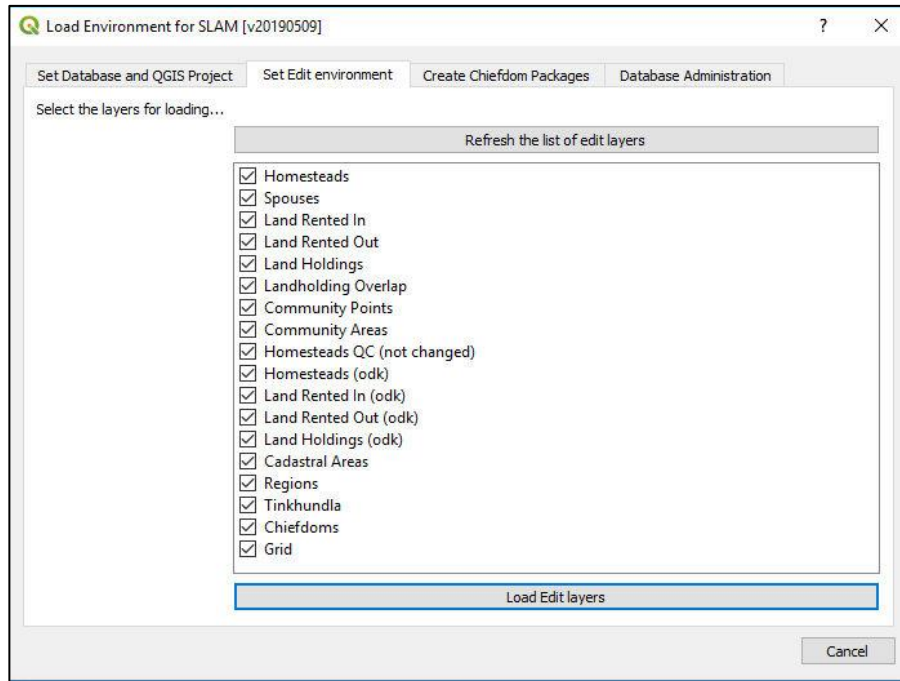
An Info message should appear to indicate that the connection was successful (see below).



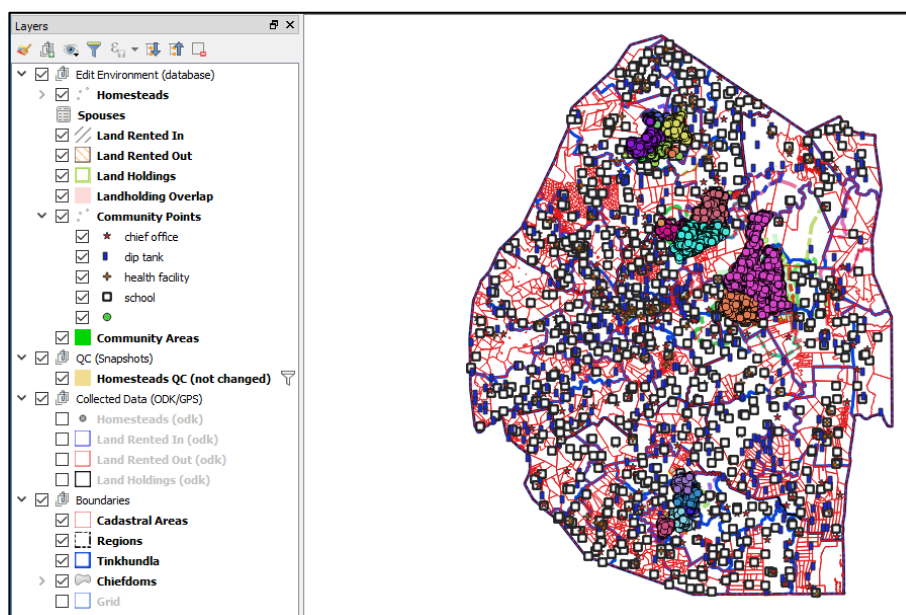
- > With **Set CRS**, the On-The-Fly (OTF) projection in the QGIS project can be chosen.
- > The **project type** can now also be selected in the bottom selection field:
  - > **Edit** (default); for loading an Edit environment with the layers for editing.
  - > **Chiefdom**; for preparing data in a format suitable for Chiefdom computers, only data relevant for a chosen chiefdom will be loaded.
  - > **All Chiefdoms**; idem, but for the data in all chiefdoms, with landholding polygons colour coded by chiefdom.

### C.2.1 Project Type: Edit

- > Select project type Edit
- > Go to tab Set Edit Environment with the list of layers for edit environment
- > Select Load Edit Layers

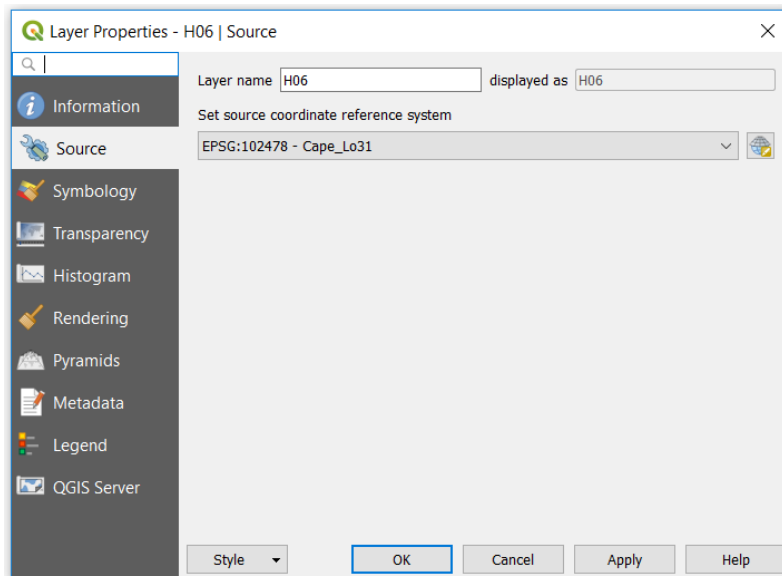


All selected layers will then appear in QGIS map window with a message with a list of layers that have been loaded into the edit environment. Note that the layers are upside down when CRS EPSG:22291 was selected.



