ROYAL GOVERNMENT OF BHUTAN

དཔལ་ལྡན་འབྲུག་གཞུང།

NATIONAL LAND COMISSION

རྒྱལ་ཡོངས་ས་ཆ་ལྷན་ཚོགས།

Training Program and Modules

Tailor-Made Training for Surveyors:

Geodetic Control Observation for Datum Transformation, Cadastral related Survey, and Mapping

(12th – 27th August 2024)

Version 1.0

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Training Background

Field observation of existing geodetic control points using GNSS-RTK for the datum transformation of cadastral maps is a key result area for the National Land Commission Secretariat (NLCS) the fiscal year 2024-2025. Given the nationwide scale of this activity, it is both resource-intensive and time-consuming. To optimize resources, NLCS plans to employ a collaborative approach by deploying Dzongkhag and Thromdee surveyors alongside a limited number of NLCS surveyors.

To prepare surveyors for this task, a three-day training session on conducting field observations is proposed. This training aims to ensure that all surveyors understand the purpose, methodology, procedures, and timing of the tasks, adopting common standards for seamless execution.

Additionally, given the NLCS's limited capacity building for surveyors, the Department of Survey and Mapping (DoSAM) has decided to use this opportunity to extend training on relevant topics related to cadastral surveying and mapping, with the objective of ultimately enhancing their professional efficiency.

Training Components

1. **Datum Transformation**

    - What is datum transformation? Need and importance of datum transformation, technical approach and methodology for datum transformation.
    - Geodetic control observation of using GNSS-RTK, use of field books, daily planning for field observation, data and file management, use of mobile app (online and offline) for navigation, data collection and sharing.

2. **Cadastral Survey and standards**

- Cadastral quality control and standards for cadastral survey, cadastral licensing and auditing, and errors associated with CORS-RTK and ways to management, maintenance of survey field book and reporting of issues.

3. **Cadastral related GIS and RS:**

- Managing GIS Files, useful and effective GIS tools, Useful techniques to extract required information from GIS data, use of opensource GIS data, basemaps and satellites image.
- Introducing basic query language: SQL, Regular expression, etc

Training Program: Daily Program

Sl No	Time	Activity	Remarks
Day 1	09:00 AM – 09:20 AM	Registration	
	09:20 AM – 09:35 AM	Opening Remarks by Director, DoSAM	
	09:35 AM – 11:10 AM	Datum Transformation	
	11:10 AM – 11:30 AM	**Tea Break**	
	11:30 AM – 01:00 PM	Datum Transformation – Use of field App	
	01:00 PM – 02:00 PM	**Lunch Break**	
	02:00 PM – 03:30 PM	Field observation and data management	Practical
	03:30 PM – 04:30 PM	**Tea Break**	
	04:30 PM – 05:00 PM	Field observation and data management	Practical
Day 2	09:00 AM – 11:00 AM	Cadastral Surveying – RTK and CORS	
	11:00 AM – 11:30 AM	**Tea Break**	
	11:30 AM – 01:00 PM	Cadastral auditing and licensing	
	01:00 PM – 02:00 PM	**Lunch Break**	
	02:00 PM – 03:30 PM	Cadastral Survey standards	Practical
	03:30 PM – 04:30 PM	**Tea Break**	
	04:30 PM – 05:00 PM	Cadastral Surveying	Practical
Day 3	09:00 AM – 11:00 AM	Cadastral related GIS &RS	Practical
	11:00 AM – 11:30 AM	**Tea Break**	
	11:30 AM – 01:00 PM	Cadastral related GIS &RS	Practical
	01:00 PM – 02:00 PM	**Lunch Break**	
	02:00 PM – 03:30 PM	Recapping, Evaluation & Feedbacks	
	03:30 PM – 04:30 PM	**Tea Break**	
	04:30 PM – 05:00 PM	Awarding of certificates by Director	

Training Program: Overall program

Venue	Date	Attendees
Thimphu	12th – 14th August 2024	Dzongkhag Surveyors from: Gasa, Wangdi, Ha, Punakha, Trongsa, Chukha Thromdee: Phuntsholing NLCS: surveyors/SEs of Topo and CID
Mongar	16th -18th August 2024	Dzongkhag Surveyors from: Bumthang, Mongar and Lhuntse
Trashigang	20th – 22nd August 2024	Dzongkhag Surveyors from: Yangtse, Trashigang, Pemagatshel and Samdrup Jongkhar Thromdee: Samdrup Jongkhar
Sarpang	25th – 27th August 2024	Dzongkhag Surveyors from: Zhemgang, Dagana, Sarpang, Samtse and Tsirang Thromdee: Gelephu

Day 1: Introducing Datum Transformation

Resource Person: Chokila, Jamphel Gyalthsen, CS Tamang, Ugyen Tshering

Mode of delivery

This module will be delivered through a combination of theoretical presentations, practical demonstrations, and hands-on training. Participants will be provided with copy of PowerPoint presentations and Standard Operating Procedures (SOPs) as reference materials.

