GEODETIC ENGINEERS OF THE PHILIPPINES

REGIONAL DIVISION III

45th ANNUAL REGIONAL CONVENTION

Land Sector Modernization
Cadastral Survey Records Reconstruction
(LandS Mode: CadSRR)

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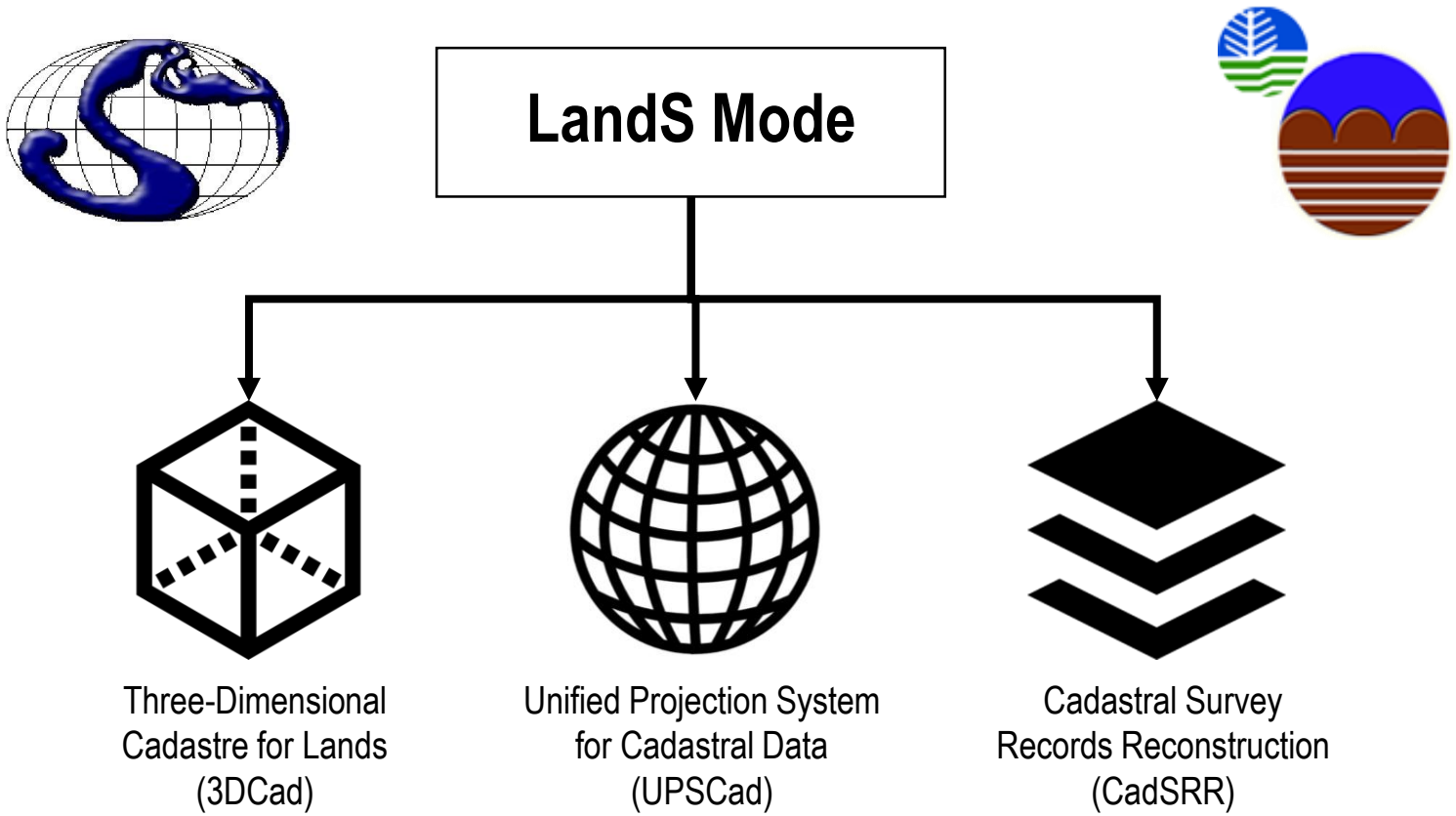
GeoSurvLAV

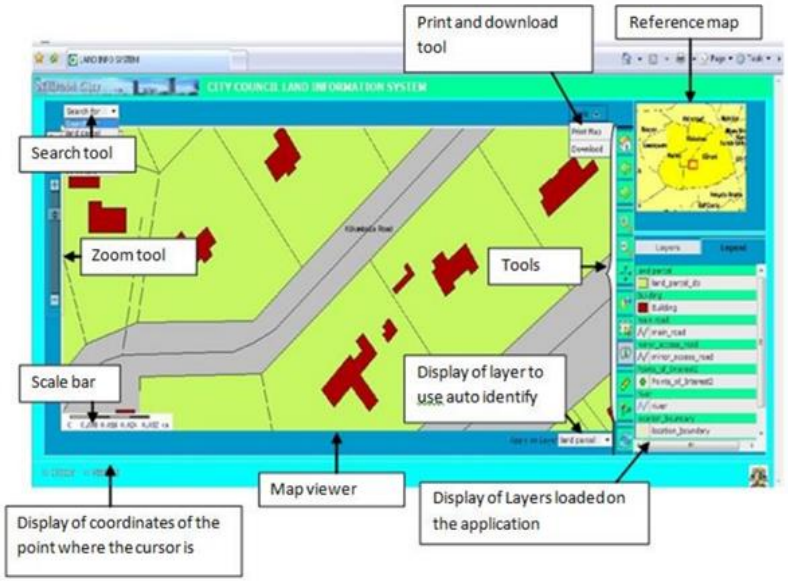
LandS Mode


LandS Mode
Three-Dimensional Cadastre for Lands (3DCad)
Unified Projection System for Cadastral Data (UPSCad)
Cadastral Survey Records Reconstruction (CadSRR)

CADSRR: Objectives

- Come up with processes and methodologies in the Cadastral data reconstruction activities
- Use GIS-Based software in handling and processing lot data

CADSRR: REx



NAIROBI City LIS (Kenya)

- QGIS was employed to process data and create the digital map.
- Output were stored into a database created using PostgreSQL and PostGIS. The database provides tools for data updating and visualization.
- The system contained information on parcel ownership, land use, taxation, location boundary, land value, encumbrance, etc.

CADSRR: REx

Cadastral Survey Reconstruction (Kosovo)

- The graphical cadastral data was compared with the alpha-numeric data in relation to the presence or completeness of the documents based on the:
  - *No. of parcels in the graphical evidences*
  - *No. of parcels in the textual evidences*
  - *No. of parcels that are not recorded or documented in the registries (but exists in the locality).*

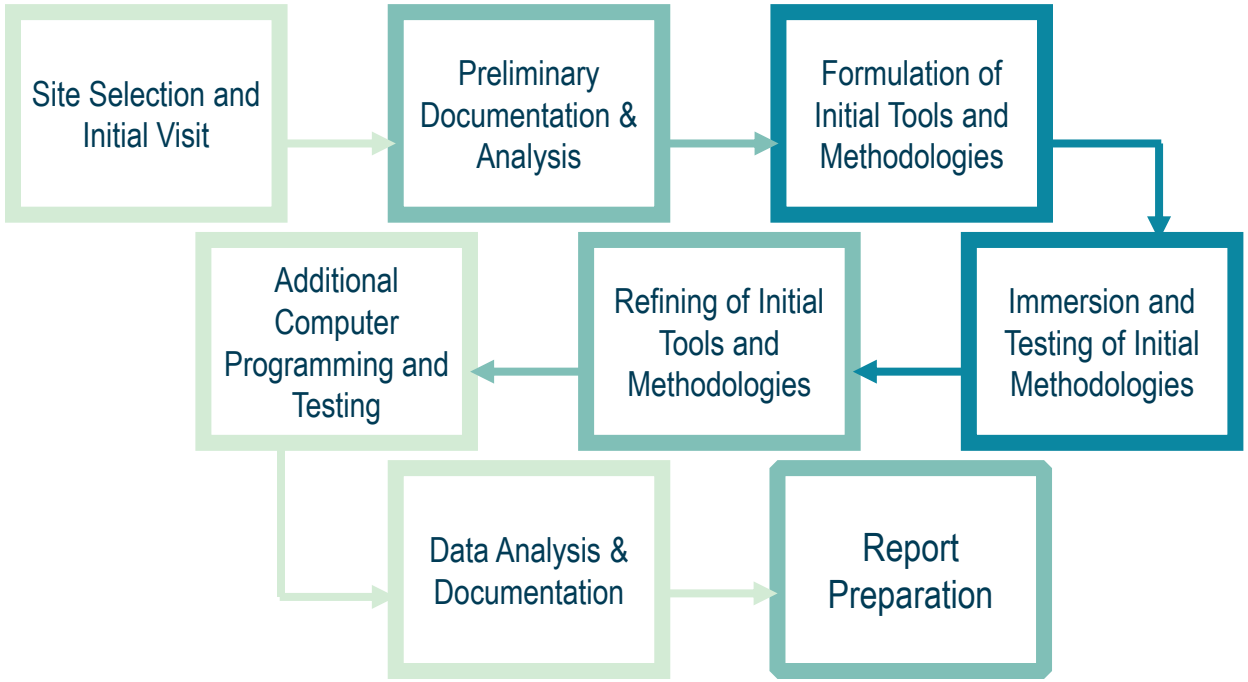
- The georeferencing and vectorization of scanned cadastral maps were done using a GIS software.

CADSRR: REx

National Land Records Modernization Programme (India)

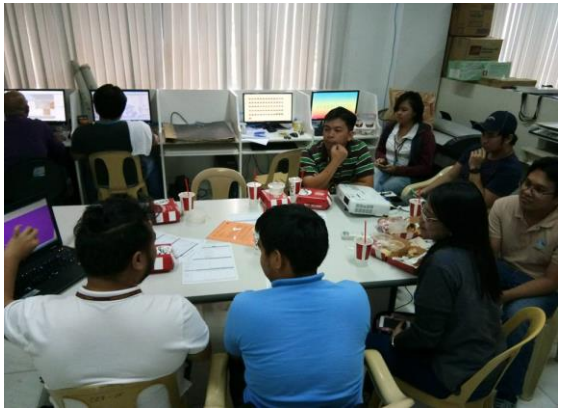
- Includes automation/resurvey of cadastral maps using modern cadastral techniques.
- Land records data are available as (a) textual data, and (b) spatial data (cadastral maps).
- Existing paper maps converted into GIS-ready digital format and then integrated with corresponding textual data.
- Cadastral Survey/Resurvey were carried out using modern surveying technologies namely GPS/ETS, high-resolution satellite imagery and aerial photogrammetric approach depending up land terrain and existing map.