- > To finish setting up QGIS for data editing, raster image orthophoto map layers must be added. Turn on the **grid** layer to identify which image map sheets you want to load (e.g. L13).
- > Then, in the QGIS **layers panel** create a **group** and name it **Image maps**. Highlight this group and: Layer > Add layer > Add raster layer
- > Click the [...] button and navigate to the directory on the computer (not the fileserver) where the ECW orthophoto maps are kept.

If the orthophoto does not load where it is expected, this means that QGIS has not recognised or incorrectly recognised its CRS. To fix this, right click on the image map number in the layers panel. In the pop-out menu, select **Properties**.



In the example above, QGIS has partly recognised the CRS but placed the image in the northern hemisphere. To correct it, click on the **Set source coordinate reference system** bar.

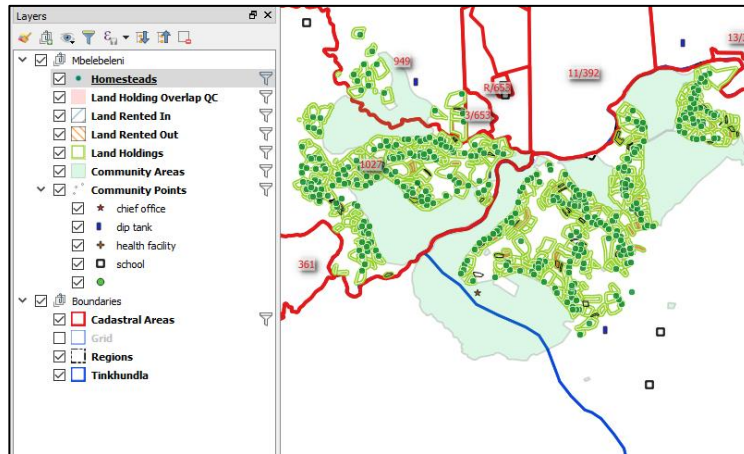
- > Select from the list EPSG: 22291 – Cape/Lo31 then [OK]. The image map should now be in the correct location.

## C.2.2 Project Type: Chiefdom

Preparing for delivery of data to the chiefdoms is also supported by the plugin:

- > Start the plugin and enter credentials
- > Press button “Test connection and load project types”
- > Select project type “Chiefdom”
- > Go to sheet “Set Chiefdom environment”
- > Select the chiefdom (e.g. Mbelebeleni)
- > Press button “Load Chiefdom Layers”

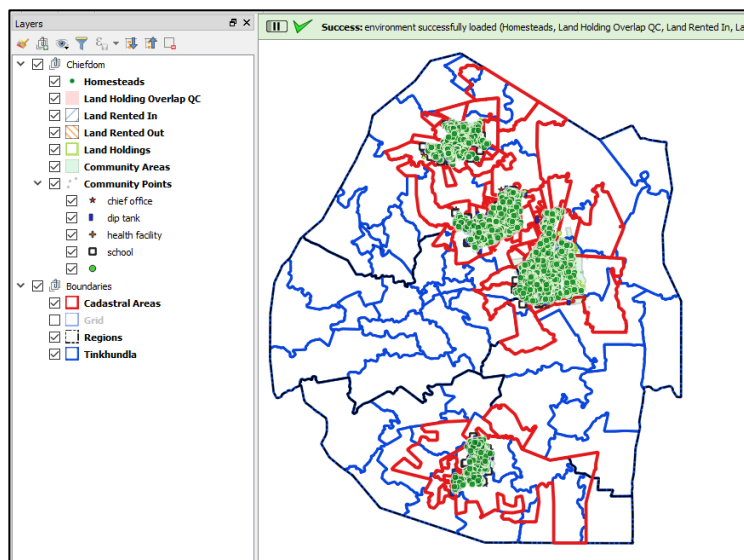
A message will appear, reporting the environment has successfully loaded with the selected layers. More elaboration is provided in section 5.3.1



### C.2.3 Project Type: All Chiefdoms

Preparing a data delivery involving data for all chiefdoms would be similar to appendix C.2.2 above:

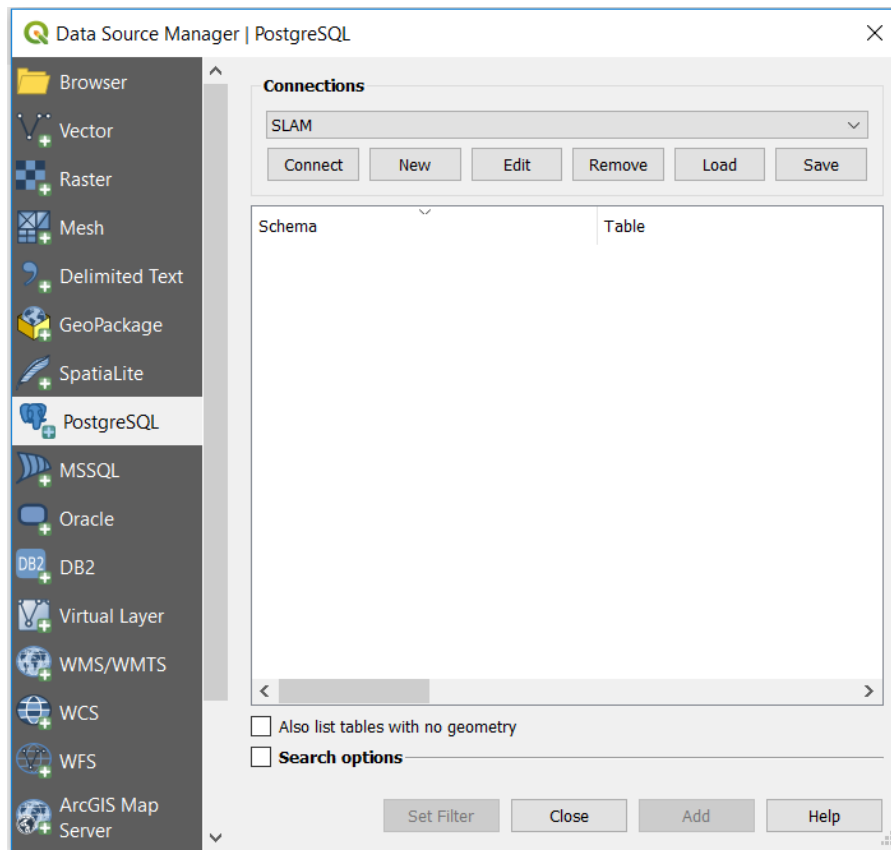
- > Start the plugin and enter credentials
- > Press button "Test connection and load project types"
- > Select project type "All Chiefdoms"
- > Go to sheet "Set Chiefdom environment"
- > Press button "Load All Chiefdoms Layers"



## C.3 Manual Connection

Occasionally it may be necessary to establish a manual connection between QGIS and the PostGIS SLAM odk\_prod database to add a layer from a database table.