General objective

Datum transformation is a complex and technical process. This module aims to simplify the concept, explaining its importance, methodology, and the specific approach used for cadastral transformation in Bhutan. The primary focus is to provide practical experience in conducting GNSS-RTK (Global Navigation Satellite System - Real-Time Kinematic) observations on existing geodetic control points following the standards operation ensuring quality control and consistent application. Additionally, the results from pilot

studies conducted in Thimphu and Paro will be presented to help trainees understand the practical outcomes of datum transformation.

Learning outcomes

Upon completing this module, participants will be able to:

1. Understand and explain the concept of a geodetic datum.
2. Types of geodetic datums.
3. New national geodetic datum for Bhutan
4. Understand the importance of carrying out datum transformations.
5. Approach and methodology used for datum transformation in Bhutan.
6. Perform RTK observations on existing geodetic control points.
7. Implement quality control measures and checks.
8. Plan and organize daily control observations.
9. Utilize apps for control point search, navigation, and data sharing.

Day 2: Quality check and control for Cadastral surveying

Resource Person: Phutsho Tashi, Ugyen Tshering

Mode of delivery

Theoretical Presentations and hands-on practical; and sharing of the PPTs and SOP as reference materials

General objective

Quality control is an integral part of surveying. The outcome of learning Quality Control for Cadastral Surveying is to ensure the accuracy, reliability, and consistency of land measurement and mapping processes. By mastering quality control techniques,

surveyors can systematically identify and rectify errors, maintain high standards of data integrity, and adhere to legal and regulatory requirements. This ensures that cadastral surveys are precise and dependable, ultimately supporting effective land management, property valuation, and dispute resolution. The participants will be informed on the current rules and regulations of cadastral licensing and auditing which will ensure that surveyors maintain and improve their present ethics and professionalism. Furthermore, some of the pertinent cadastral surveying issues will be discussed to further improve the land conveyance system in Bhutan.

Learning outcomes

On completion of the module, the trainee will be able understand and explain:

1. Sources of error for GNSS-RTK survey
2. Quality check and control for cadastral survey
3. Standard Procedures for cadastral survey
4. Scale factors for cadastral survey
5. Data processing and management

Day 3: GIS and RS tools for Cadastral related survey and mapping

Resource Person: Chokila

Mode of delivery

This module will be delivered through a combination of theoretical presentations and hands-on practical exercises using real-world data. Participants will be provided with copy of PowerPoint presentations and useful manual of practice as reference materials.

General objective

This module is designed to introduce fundamental Geographic Information System (GIS) tools and use of open source satellite basemaps and their applications in cadastral surveying and mapping. By learning these GIS tools, surveyors will be able to effectively integrate cadastral data in combination with other geospatial datasets, enabling them to derive valuable insights and contribute to more effective land governance and administration in the country.

Learning outcomes

Upon completing this module, participants will be able to perform the following GIS operations:

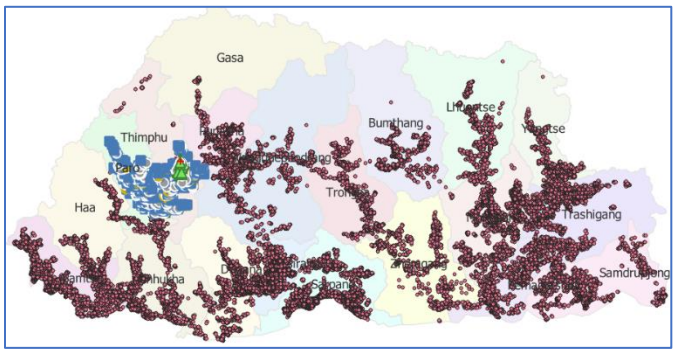
1. Manage GIS data and projects using the GeoPackage format.
2. Conduct spatial analysis and processing, including tasks like buffering, intersections, joining, and counting features.
3. Apply basic regular expressions and SQL commands for data manipulation.
4. Perform basic geo-statistical analyses and summaries.
5. Access and utilize open-source basemaps such as OpenStreetMap (OSM), Google Maps, and NICFI.
6. Use tools for coordinate conversions.
7. Navigate QMap to different open-source basemaps.
8. Zoom to specific coordinates within the GIS environment.