CADSRR: Methodology



CADSRR: Immersion

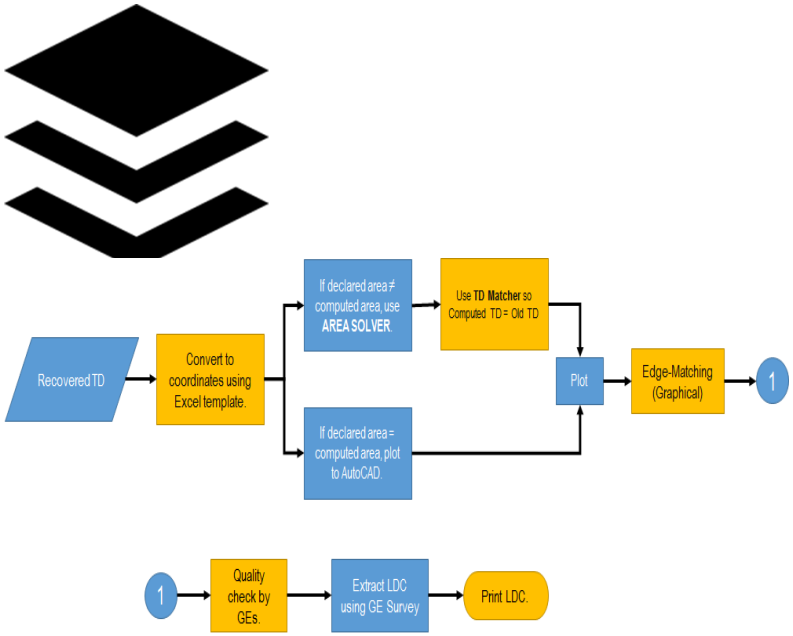
- Familiarize and review the current practices in the survey records reconstruction of the selected Regional Offices.
- DENR Regional Offices: III, NCR, CALABARZON & MIMAROPA



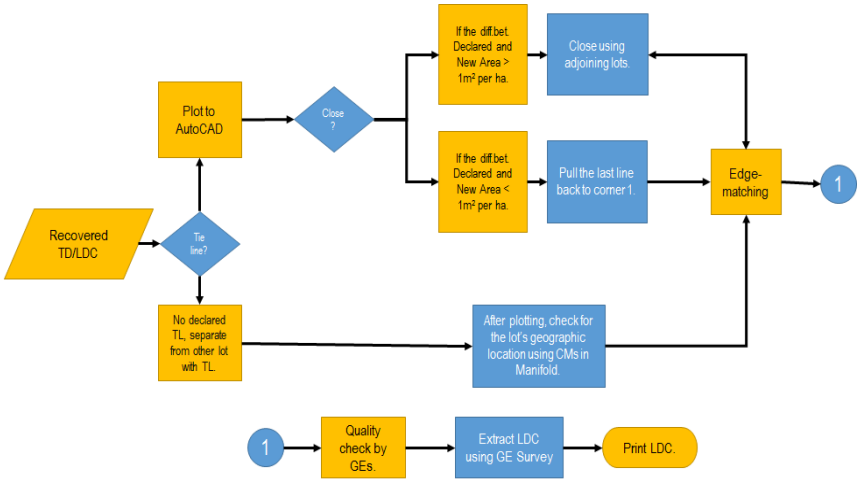
CADSRR: Immersion

- Consultation with LMB-LAMS

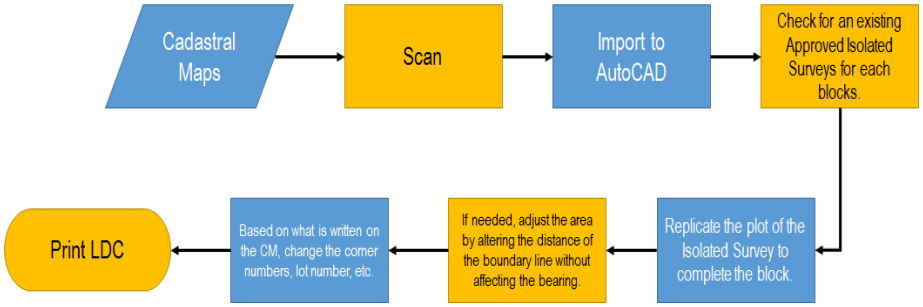
CADSRR: Immersion



Region III



CALABARZON



NCR

CADSRR: Immersion

RECONSTRUCTION ACTIVITIES PER REGION				
	III	**CALABARZON**	**MIMAROPA**	**NCR**
Data	Bearing-distance data, Coordinates	Bearing-distance data, Coordinates, Cadastral and Projection Maps	Coordinates from LMB and Private GEs	Bearing-distance data, Coordinates of Cadastral Lots
Encoding/Plotting	Excel → AutoCAD	AutoCAD	AutoCAD	AutoCAD (GE Survey)
Error of Closure	Adjustments with the aid of Excel	Graphical Adjustment (allowable area difference must not exceed $1m^2/ha$)	-	Graphical Adjustment (allowable linear error of closure must not exceed 0.01m)
Edge Matching	Area Solver, TD Matcher Adjustments in Excel	Adjustments in Manifold (CMs, PMs and DCDB as basis)	-	Adjustments in AutoCAD (Approved isolated surveys as basis)

Disclaimer: Data was collected during the months of March, April and May of 2018

CADSRR: Immersion

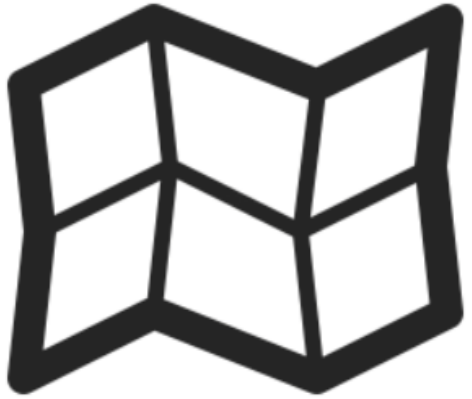
RECONSTRUCTION ACTIVITIES PER REGION				
	III	**CALABARZON**	**MIMAROPA**	**NCR**
Strengths	Systematic way of reconstructing lots	Fast-paced work for reconstruction of lots	Local GEs providing them with data containing coordinates	Old Cadastral Maps contain distances and bearings for lot lines
	Always aim to return the same technical description with respect to its source	Utilizes Manifold for observation of Cadastral Maps overlaid by the lot data		Use of database for linkage of reconstructed lots
Weakness	Tedious and lengthy procedure	Technical description does not always match from its sources	Reconstruction is still limited to data obtained from Lot Data Computation Sheets	Limited data

Disclaimer: Data was collected during the months of March, April and May of 2018

CADSRR: GIS Based Solutions

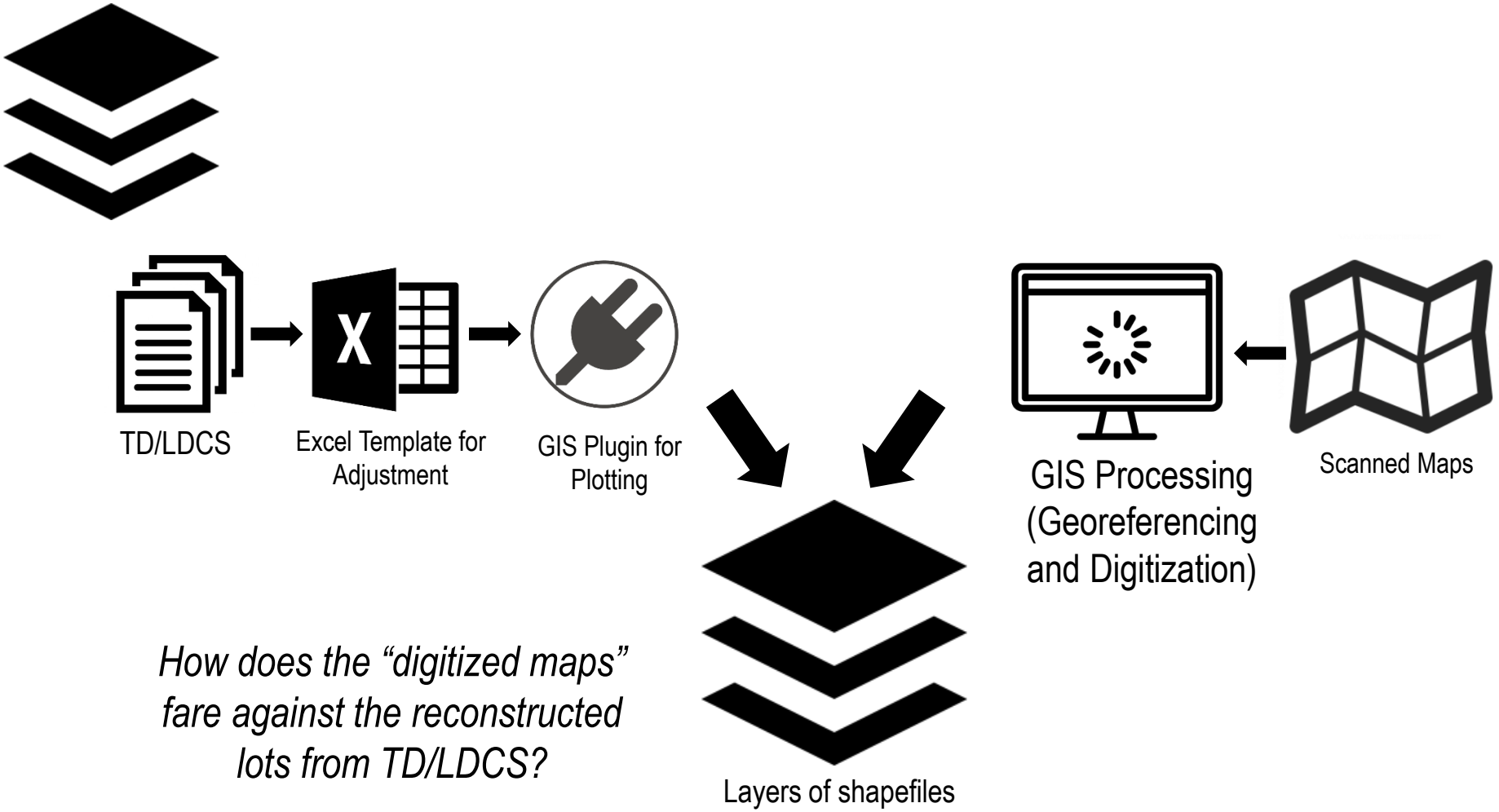
Coordinate Data (Lot Data Computation Sheet)

Bearing-Distance Data (Technical Description)



Scanned Maps (Cadastral Maps, Projection Maps, etc.)

CADSRR: GIS Based Solutions

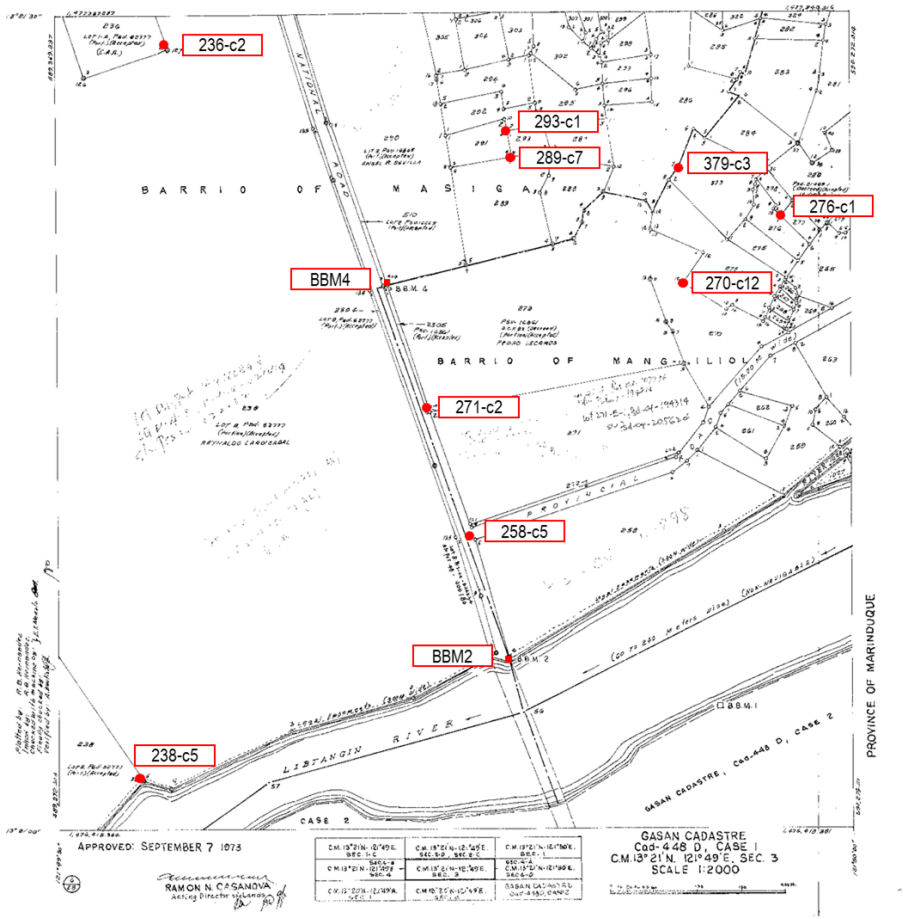


How does the "digitized maps" fare against the reconstructed lots from TD/LDCS?