- > Layer > Add layer > Add PostGIS layer



The Data Source Manager window will open and by default the connection will be **SLAM**.

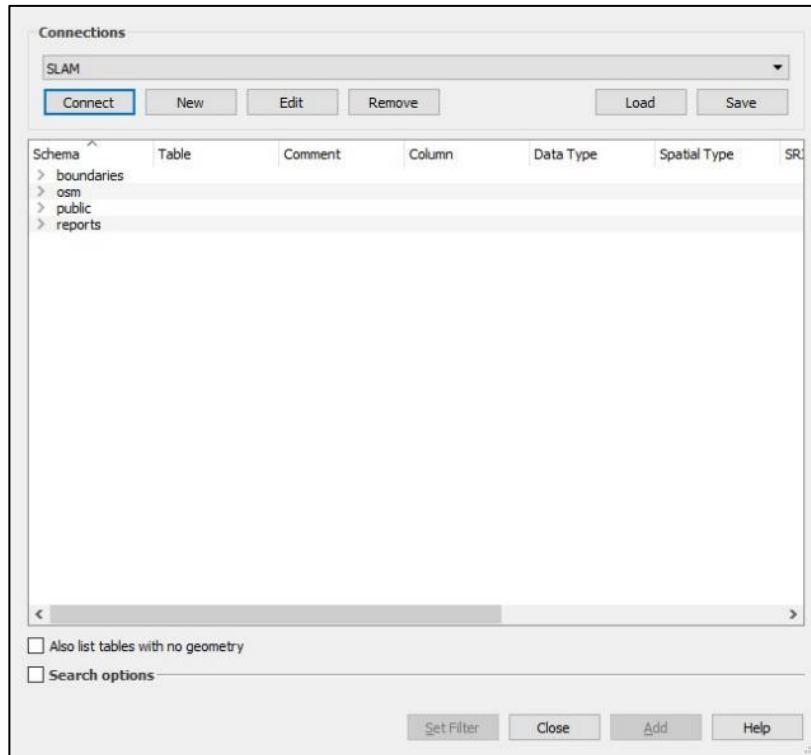
- > Click [Connect]. On the first occasion after initial installation – without setting up a SLAM edit environment – the connection will request your username and password for a new connection. Complete the connection information:
  - > Name **SLAM**
  - > Host **192.168.8.2**
  - > Port **5432**
  - > Database **odk\_prod**

A basic connection is all that is necessary, with your username and password. To finish, click [Test Connection].

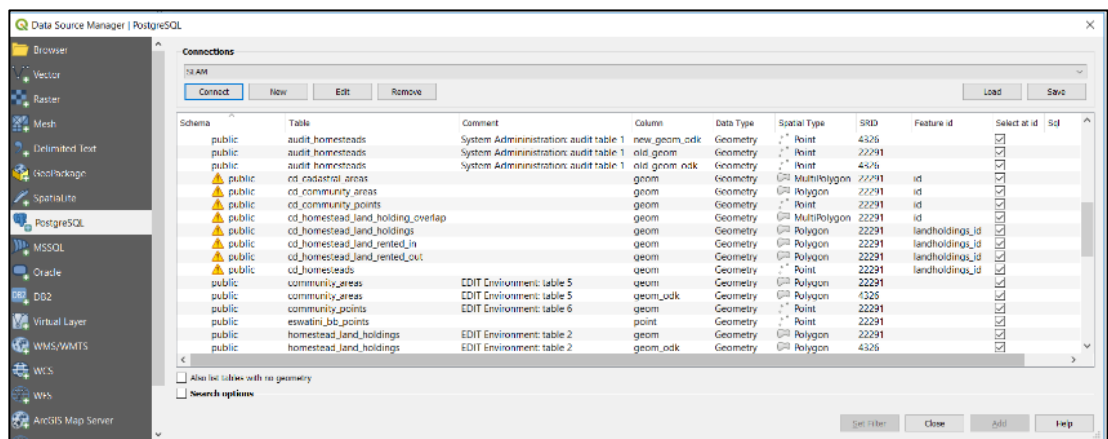
On subsequent occasions your credentials should be remembered by QGIS.

- > After the connection is established, the window will list the data schemas. Click the arrow next to the schema name to display the tables in each category.
  - > boundaries – these show layers such as the regions and tinkhundla.
  - > odk\_prod – dedicated to collected field data.
  - > osm – is open street map, with a copy of Open Street Map data from beginning 2018, primarily to support field and office work.
  - > public – these are the data layers and views of the data
  - > reports – these are views and saved queries for report purposes.





Opening the public schema will reveal various tables and views. The layers prefixed 'cd\_' are for 'chiefdom data' and 'v\_odk\_' for views of the collected data.



- > Manually select the layers that you want you want to appear in the QGIS map window.

## Appendix D Database Administration

### 1 Connect to the Server

- > Connect to the SlamDataCollection network.
- > Start Remote Desktop

Adding and changing (the rights of) users can be done “manually” via pgAdmin, but the easiest would be to use the **database administration** section of the plugin.

### 2 Using **database administration** section of the plugin

- > Start the plugin
- > Check/provide login details (for a user with **slam\_administration** right).
- > **Test Connection** with these login credentials.
- > Go to Database Administration and select database function “**Set User**”.
- > Check/Provide Parameter Values:
  - > Database **user**: following naming convention: lastname and first initial, all in lowercase, e.g. *johnsons*.
  - > **Password**: note that the password here will be visible, but not during a normal logon to the database.
  - > Database **role**; *slam\_read* [read only use], *slam\_edit* [for edit environment], and *slam\_admin* [for performing db functions].
  - > Revoke **right**: true; undoing all rights that might have been previously *ad-hoc* provided.
  - > **Comment**: will be stored in the database for administration purposes.

Note that the same function can be used to update an existing user, e.g. to update password or database role.

Select the database function to execute...