Day 1: Standard Operating Procedure (SOP) for Geodetic Control Observation Using GNSS RTK

1. Project Planning

During the planning phase of survey projects, it is essential to precisely plan and ensure that all necessary preparations for datum transformation are thoroughly completed. The field team should coordinate with Dzongkhag surveyors in line with the adopted transformation procedures and techniques. Proper planning at this stage is crucial to avoid errors, ensure data accuracy, and streamline the subsequent phases of the survey.

Fig 1: Shows the project planning in the designated areas.



Sl No	Dzongkhag	Field work sequence	Survey Team		Tentative Duration (up to)
			NLCS	Dzongkhag / Dungkhag	
1	Gasa	1	1	1	1 month
2	Punakha		1	1	
3	Wangdue Phodrang		2	1	
4	Trongsa		2	1	
5	Bumthang	2	1	1	1 month
6	Lhuentse		2	1	
7	Monggar		2	1	
8	Trashigang	3	2	1	1 month
9	Trashi Yangtse		1	1	
10	Pema Gatshel		2	1	
11	Samdrup Jongkhar	4	3	1	1 month
12	Zhemgang		2	1	
13	Tsirang	5	1	1	1 month
14	Dagana		2	1	
15	Sarpang		2	1	
16	Chhukha	6	2	1	1 month
17	Samtse		2	1	
18	Haa		1	1	

2. Field Preparation

Before the field survey begins, several prerequisites must be completed, including preparing field equipment and software needed to conduct the survey.

2.1 Equipment

(i) GNSS RTK set

(ii) Rover pole

(iii) Dual strut

(iv) Spade

(v) Crower

(vi) Knife

(vii) Field form

2.2 Software.

(i) QGIS

(ii) QField

3. QGIS 3.28

Fig 2: Demonstrating the download of QGIS 3.28 from Google.

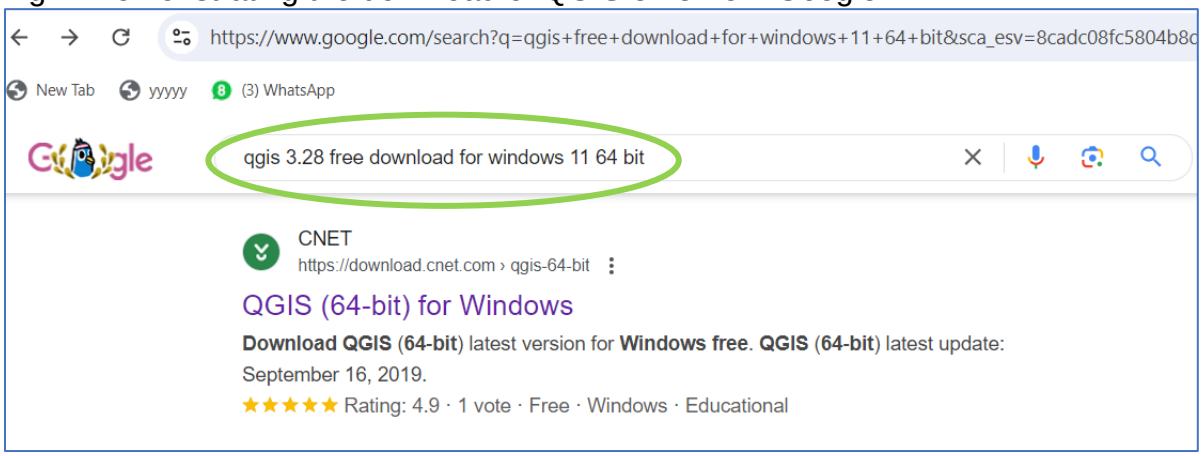


Fig 3: Demonstrate the installation of QGIS 3.28.