CADSRR: Analysis

GEOREFERENCING

Points	Lot Data Computation Sheet	
	N	E
BBM2	1476608.930	589882.670
BBM4	1477033.020	589745.120
293-c1	1477206.530	589882.110
276-c1	1477110.590	590193.910
236-c2	1477299.590	589495.710
258-c5	1476744.990	589844.570
379-c3	1477165.700	590076.940
289-c7	1477176.440	589886.520
270-c12	1477034.490	590081.490
271-c2	1476889.370	589793.880
238-c5	1476471.52	589469.42



Analysis of Georeferencing Techniques available in QGIS

CADDSRR: Analysis

GEOREFERENCING

Transformation Model	Position Error (m)			Error < 1 m (out of 113 pts)
	Highest Value	Lowest Value	Mean	
HELMERT	5.912	0.255	2.374	10
LINEAR	4.775	0.092	1.321	62
1ST POLYNOMIAL	**4.693**	**0.082**	**0.795**	**84**

Analysis of Georeferencing Techniques available in QGIS

CADSRR: Analysis

DIGITIZATION

Area	Gasan, Marinduque	Manila
Images Provider	DENR-R4B	DENR-NCR
No. of Images	3	2
No. of Features	128 Features	266 Features
Scale	1:1000 and 1:2000	1:500

Accuracy check of Digitized Lots from Cadastral Maps

CADSRR: Analysis

DIGITIZATION

Accuracy check of Digitized Lots from Cadastral Maps

Table for the Digitized Features in Gasan Cadastre			
% Error Range			Frequency
0.00%	-	0.01%	1
< 0.01%	-	0.05%	1
< 0.05%	-	0.10%	2
< 0.10%	-	0.25%	8
< 0.25%	-	0.50%	12
< 0.50%	-	1.00%	23
< 1.00%	-	2.50%	30
< 2.50%	-	3.00%	8
< 3.00%	-	3.50%	10
< 3.50%	-	4.00%	4
< 4.00%	-	4.50%	4
< 4.50%	-	5.00%	3
< 5.00%	-	7.50%	11
< 7.50%	-	10.00%	7
<10.00%	-	12.50%	0
<12.50%	-	15.00%	1
<15.00%	-	17.50%	2
<17.50%	-	100.00%	0

- As per DAO 2007-29, the 1 square meter per 1 hectare error corresponds to 0.01% error.
- 2 out of 128 lots near the allowable error.

- Average of **2.69% for 1:1000 and 1:2000 Scaled Cadastral Maps**

**Comparison of error is between the computed area per reference system and the declared area*
***Although some lots' declared area were changed to their computed area from the coordinates of the lot*

CADSRR: GIS Based Solutions

DIGITIZATION

Accuracy check of Digitized Lots from Cadastral Maps

Table for the Digitized Features in San Lazaro Estate			
% Error Range			Frequency
0.00%	-	0.01%	1
< 0.01%	-	0.05%	8
< 0.05%	-	0.10%	5
< 0.10%	-	0.25%	23
< 0.25%	-	0.50%	31
< 0.50%	-	1.00%	69
< 1.00%	-	2.50%	100
< 2.50%	-	3.00%	10
< 3.00%	-	3.50%	10
< 3.50%	-	4.00%	3
< 4.00%	-	4.50%	2
< 4.50%	-	5.00%	2
< 5.00%	-	7.50%	1
< 7.50%	-	10.00%	0
<10.00%	-	12.50%	0
<12.50%	-	15.00%	0
<15.00%	-	17.50%	1
<17.50%	-	100.00%	0

- As per DAO 2007-29, the 1 square meter per 1 hectare error corresponds to 0.01% error.
- 9 out of 266 lots to be near the allowable error.
- With an average **of 1.28% for 1:500 Scaled Cadastral Map**

Although, Manila Cadastre has no LDCS, areas are indicated on the Cadastral Map, therefore, comparison was still provided.

**Comparison of error is between the computed area per reference system and the declared area*
***Although some lots' declared area were changed to their computed area from the coordinates of the lot*

CADSRR: Outputs

- Data Templates
- GIS Procedures in Reconstruction
- Plugins
- Training Modules

CADDSRR: Outputs

Data Templates

- Regional offices encode two kinds of textual data as part of their survey reconstruction activities
  - *coordinates from lot data computation sheets*
  - *bearing-distance data from technical descriptions*

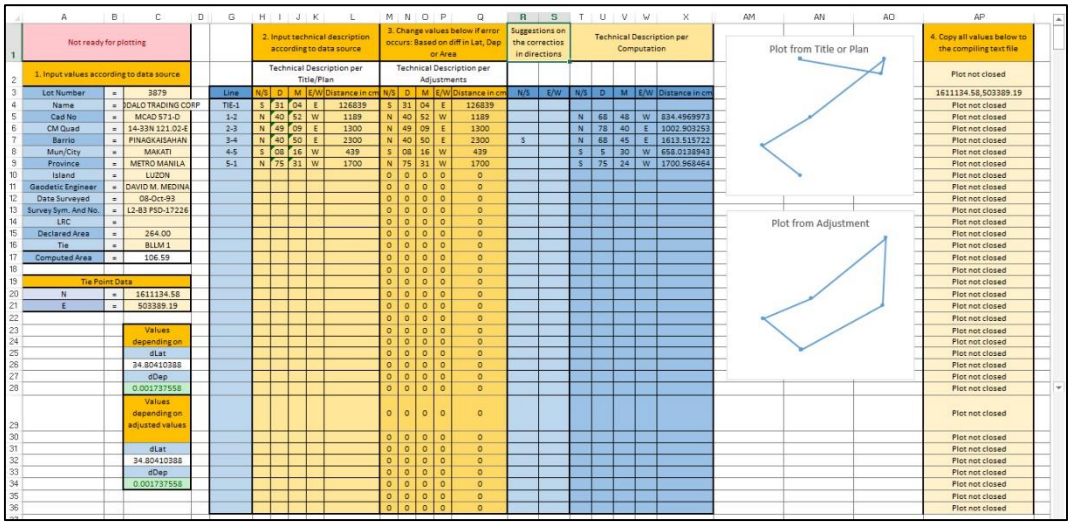
- Developed two spreadsheet templates for these data which can also perform accuracy checks.
  - *Bearing-Distance Template*
  - *Coordinates Template*

CADSRR: Outputs

Data Templates: Bearing-Distance

- If the Linear Error of Closure is greater than the **user-defined tolerance**, an error message will appear and corrections should be done to close the lot.

- The template will produce a new technical description with adjusted values and also some suggested corrections in the directions.



CADSRR: Outputs

Data Templates: Coordinates

- This template is from the lot data computation used by the DENR Regional Offices, which is an input for one of the plugins

LOT DATA COMPUTATION

INSTRUCTIONS:

1. Enter required data in the yellow colored cells.
2. Compare declared area with computed area for error checking.

Lot No.	=	320
Owner	=	Salazar, Gregorio
Cad Survey No.	=	CAD-448-D C-1
CM Quadrangle	=	13-15 N 121-49 E
Barrio	=	Masiga
Mun / City	=	Gasan
Province	=	Marinduque
Island	=	Marinduque
Geodetic Engr.	=	Almar Surveying Co
Date Surveyed	=	4/25/1972
Surv. Sym. & No.	=	CAD-448-D C-1
L.R.C. No.	=	
Declared Area	=	3598.43

TIE POINT DATA:

BLLM 1	=	1,473,735.420	N
		591,590.850	E

NO.OF CORNERS: 5

ERROR CHECKING:

DOUBLE AREA	2,043.99
AREA	1021.99615

ACCURACY STANDARDS:

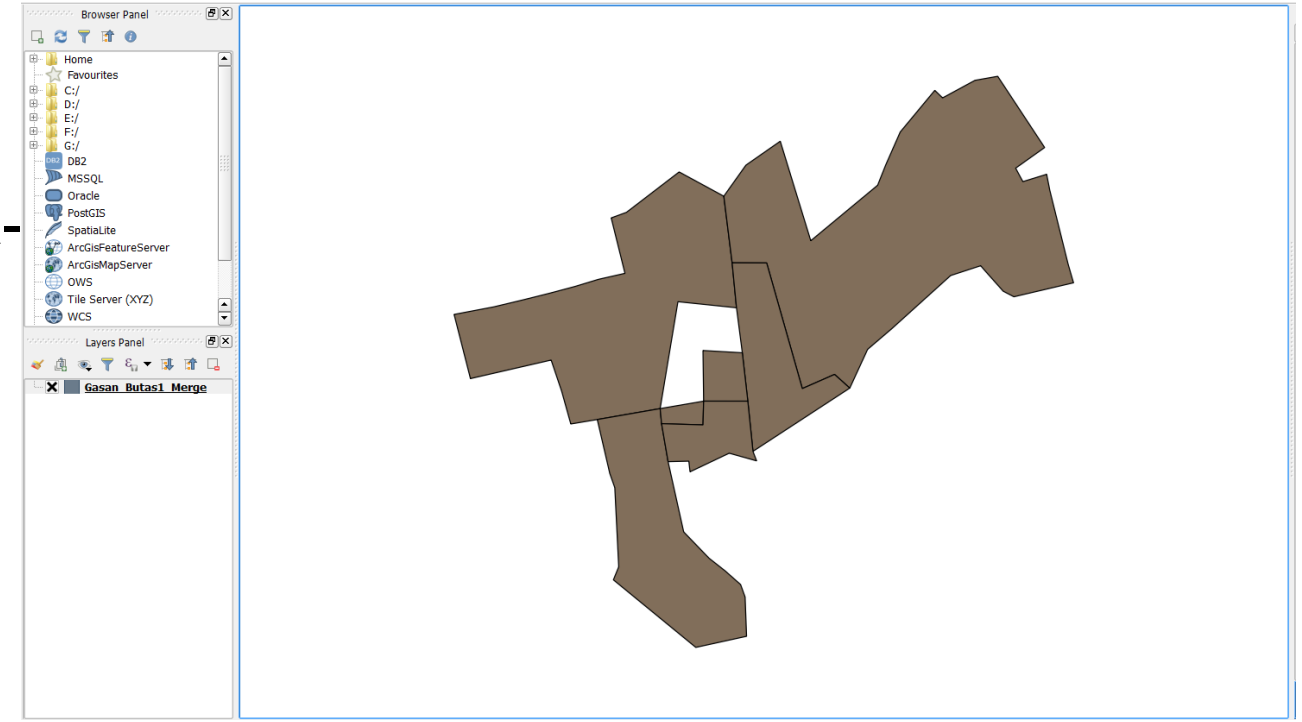
L.E.C.	0.002451267
R.E.C.	67,862
ACC	1 : 68000

STATIONS	COORDINATES		TECHNICAL DESCRIPTION					REMARKS	LAT	DEP	AREA COMPUTATION			For Plotting
	NORTHINGS	EASTINGS	DISTANCES	BEARINGS							LINE	DMD	DPA	
ERROR CHECK			166.35	N/S	DEG	MIN	E/W		0.00	0.00				
BLLM 1	1,473,735.420	591,590.850	4007.77	N	22	09	W	area dicrepancy	3712.00	-1511.06	BLLM 1 - 1			320
1	1,477,447.620	590,080.280	48.36	N	49	03	E		31.70	36.53	1 - 2	-31.69	1,157.64	590080.28,1477447.62
2	1,477,479.310	590,116.810	19.11	N	71	46	E		5.98	18.15	2 - 3	-69.36	1,258.88	590116.81,1477479.31
3	1,477,485.290	590,134.960	2.63	S	41	55	E		-1.96	1.76	3 - 4	-73.38	129.15	590134.96,1477485.29
4	1,477,483.330	590,136.720	73.38	S	39	41	W		-56.47	-46.86	4 - 5	-14.95	-700.56	590136.72,1477483.33
5	1,477,426.860	590,089.860	22.86	N	24	46	W		20.76	-9.58	5 - 1	20.76	198.88	590089.86,1477426.86