	Name	Required Role
1	Assign Landholdings numbers	slam_admin (slam_admin)
2	Get database time	slam_read (PUBLIC)
3	Set user	slam_admin (slam_admin)
4	List project layer styles	slam_read (slam_edit)

Set parameters for function 'Set user'

	Parameter	Datatype	Value	Instruction
1	Database User	character varying	lastnameinitial	
2	Password	character varying	123	
3	Assigned Database Role	character varying	slam_read	Options: slam_read, slam_edit, slam_admin
4	Revoke rights	boolean	true	Revoke all rights before reassigning (this will affect manual
5	User comment	text	this is a edit user	Comment to db user, stored in db

Execute function 'admin\_set\_user'

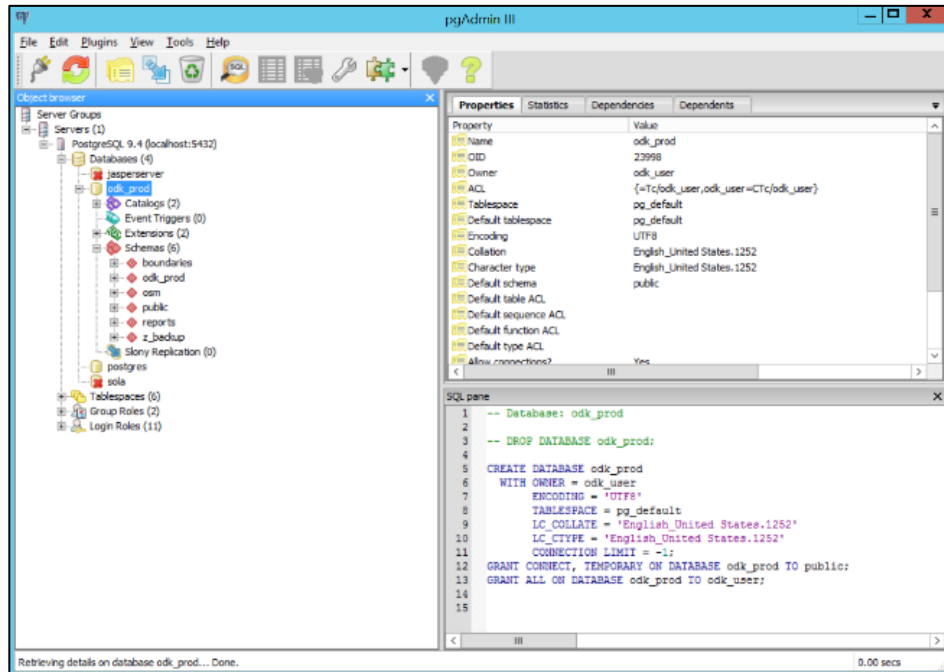
```
User 'lastnameinitial' created; comment added; all rights revoked; role
slam_read assigned
```

### 3 Assign Landholdings Numbers

The database administration function to assign landholdings\_id numbers is described in 4.5 on page 50.

### 4 Using pgAdmin

- > Start pgAdmin and connect to the odk\_prod database.



To load and run SQL scripts:

- > Tools > Query tool > Open file (or enter/copy/paste SQL statement)

To create a user with edit rights:

- > Type in the following SQL script...

```
select admin_set_user('trumpd', 'americalst', 'slam_edit', true, 'read only user Donald Trump', false)
```

To change the same user to read\_only rights (or to create the user as such):

```
select admin_set_user('trumpd', 'americalst', 'slam_read', true, 'read only user Donald Trump', false)
```

To change the user password:

```
select admin_set_user('trumpd', 'america2nd', 'slam_read', true, 'read only user Donald Trump', false)
```

OR

```
Alter user trumpd WITH password 'america2nd'
```

To delete a user:

```
DROP ROLE IF EXISTS trumpd
```

## 5 Automatic Server Tasks (Task Scheduler)

In the operating system Windows Server 2012, a program Task Scheduler is available, which allows administrators to define server tasks that will run at set intervals. These tasks are based on batch files as depicted below:

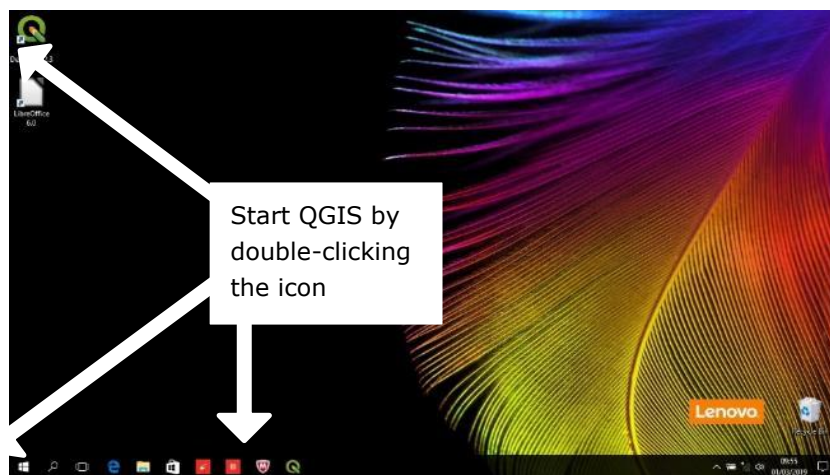
- > **ServerTask\_backup\_odk\_prod\_database.bat**: runs the executable *pg\_dump.exe*, which creates a backup of the *odk\_prod* database, resulting in a file containing all data, its name labelled with database and date, e.g. *odk\_prod\_20190319.backup*.
- > **ServerTask\_odk\_to\_slam\_automatic.bat**: runs a database stored function *odk\_to\_slam\_automatic*, which copies the collected information from mobile devices in the ODK Aggregate database (schema *odk\_prod* inside the database *odk\_prod*) to the edit environment (schema *public*).
- > **ServerTask\_refresh\_materialized\_views.bat**: runs a SQL command for refreshing the materialised views.