CADSRR: Outputs

GIS Procedures in Reconstruction: Filling Shapefile

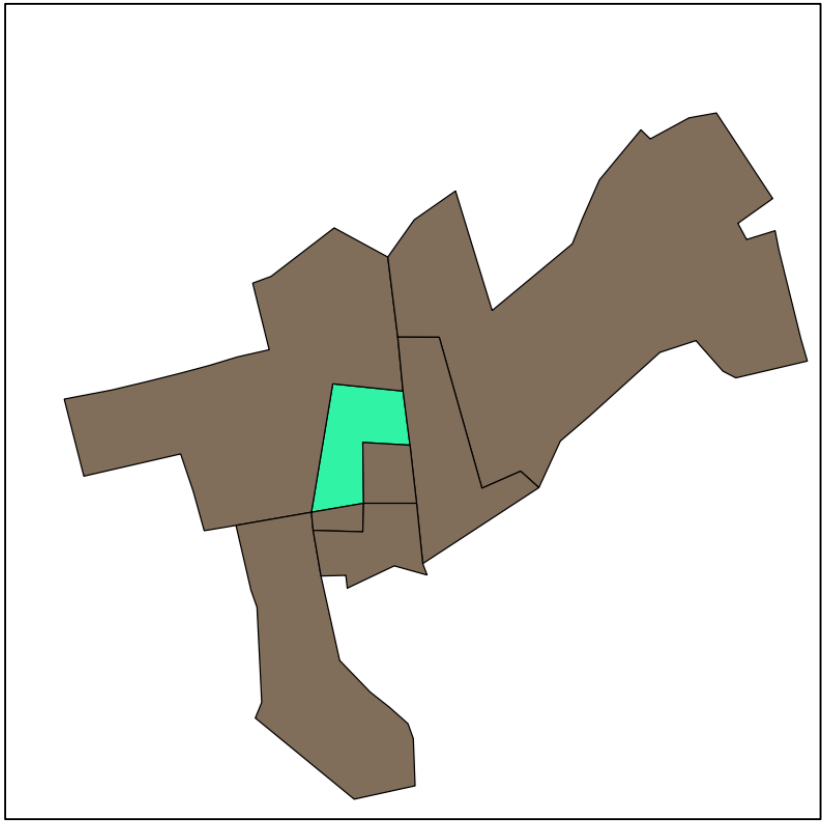
- Manual on filling a missing feature on a shapefile using built-in tools in QGIS.



CADSRR: Outputs

GIS Procedures in Reconstruction: Filling Shapefile

- Disclaimer:
  - There should be **no gaps** in between adjoining features, unless, it is the missing lot.
  - The filled lot is the **cluster of the missing lots.** If identified to be one missing lot, the filled lot is the missing lot.



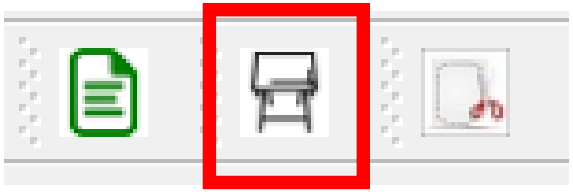
CADSRR: Outputs

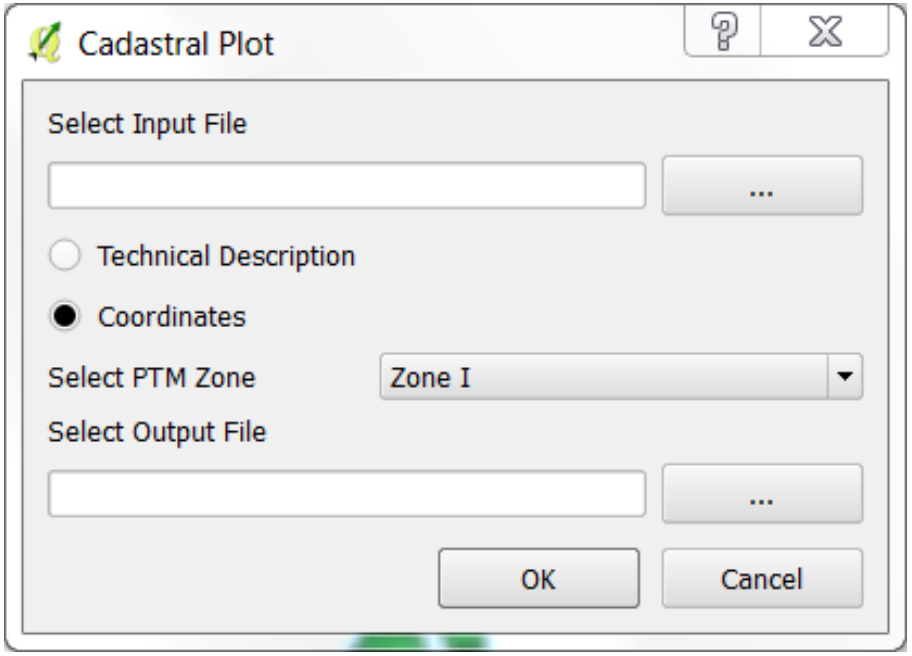
Developed Plugins

- Cadastral Plot Plugin
- TD Generator Plugin
- Lot Raster Clipper

CADSRR: Outputs

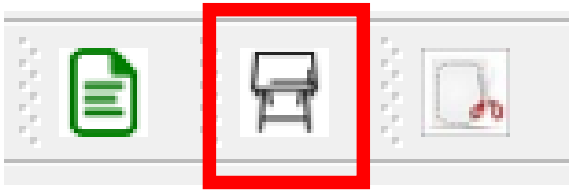
Plugin: Cadastral Plot





CADSRR: Outputs

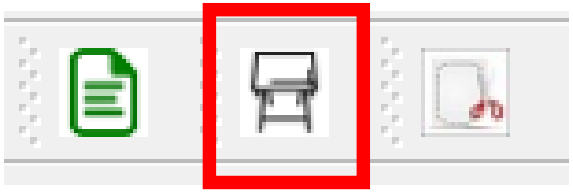
Plugins: Cadastral Plot



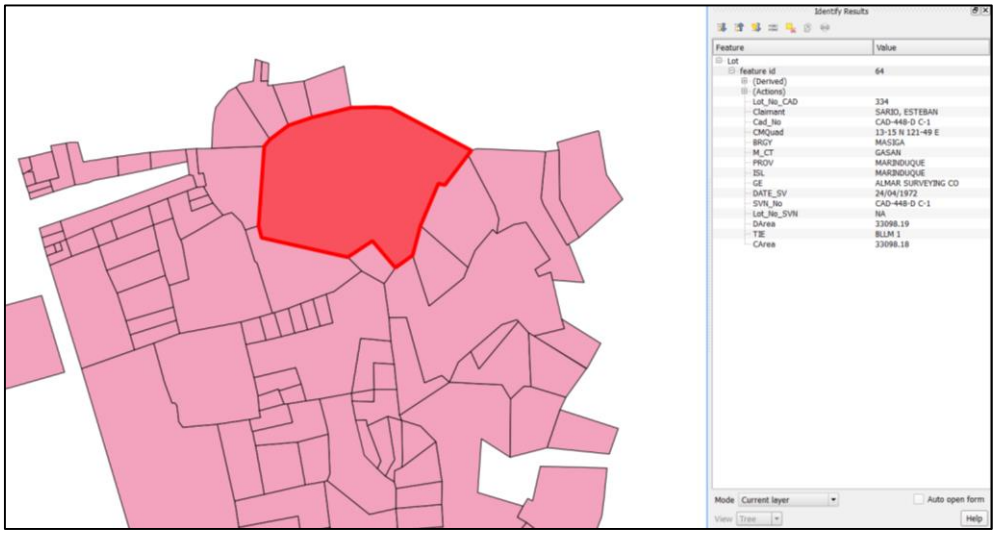
- **CadastralPlot** is a QGIS plugin that plots cadastral data (technical descriptions and lot data computation) into a shapefile. Accepts **spreadsheet files** (.xls/.xlsx) with specialized format.

CADSRR: Outputs

Plugins: Cadastral Plot

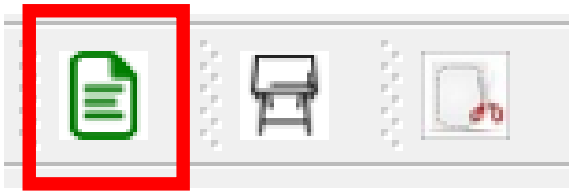


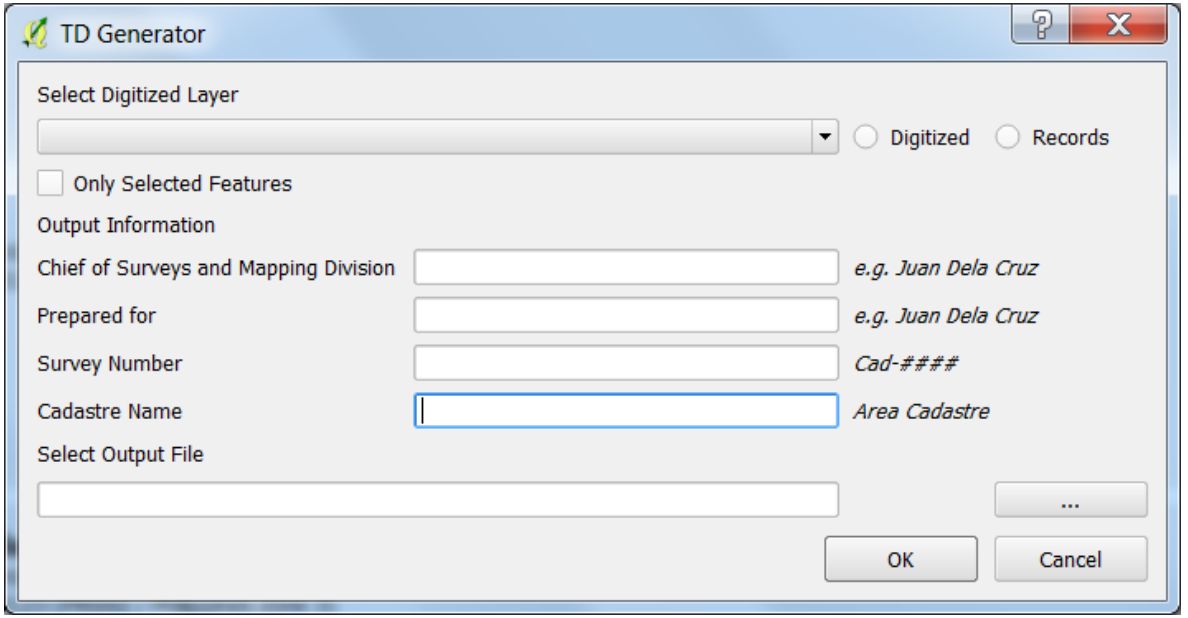
- The output shapefile of this plugin has the capacity to store the geographic location, shape, and other associated attributes of the lot such as lot number, claimant, area, date surveyed, GE who performed the survey, barangay, province, etc.



CADSRR: Outputs

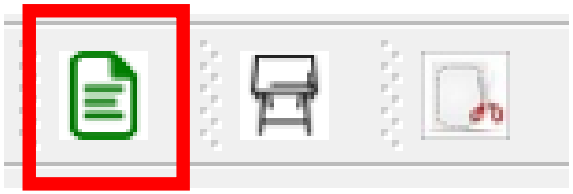
Plugins: TD Generator

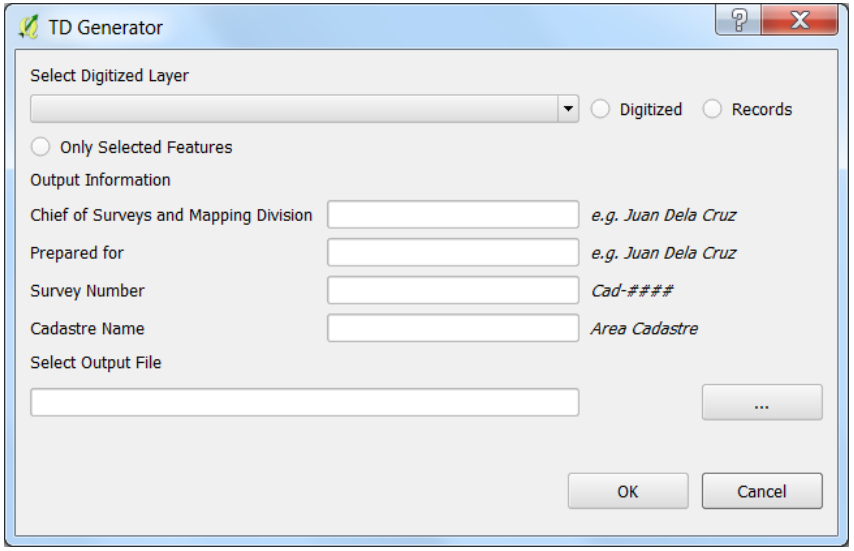


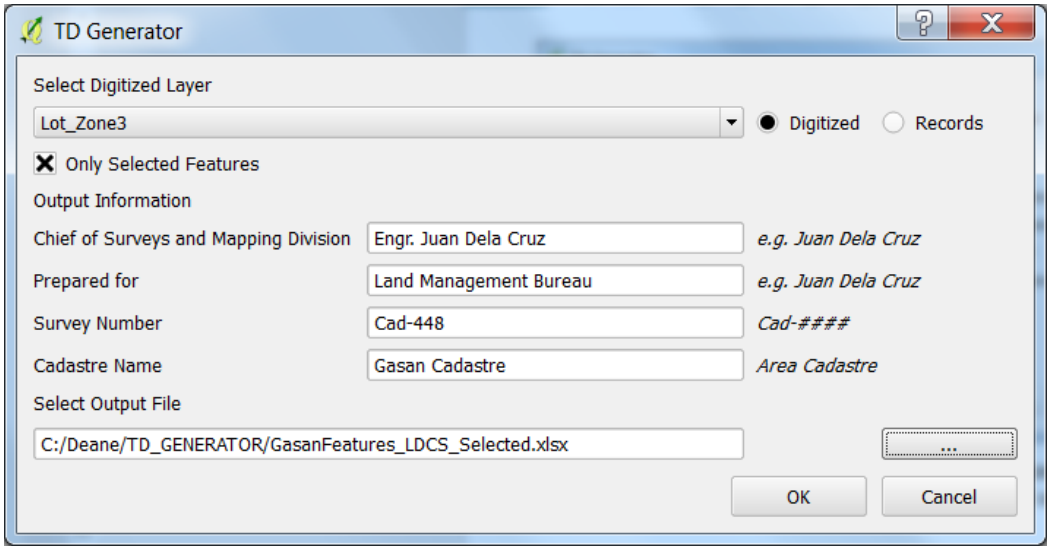


CADSRR: Outputs

Plugins: TD Generator



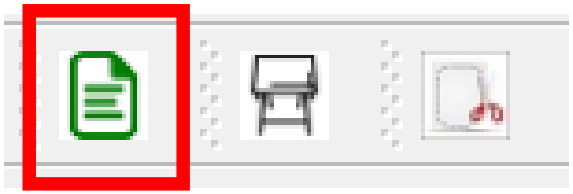




This plugin aims **to extract lot data computation sheets from shapefiles** of lot polygons, whether they are digitized data or recorded data. Some details needed for the LDCS are input in the plugin.

CADSRR: Outputs

Plugins: TD Generator



LMB Form ###### | Sheet 1/1

LOT DATA COMPUTATION SHEET

Lot No.	228	Location:	GASAN,MARINDUQUE	
Owner	VITTO, CRISANTO			
Area.	867.57 sq. m.	Geodetic Engr:	ALMAR SURVEYING CO	
Survey Number	CAD-448-D C-1			

Point	Northings	Eastings	Line	Bearing	Distance	Adjoining Lot
R.P.	1,473,735.420	591,590.850				
			R.P.-1	N 42d04' W	4,355.39 m	
1	1,476,968.680	588,672.720				
			1-2	N 01d06' E	6.81 m	229
2	1,476,975.490	588,672.850				
			2-3	S 89d55' E	63.41 m	227
3	1,476,975.400	588,736.260				
			3-4	S 00d13' E	5.45 m	227
4	1,476,969.950	588,736.280				
			4-5	S 89d46' E	59.95 m	227
5	1,476,969.710	588,796.230				
			5-6	S 06d04' E	4.25 m	238
6	1,476,965.480	588,796.680				
			6-7	S 89d38' W	104.74 m	230
7	1,476,964.820	588,691.940				
			7-8	N 20d33' E	3.84 m	230
8	1,476,968.420	588,693.290				
			8-1	N 89d17' W	20.57 m	230
1	1,476,968.680	588,672.720				

			8-1	N 89d17' W	20.57 m	230
1	1,476,968.680	588,672.720				

Date Prepared	**10-29-2018**
Prepared for	**LMB**
Reference System	**PTM Zone III**

CERTIFICATION

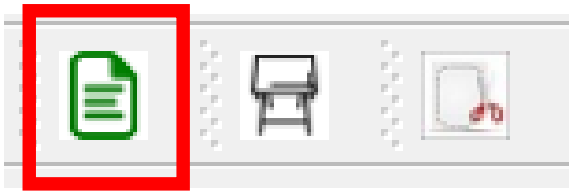
I hereby certify to the correctness of this reconstructed lot data computation based on available data gathered.

ENGR. JUAN DELA CRUZ

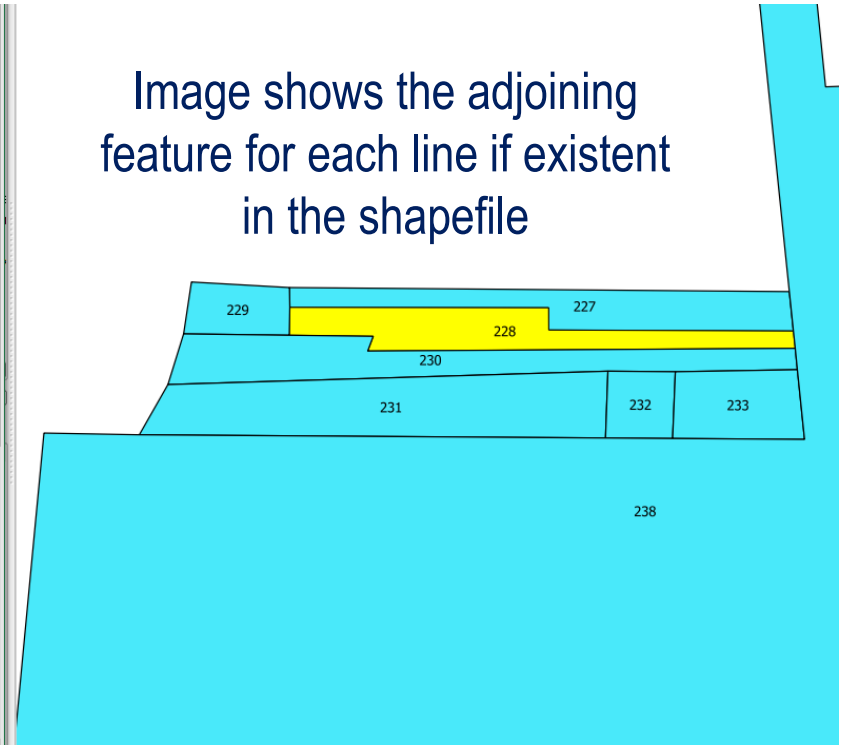
Chief, Surveys and Mapping Division

CADSRR: Outputs

Plugins: TD Generator

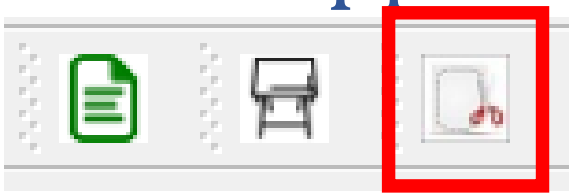


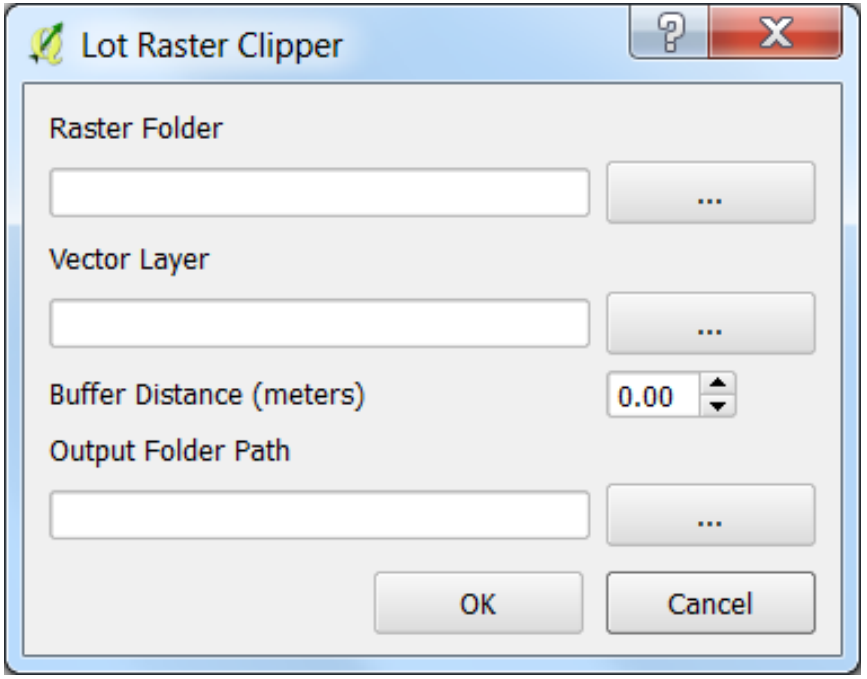
LMB Form ######					Sheet	1/1
LOT DATA COMPUTATION SHEET						
Lot No.	228				Location:	GASAN,MARINDUQUE
Owner	VITTO, CRISANTO					
Area.	867.57 sq. m.				Geodetic Engr:	ALMAR SURVEYING
Survey Number	CAD-448-D C-1					CO
Point	**Northings**	**Eastings**	**Line**	**Bearing**	**Distance**	**Adjoining Lot**
R.P.	1,473,735.420	591,590.850				
			R.P.-1	N 42d04' W	4,355.39 m	
1	1,476,968.680	588,672.720				
			1-2	N 01d06' E	6.81 m	229
2	1,476,975.490	588,672.850				
			2-3	S 89d55' E	63.41 m	227
3	1,476,975.400	588,736.260				
			3-4	S 00d13' E	5.45 m	227
4	1,476,969.950	588,736.280				
			4-5	S 89d46' E	59.95 m	227
5	1,476,969.710	588,796.230				
			5-6	S 06d04' E	4.25 m	238
6	1,476,965.480	588,796.680				
			6-7	S 89d38' W	104.74 m	230
7	1,476,964.820	588,691.940				
			7-8	N 20d33' E	3.84 m	230
8	1,476,968.420	588,693.290				
			8-1	N 89d17' W	20.57 m	230
1	1,476,968.680	588,672.720				