## Appendix E Chiefdom LIMS User Guide

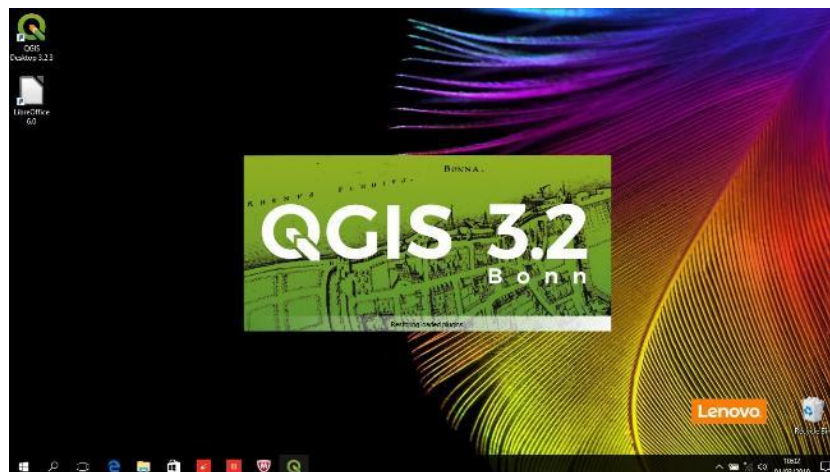
Landholding data is provided 'off-line' to each chiefdom. A subset of the SLAM database is copied and stored on the chiefdom laptop computer. An Internet connection is not necessary for viewing and querying a chiefdom's landholding data.

Chiefdom data is made available on the laptop for user SLAM. There is no password for this user.

The software for viewing and querying chiefdom landholdings is QGIS 3.2. The software application is started by double-clicking the QGIS icon on the desktop, start menu or taskbar.



QGIS software will appear with a start-up screen. Note if you are using QGIS version 3.4 a slightly different start-up screen to the one below will appear.

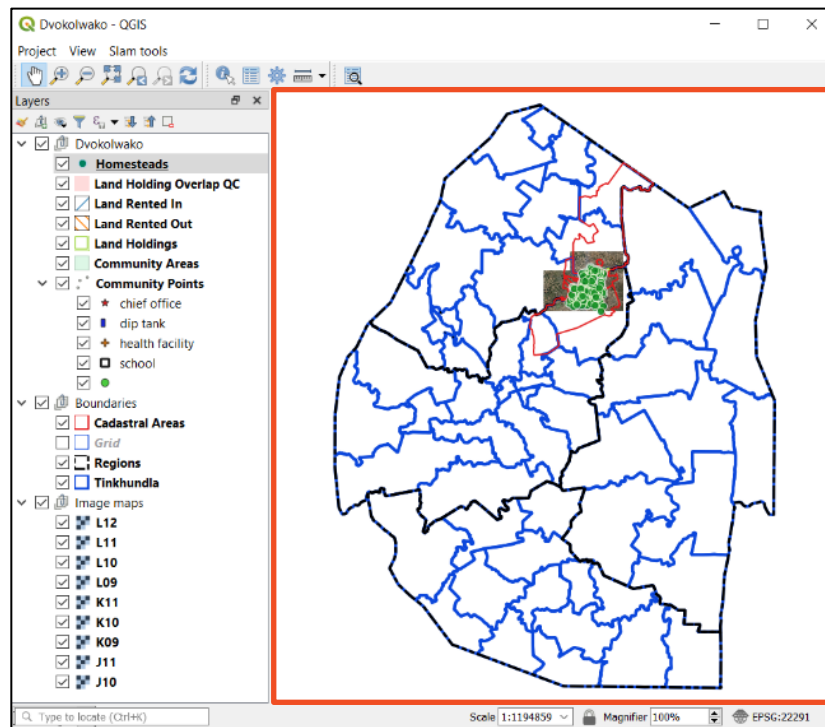


The user interface for QGIS has been customized to remove all functions other than those needed for viewing and querying the data.

The components of the user interface are indicated and described below:

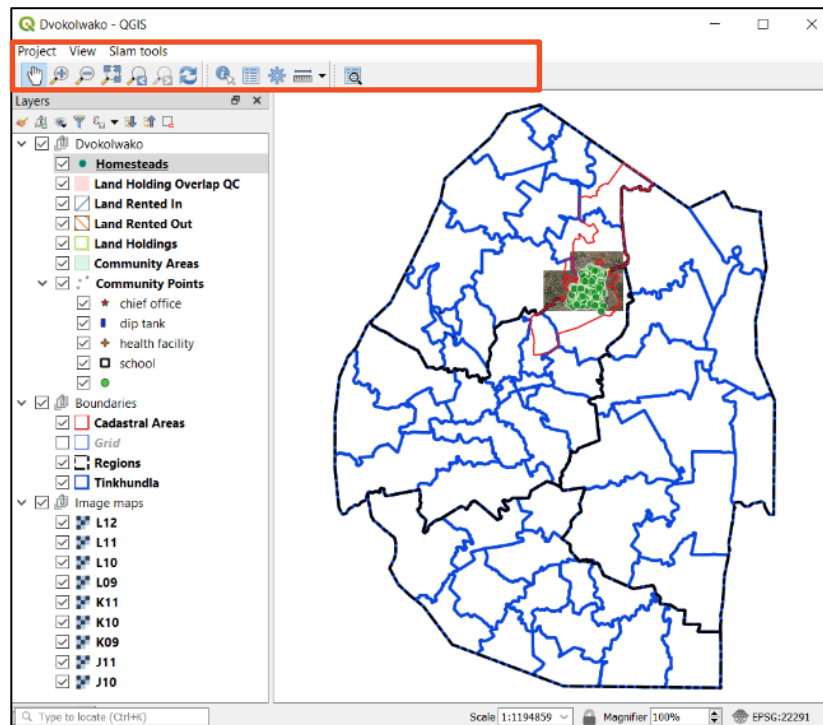
### Map Window

The main part of the screen (outlined in red below) is called the 'map window'. Tools to navigate the map are available in the menu bar and the input device (e.g. mouse) buttons (e.g. mouse wheel zooms in and out).

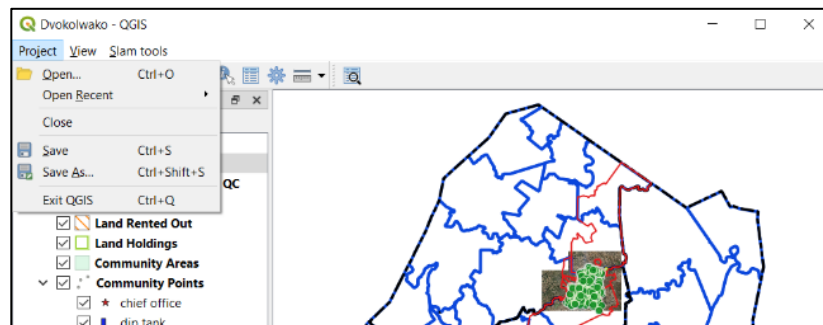


## Menu bar

- > The menu bar has both 'drop-down' sub-menus and function icons.



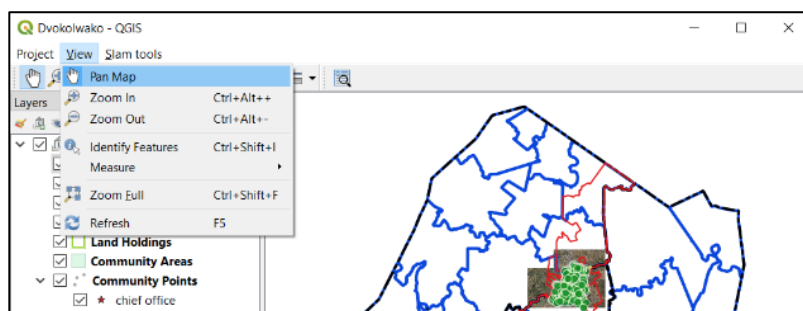
- > Clicking on [Project] will drop down a sub-menu. The top item [Open] will open a project data file but this is not needed because QGIS always opens project data.



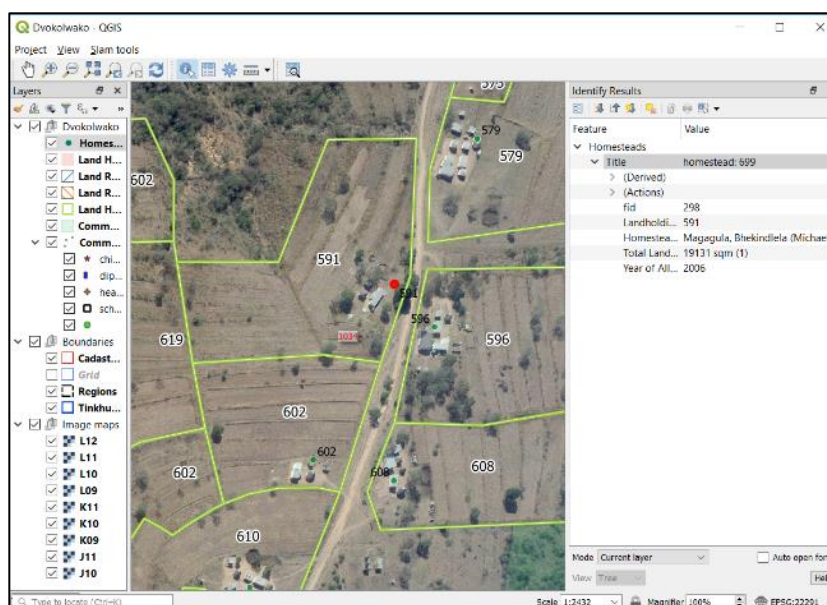
- > [Close] will close the project data file and return QGIS to the Recent Projects List. Double-click the project bar to return to viewing data.
- > [Save] will save any changes, but because changes cannot be made, nothing will be saved.
- > [Exit QGIS] closes the software.
- > The [view] sub-menu provides tools for panning and zooming the map window.
- > [Pan map] changes the cursor into a hand so that the map can be moved around in the window.



- > [Zoom in] and [Zoom out] make the map view bigger and smaller. Clicking once with the magnifier tool will zoom in a set amount. Clicking, holding and dragging the cursor will create a zoom window.



- > The [Identify feature] tool reveals attribute text data about a homestead or landholding.

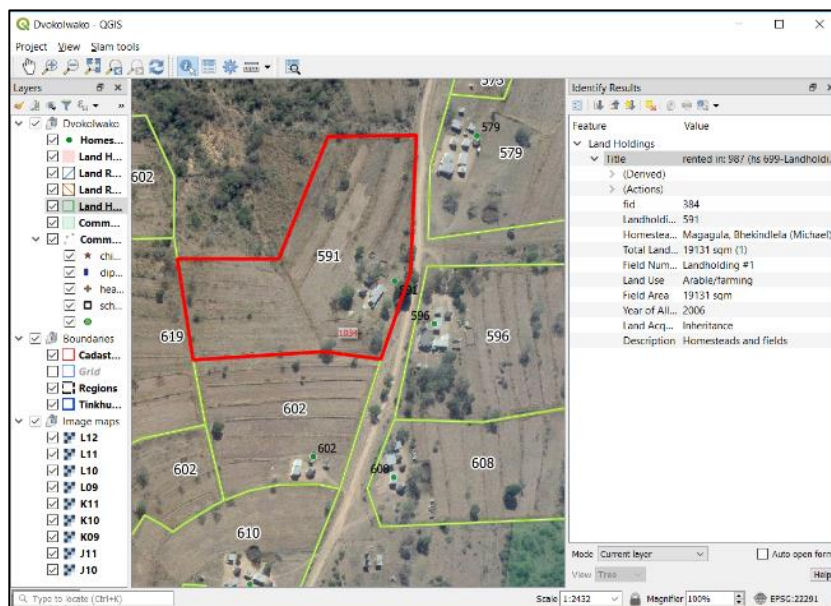


However, to reveal data about a homestead, the homestead layer in the left panel must first be selected and highlighted. By clicking the arrow point cursor on the green dot, which represents the homestead, will open a new window revealing data about the name of the homestead head, the area of land, and year of allocation. The homestead selected will appear in the map window with a red dot.