CADSRR: Outputs

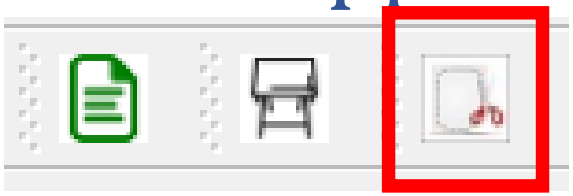
Plugins: Lot Raster Clipper

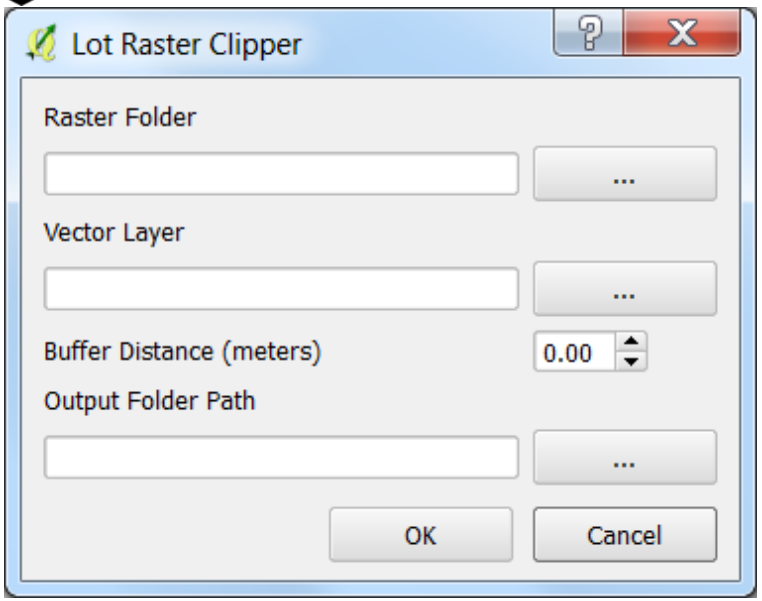




CADSRR: Outputs

Plugins: Lot Raster Clipper

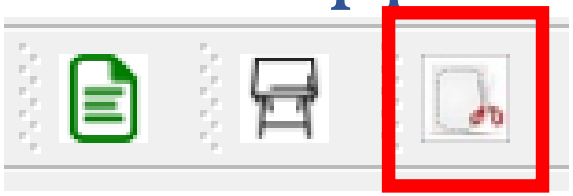


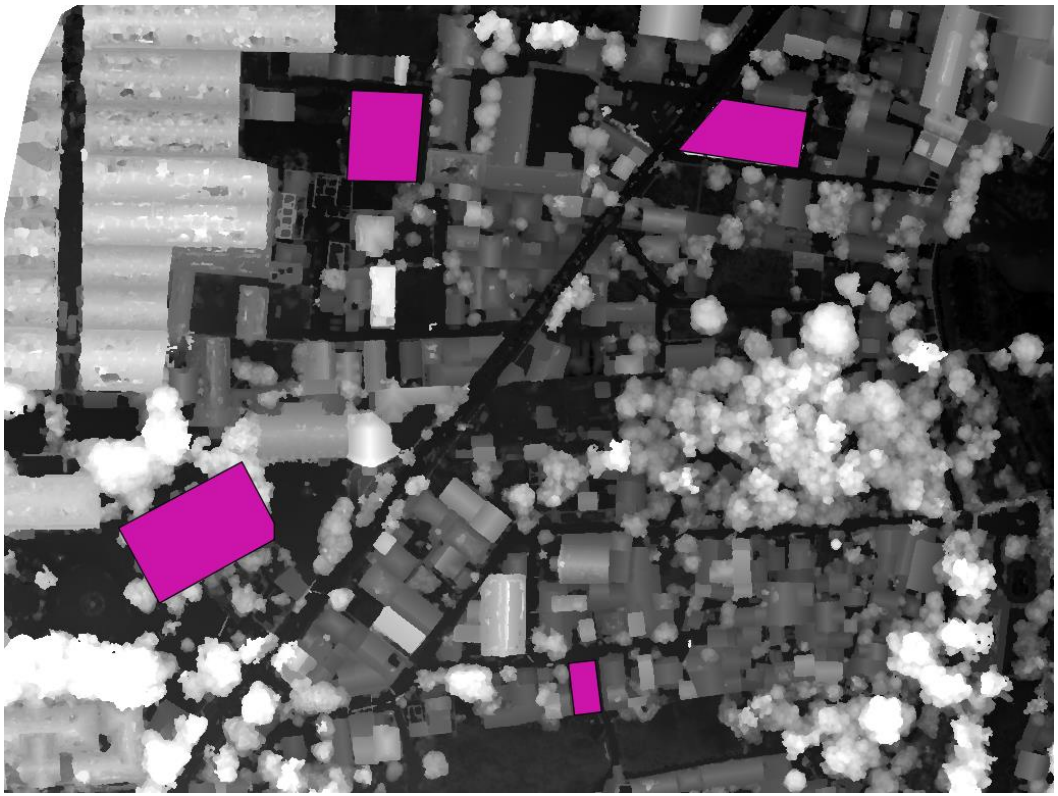


Plugin for **buffering** multiple features in a single **shapefile**, and **clipping** from **multiple raster data** (DEM, DSM, Orthophotos) obtained from 3D Cadastre .