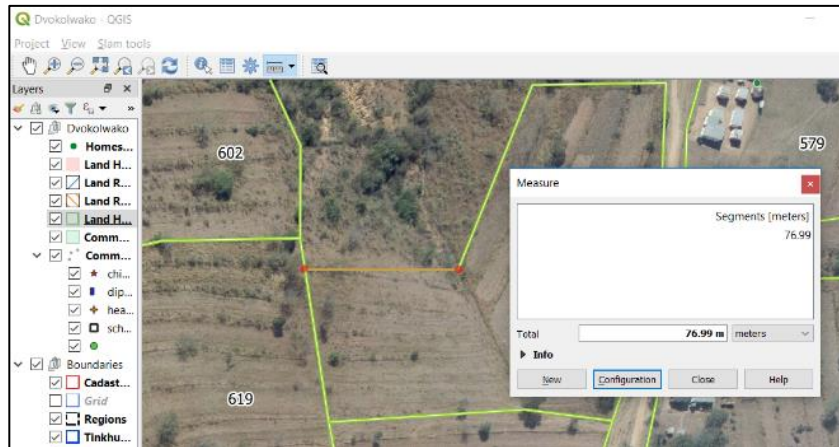
- > To reveal information about the landholding or homestead fields, first select and highlight the landholdings layer in the layers panel, then select anywhere inside the landholding shape. The landholding selected will be highlighted with a red boundary.
- > Similarly, selecting and highlighting the land rented in layer will enable features on that layer to be viewed and data revealed.
- > Clicking where there isn't a feature on the selected layer will show no results in the data window. However, clicking a feature when all the data layers are revealed will list all those layers in the attributes window. Click the right-arrow (>) to open the layer data.

Feature	Value
Homesteads	
Title	homestead: 948
(Derived)	
(Actions)	
fid	543
Landholdings Id	235
Homestead Head	Maseko, Msongelwa (Absolom)
Total Landholdings Area (amoun...	22579 sqm (1)
Year of Allocation	1980
Land Holdings	
Title	rented in: 1295 (hs 948-Landhold...
Cadastral Areas	
Regions	
Tinkhundla	
5	K09

- Other tools are available for revealing more information about a landholding and searching on specific attributes, such as a person's name.

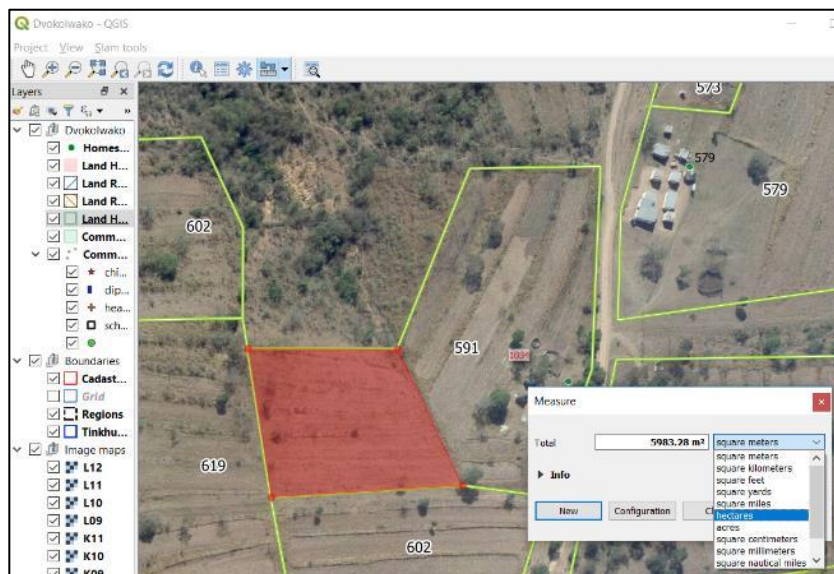


- To close / put away the identify results window, click on the in the top right corner of the identify results window box. Be careful not to click the uppermost in the main window as this will close the QGIS program. If the layers window is closed accidentally, it can be brought back by pressing the [Ctrl] key and [1] key at the same time.
- The [measure] tool shows the distance between two points identified by a cursor click.



In the above example, the distance between the two red dots that were clicked with the cursor is 76.99 metres.

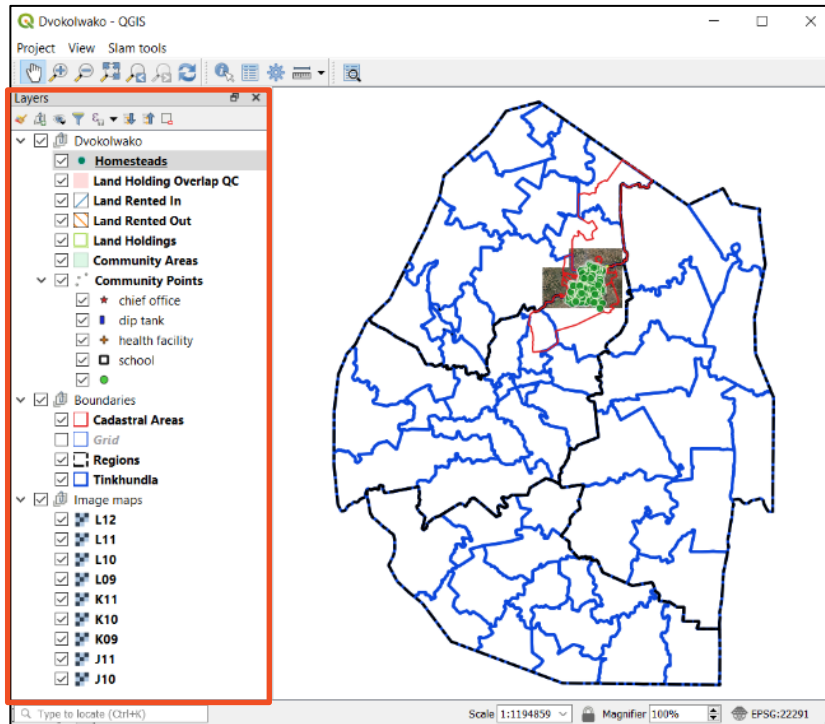
- > Similarly, an area can be measured. Identify each point around the area in turn and right-click when finished to show the highlighted area in square metres. If needed, the area units can be changed by clicking the down arrow on the unit box.



- > [Zoom full] will return the map window to its full zoomed out extent.
- > [Refresh] will update the current view and clear any highlighting.
- > The [SLAM tools] menu as only one option at the current time, which is Search Chiefdom Layers.

### The Layers Panel

The layers panel shows the contents of the map window. A tick ✓ in the box next to the layer name means that the map data in that layer appears in the map window. Layers can be turned on and off by clicking the cursor inside the tick box.



The layers panel is also a *legend* that reveals how map data are shown. For instance, homesteads are shown as a green dot, landholdings as empty green shapes, community areas as semi-transparent green areas.

Where two landholdings overlap, often meaning that both homesteads think they hold the same land, the overlapping area is highlighted in semi-transparent red.

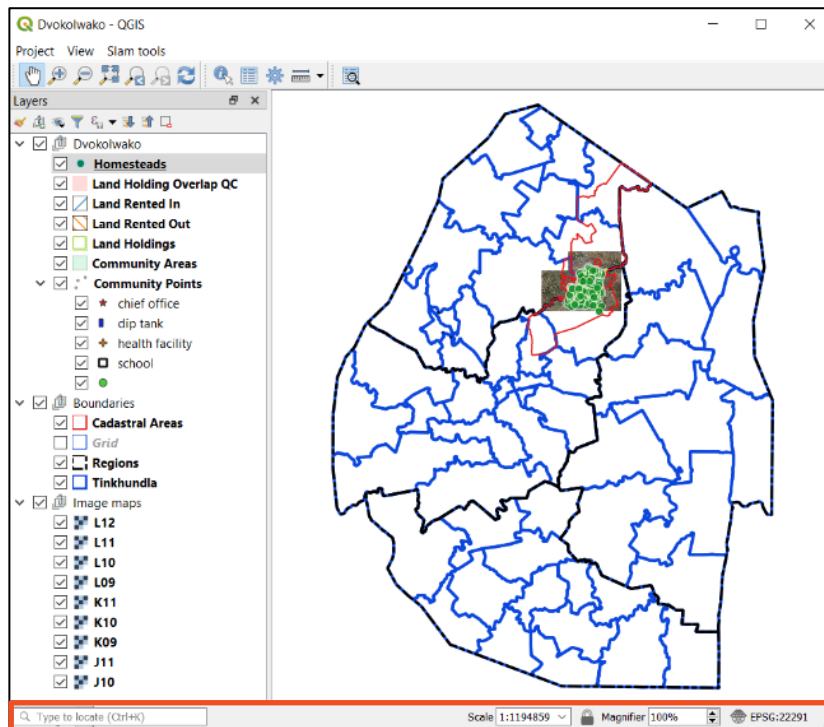
Land rented or borrowed from others is shown with diagonal blue cross-hatched lines, and land lent out to others by diagonal orange lines. Note that not all land lent out is shown with a corresponding borrowed from, or vice versa. This is because some homesteads have not revealed, or they forgotten they borrow in or out some of their land.

The boundaries layer group shows *tinkhundla* as areas bounded by blue lines and cadastral areas bounded by red lines. All tinkhundla are shown but only the cadastral areas in the vicinity of the chiefdom. Cadastral areas include SNL as well as TDL. The Surveyor General's Department have assigned numbers to all cadastral areas, SNL and TDL farms. Therefore, the red numbers do not necessarily infer that the cadastral area is a farm.

The layer called **grid** which is turned off by default shows all the orthophoto maps available at the Surveyor General's Department. Some of these maps, which cover the chiefdom, are included and listed in the image maps group of layers.

## Status Bar

The bottom of the QGIS window is called the *status bar*.

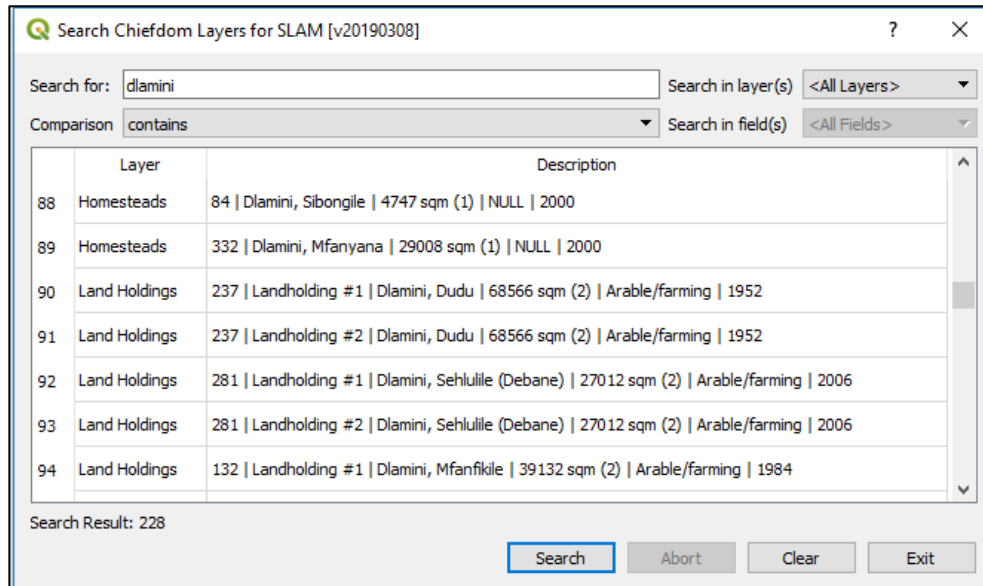


The search box [Type or locate] is not used. The scale box shows the map window scale ratio. Magnifier zooms in or out without changing the map scale. EPSG is a code for how the map data is shown, and like the other items in the status bar, is not important.

Finally, in the top right hand corner of the QGIS window are three shapes. These are standard to all Microsoft computer programs. Clicking the dash – will minimise the QGIS window and place it on the laptop's desktop status bar (at the bottom of the laptop screen). Clicking the □ box will maximise the QGIS window to the whole laptop screen. Clicking the ✕ will close the QGIS software.

## E.1 Plugin Search Chiefdom Layers

[[Search chiefdom layers](#)] allows landholding attribute text data to be revealed by searching for specific text, such as person's name.



A search box will open. Type the text to search in the [[Search For](#)] box. The search can be made on all layers, as in the example above, or restricted to specific layers and if a search layer is defined [[Search in Layer](#)], the search can be more specific to the type of data or [[Search in Field](#)].

Clicking the [[Search](#)] button reveals all data records that match the search criteria, and in the case above, all records with "Dlamini" in one of the fields of the layer.

Highlighting (clicking) the a result line in the box will automatically pan and zoom the map window to the location of the selected line. If result in layer "Homesteads" is selected, the map will **pan** to the homestead point (dot), which will be highlighted in yellow. If a result in layer "Land Holdings" is selected, the map will **zoom** to the field area, highlighted in yellow.

The search criteria [[Comparison](#)] provides for more detailed searches and results. The default option is **contains** meaning any text that contains the [Search For] text will be found. If **=** is used, the search is much more exact on complete content begin equal to the [Search For] text. The third option **begins with** shows only results where the text begins with these characters entered in the [Search For].