CADSRR: Outputs

Plugins: Lot Raster Clipper

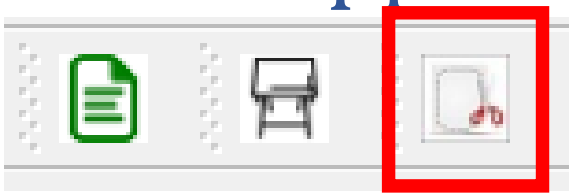


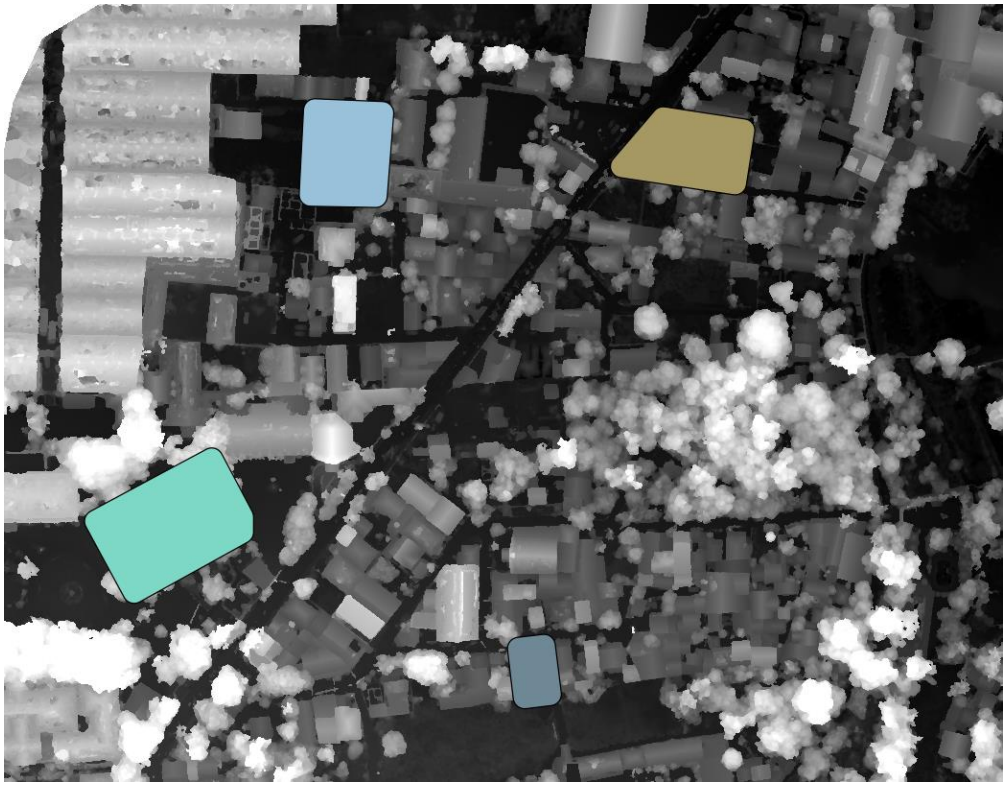


Sample Features in DSM of GTO

CADSRR: Outputs

Plugins: Lot Raster Clipper

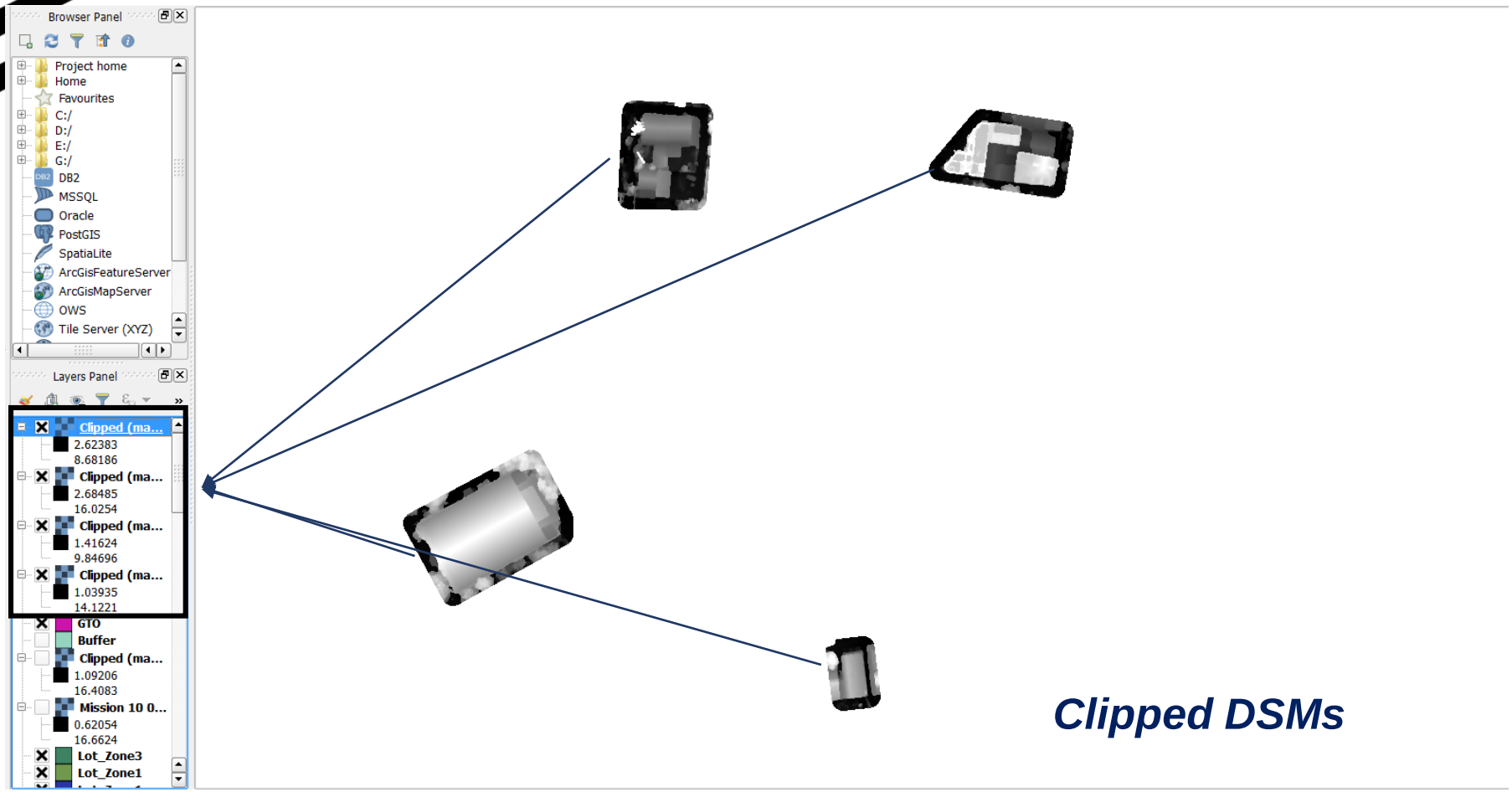




Features buffered by 5 meters

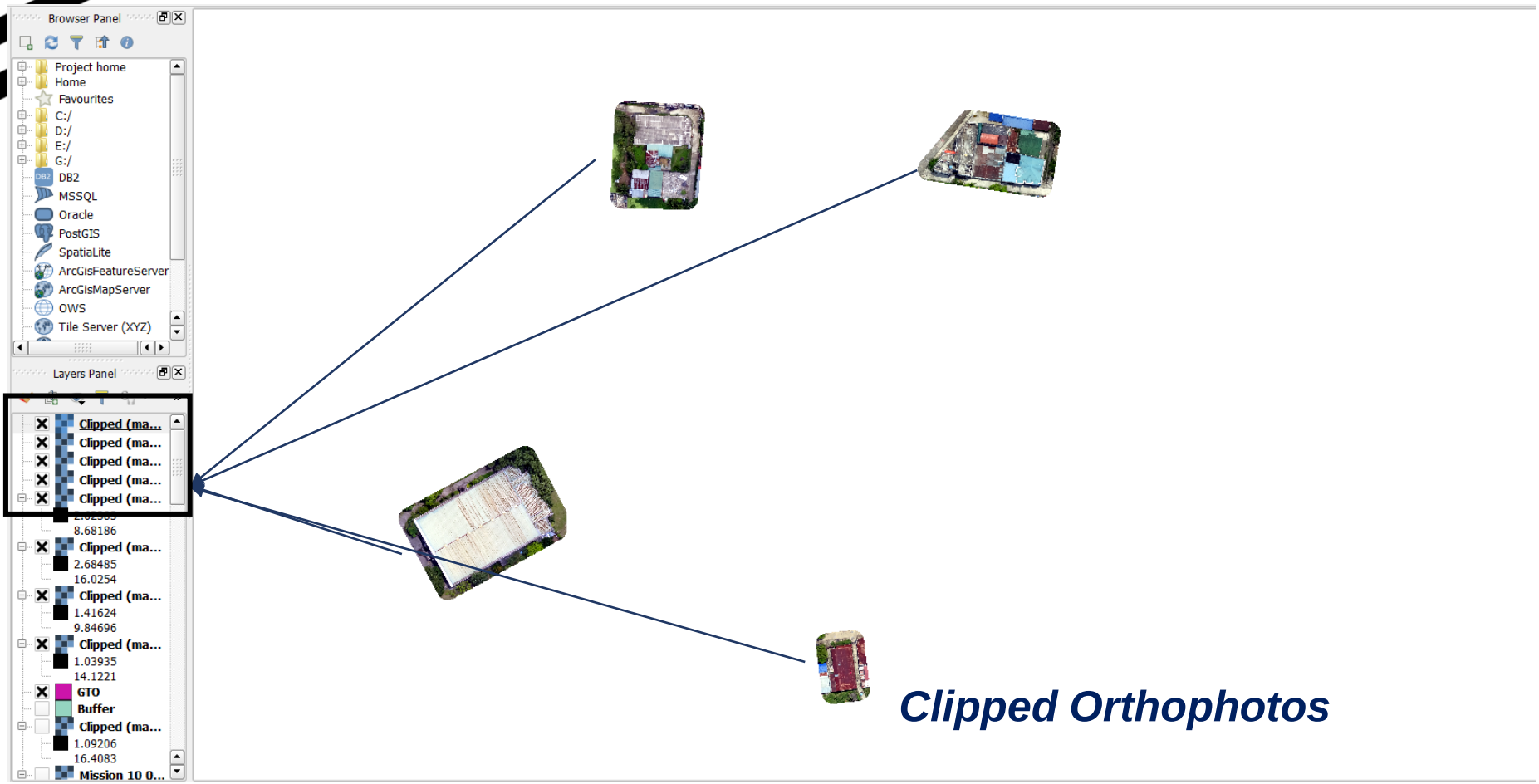
CADSRR: Outputs

Plugins: Lot Raster Clipper



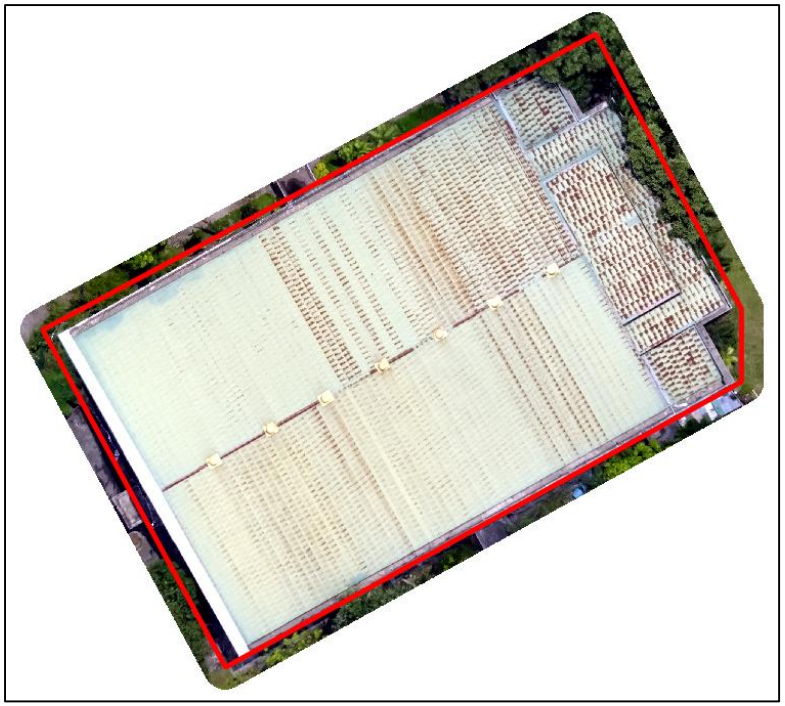
CADSRR: Outputs

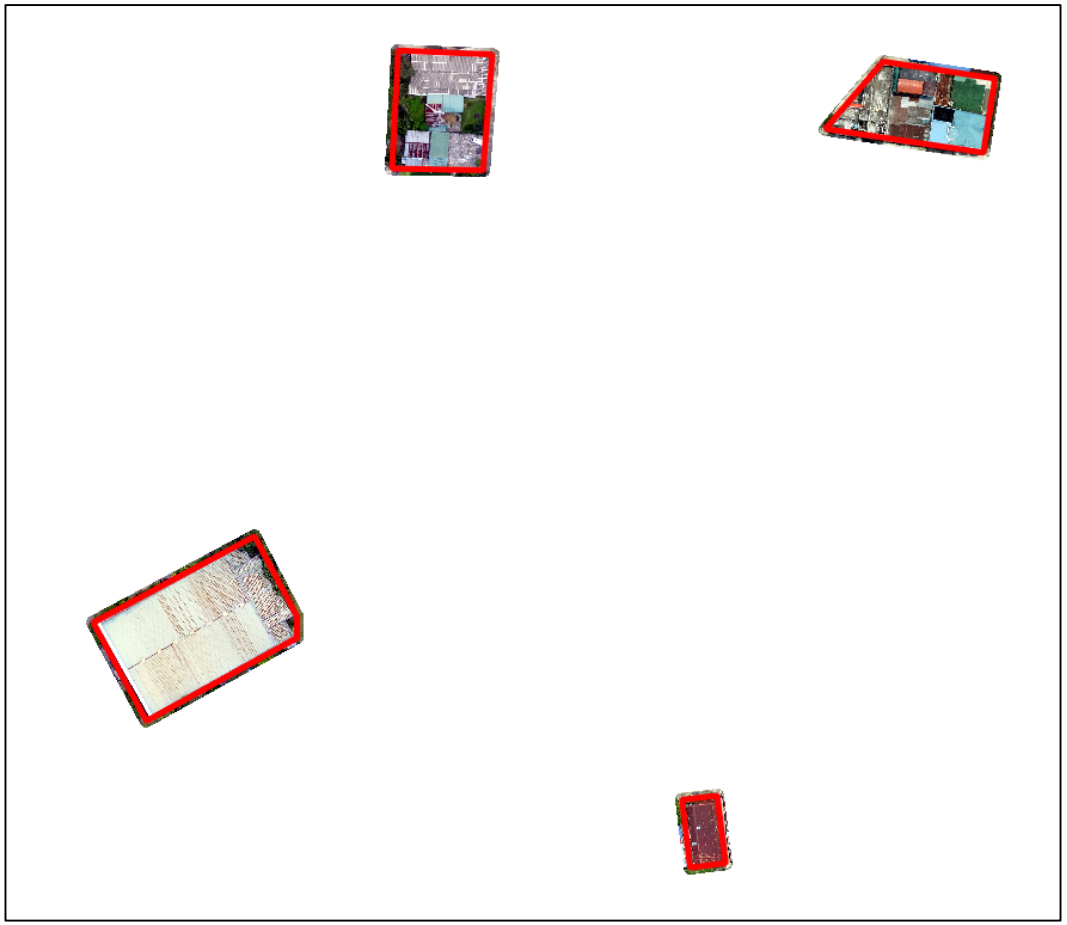
Plugins: Lot Raster Clipper



CADSRR: Outputs

Plugins: Lot Raster Clipper





CADSRR: Outputs

Training Modules

Module 1: QGIS Plugin System

One of the advantage of QGIS from other GIS software is the active community who support it. QGIS offers a library of useful features called plugins. The plugins are created by QGIS developers and other independent users who want to extend the functionality of the software. These extensions are free and available for all users.

Objective

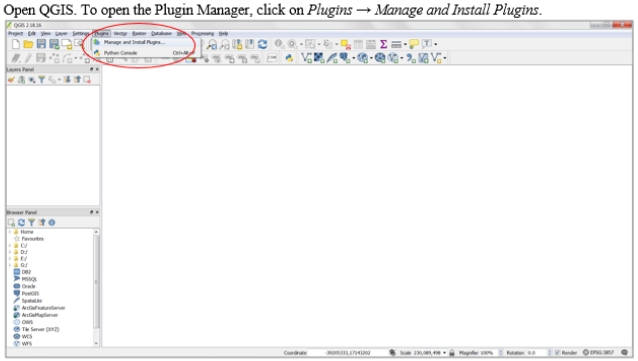
This module covers the basics which includes downloading, installing, and activating plugins. After this module, users will be familiarized with the QGIS plugin system, specifically on how to use the *QGIS Plugin Installer* and *Plugin Manager* tool. Users will also learn how to locate the plugin from the QGIS menu once they are installed.

Managing Plugins

There are two kinds of QGIS plugins, "Core Plugins" and "External Plugins". Core plugins are already part of the standard QGIS installation. To use these, users only need to enable it. On the other hand, external plugins must be installed prior to use. These are available in the *QGIS Plugins Repository*. An easy way to browse and install these plugins is by using the Plugin Manager tool.

Enabling Core Plugins

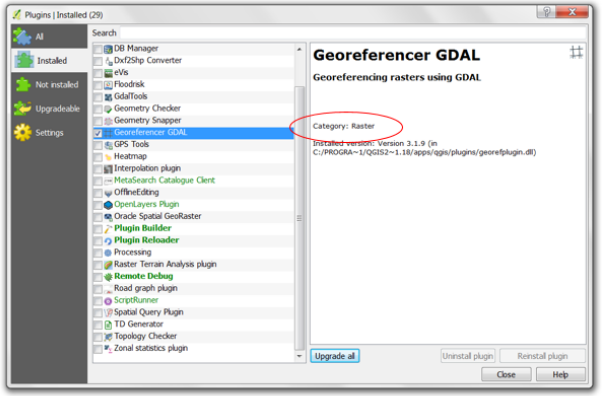
1. Open QGIS. To open the Plugin Manager, click on *Plugins* → *Manage and Install Plugins*.



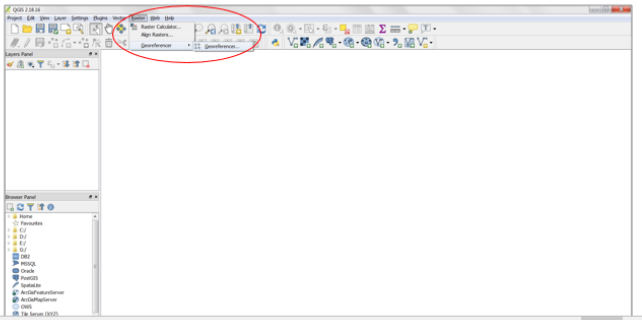
2. First time users may already see a lot plugins under the Installed Tab. These are the Core plugins installed during the QGIS installation.

3. Find the *Georeferencer GDAL* plugin. Check the checkbox besides the icon to enable the plugin.

for clues. Here the description says *Category Raster*. That indicates that the plugin would be found under the Raster menu once enabled.



4. After activating the Georeferencer GDAL plugin, go to *Raster* → *Georeferencer* → *Georeferencer* to use the added functionality of the plugin.



words English (United States)

CADSRR: Outputs

Training Modules

Module 2. Georeferencing and Digitizing in QGIS

2.1 Georeferencing a Map

Updating the information of a land area is a fairly common task in land management. Analog collection of data, some of which dating several years back, necessitates the shift to digitization of the inventory data.

For instance, users would typically use the information in GIS to compare with later inventories. Thus, the information at hand must be first digitized using the GIS software. However, before the digitization procedure, an important first step must be done – scanning and georeferencing the paper map.

Objective

The goal for this section is for the user to learn how to operate the Georeferencer tool in QGIS.

Scan the map

The first task in georeferencing is scanning the map. Large maps can be scanned in different parts. Note however, that users need to repeat preprocessing and georeferencing tasks for each part. Thus, it is recommended to scan the map in as few parts as possible.

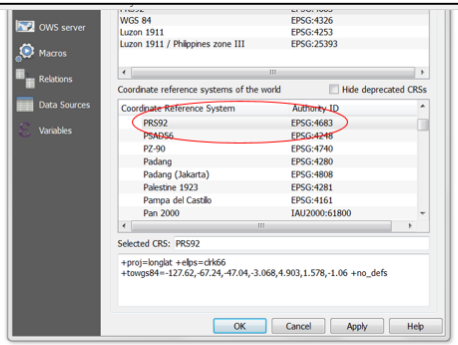
Users may use their own maps for the purposes of this manual. Scan the map as an image file with a resolution of at least 300 DPI. For colored maps, scan the image in color for additional information. Color shades in the inventory maps can be used to separate information into different layers (e.g. forest stands, contour lines, roads).

For this module, users may use a previously scanned map, titled sample_map.tif and located in the data folder module2_data/georeferencing.

Georeferencing the scanned map

1. Open QGIS. The project's CRS must be set to PRS92 in *Project → Project Properties → CRS*. Note that PRS92 is the CRS currently used in the Philippines.

2. Save the QGIS project as map_digitizing.qgs. Since we will be working on data with another CRS, confirm if Enable 'on the fly' CRS transformation is checked.



3. The georeferencing plugin from QGIS will be used. Recall that it is already installed in QGIS. Using the plugin manager, activate the plugin similar to the steps in the previous module. The plugin name is Georeferencer GDAL.

4. To georeference the map:
   - Launch the georeference tool, *Raster → Georeferencer → Georeferencer*.
   - Add the map image file, sample_map.tif, as the image to georeference, *File → Open raster*.
   - Find and select the Luzon 1911/Philippines zone III CRS when prompted. This is the CRS that was used in 1973 when this map was created.
   - Click OK.

5. Next, define the transformation settings for georeferencing:
   - Open *Settings → Transformation settings*.
   - Click the icon next to the Output raster box, go to the folder and create the folder training_output\module2 and name the file as sample_georef.tif.
   - Set the rest of parameters the same as below.
   - Click OK.

ords English (United States)

CADSRR: Outputs

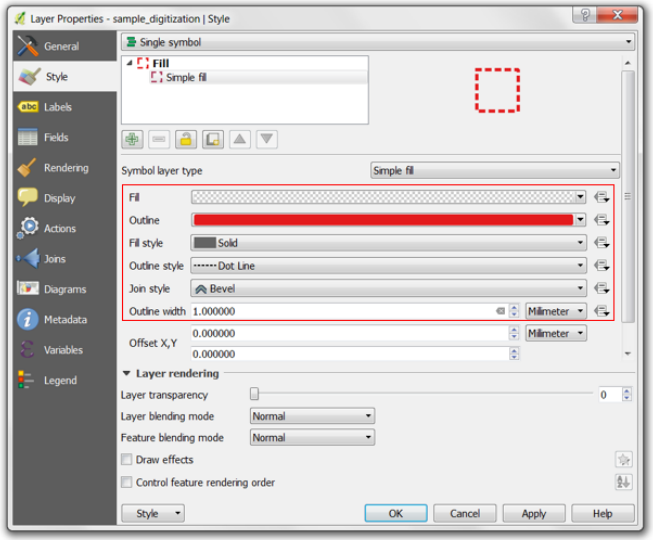
Training Modules

Symbology

Symbology can be define as the visual appearance of a geographic information on the map. One of the core strength of GIS is its ability to represents data in many forms and styles.

To change a layer's symbology, *right click on the layer → Properties* and select the *Style* tab.

- Change the symbology of your digitization output into **red dotted line with no fill**.
- Select *Simple Fill*. Set the of parameters the same as below



- The output should look like this:

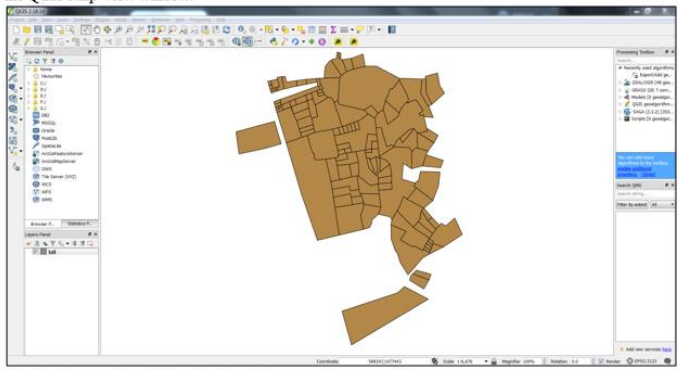
In the current survey records reconstruction efforts of DENR-LMB, lots reconstructed through digitizing georeferenced maps are categorized as **non-survey data**.

Module 3. Cadastral Survey Records Reconstruction Application

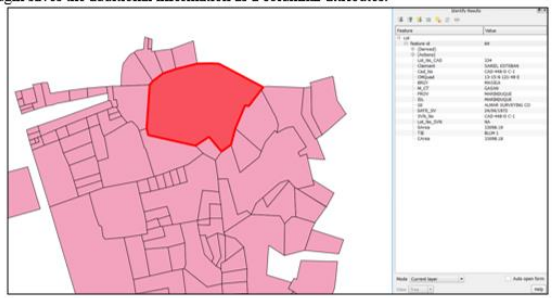
CADSRR: Outputs

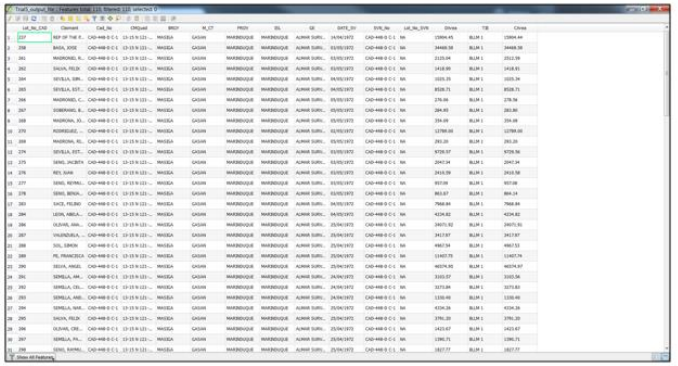
Training Modules

5. Lastly, select the destination folder of the output file. After running the plugin, the plot will appear in the QGIS Map View window.



6. The plugin saves the additional information as a columnar attributes.





Shapefile Format

CadastralPlot plugin converts the information inside the text file into a shapefile format. The shapefile format is consists of 3 primary files with the same name, but the following file extensions:

a) **.shp** - contains the spatial information, namely, x,y coordinate pairs which describes the point, line or polygon features contained in the file.
b) **.dbf** - contains the attribute information, or the descriptive characteristics of the features.
c) **.shx** - links the .shp and .dbf file. It matches up the correct row in the .shp file with the correct record in the .dbf file. The shapefile will not work properly without these 3 files.

The output shapefile of the plugin also contains a .prj, .qpj and .cpg file. The .prj and .qpg contains the coordinate system and projection information. These file are necessary for correct positioning of data with respect to other spatial data. , and for measuring and calculating distance. The .cpg file is an optional plain text files that describes the encoding applied to create the shapefile.

English (United States)

CADSRR: Recommendations

Cadastral Survey Reconstruction

- The step and approach in reconstruction of records shall depend on the source data or records identified during the research process.

Condition	Numerical	Graphical (CM, PM)
Case 1	✓	✓
Case 2	✓	-
Case 3	-	✓

- The output can be categorized into 2: survey-accurate and non-survey-accurate data.
- ***Survey Accurate*** *– reconstructed from numerical data*
- ***Non-Survey Accurate*** *– extracted from maps*

**CM – Cadastral Map*
**PM – Projection Map*

CADSRR: Recommendations

Cadastral Survey Reconstruction

Case 1: Both Numerical and Graphical Data are available

- Numerical data will be used for reconstruction while graphical data will serve as basis for cleansing (identification and correction of erroneous, gaps and overlaps).

Condition	Recommendations
Error of Closure	• The maximum allowable error of closure is **2.50%** of the area *(for reconstruction purposes only*). Once the data of its adjoining lots becomes available, the lot can be reconstructed **by extracting its corners from its surrounding lots**.
Erroneous/Missing Tie Line Description	• Using adjoining lots. • Overlaying a **georeferenced map** where the map will guide the **translation of the displaced lot**.

CADSRR: Recommendations

Cadastral Survey Reconstruction

Basis for 2.50%

Area	Gasan, Marinduque	Manila
Images Provider	DENR-R4B	DENR-NCR
No. of Images	3	2
No. of Features	128 Features	266 Features
Scale	1:1000 and 1:2000	1:500

Table for the Digitized Features in Gasan Cadastre			
% Error Range			Frequency
0.00%	-	0.01%	1
< 0.01%	-	0.05%	1
< 0.05%	-	0.10%	2
< 0.10%	-	0.25%	8
< 0.25%	-	0.50%	12
< 0.50%	-	1.00%	23
< 1.00%	-	2.50%	30
< 2.50%	-	3.00%	8
< 3.00%	-	3.50%	10
< 3.50%	-	4.00%	4
< 4.00%	-	4.50%	4
< 4.50%	-	5.00%	3
< 5.00%	-	7.50%	11
< 7.50%	-	10.00%	7
<10.00%	-	12.50%	0
<12.50%	-	15.00%	1
<15.00%	-	17.50%	2
<17.50%	-	100.00%	0

Table for the Digitized Features in San Lazaro Estate			
% Error Range			Frequency
0.00%	-	0.01%	1
< 0.01%	-	0.05%	8
< 0.05%	-	0.10%	5
< 0.10%	-	0.25%	23
< 0.25%	-	0.50%	31
< 0.50%	-	1.00%	69
< 1.00%	-	2.50%	100
< 2.50%	-	3.00%	10
< 3.00%	-	3.50%	10
< 3.50%	-	4.00%	3
< 4.00%	-	4.50%	2
< 4.50%	-	5.00%	2
< 5.00%	-	7.50%	1
< 7.50%	-	10.00%	0
<10.00%	-	12.50%	0
<12.50%	-	15.00%	0
<15.00%	-	17.50%	1
<17.50%	-	100.00%	0

CADSRR: Recommendations

Cadastral Survey Reconstruction

Case 2: Only Numerical Data are available

- For lots with missing or erroneous tie lie description, place it in a **separate layer for cleansing**.
- Cluster the lots by block and according to number to easily translate them all at once. Use **adjoining lots** for edge matching.

CADSRR: Recommendations

Cadastral Survey Reconstruction

Case 3: Only Graphical Data are available

- In case there are **no numerical data** present, **georeferenced map** can be **digitized** to extract lot data. These reconstructed lots will fall under the **non-survey accurate** category and will be stored in a separate layer.
- Digitized data **cannot** be used as **substitute for re-survey** and will only be used for the **completion of DCDB**.
- Digitized data will be **connected to a reference point** nearest to the lot cluster.
- Digitized data can be extracted from High Definition Orthophotos, where possible boundaries can be extracted.

CADSRR: Recommendations

Cadastral Survey Reconstruction

Case 3: Only Graphical Data are available

Condition	Recommendations
Georefencing	• Use the map corners as GCPs and apply the given map projection. For the sampling method and transformation algorithm, use Cubic and 1st Order Polynomial respectively.
Establishment of Base Project	• If two adjacent maps have different scales, the large scale map will be the basis of adjustments for adjacent smaller scale maps. • If two adjacent maps have the same scale, the map with a lower RMSE, in terms of Georeferencing, will be the basis of adjustment.
Manner of Digitization	• Add vertices on the center of corner's circle and follow the corner numbers (always start at corner 1). • **Another layer to indicate assumed boundary lines** that is subject for further validation and amendments.

CADSRR: Possible Future

- Extend the plugins' input and output to several type of files, making it **compatible** to various format such as **variations of spreadsheet files** for input and output of the **Cadastral Plot and TD Generator Plugins**, respectively. (dbf format, LAMS Spreadsheet)

- TD Generator plugin for **multiple shapefiles** consisting of varying survey numbers, beneficial for **filling the adjoining lot column**.

"The application of GIS is limited only by the imagination of those who use it." ***- Jack Dangermond***