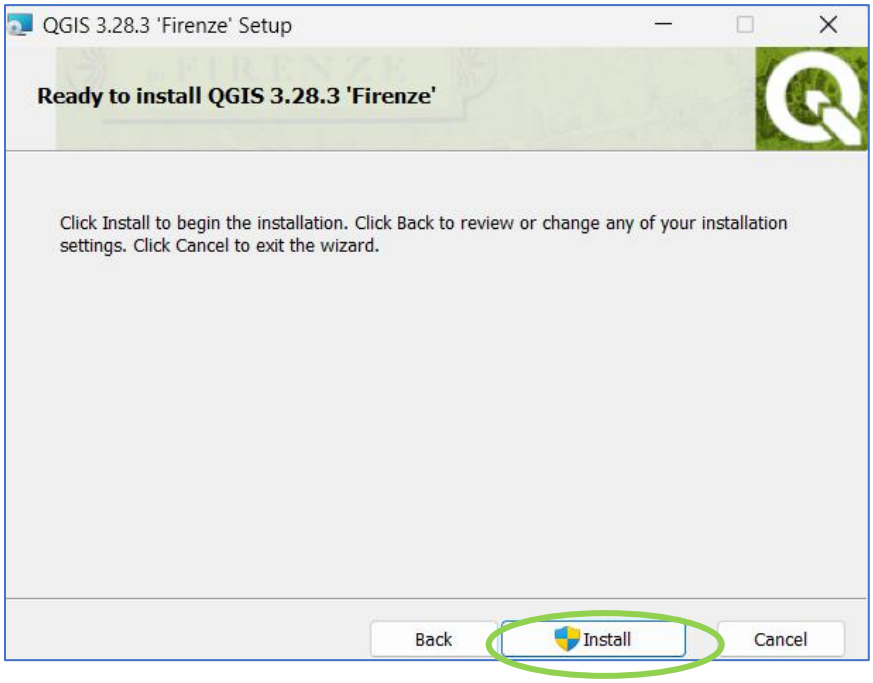


Fig 4: Demonstrates the opening of a new, empty project.

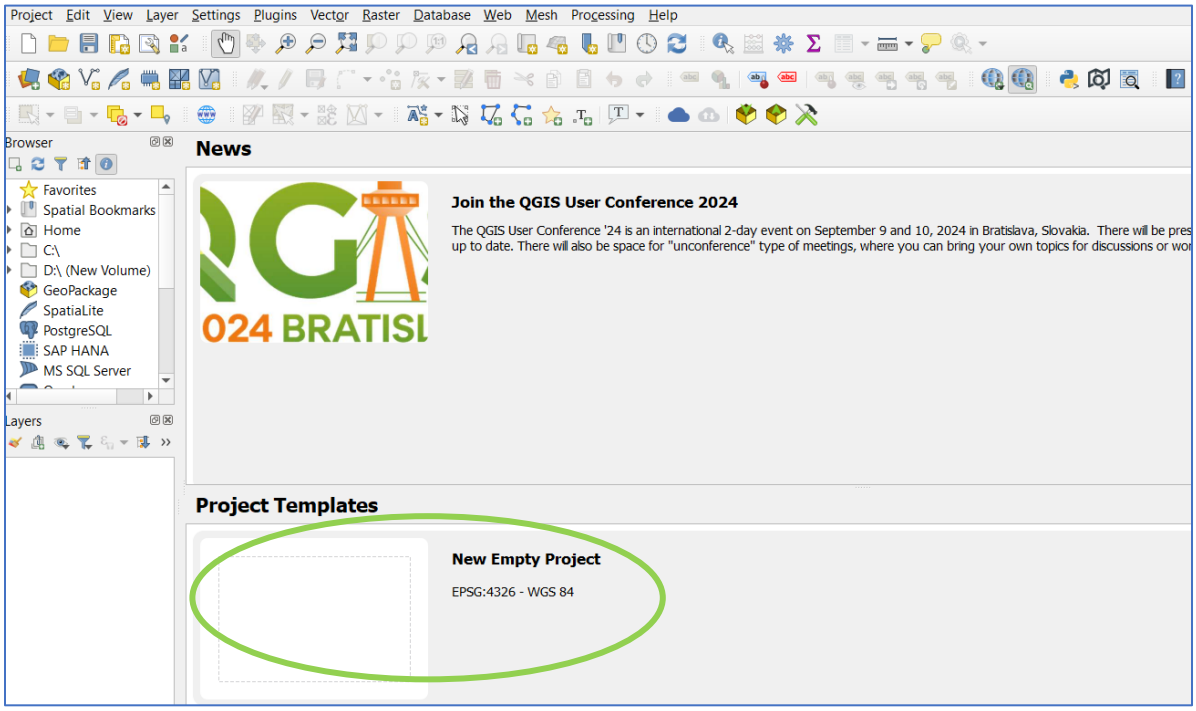
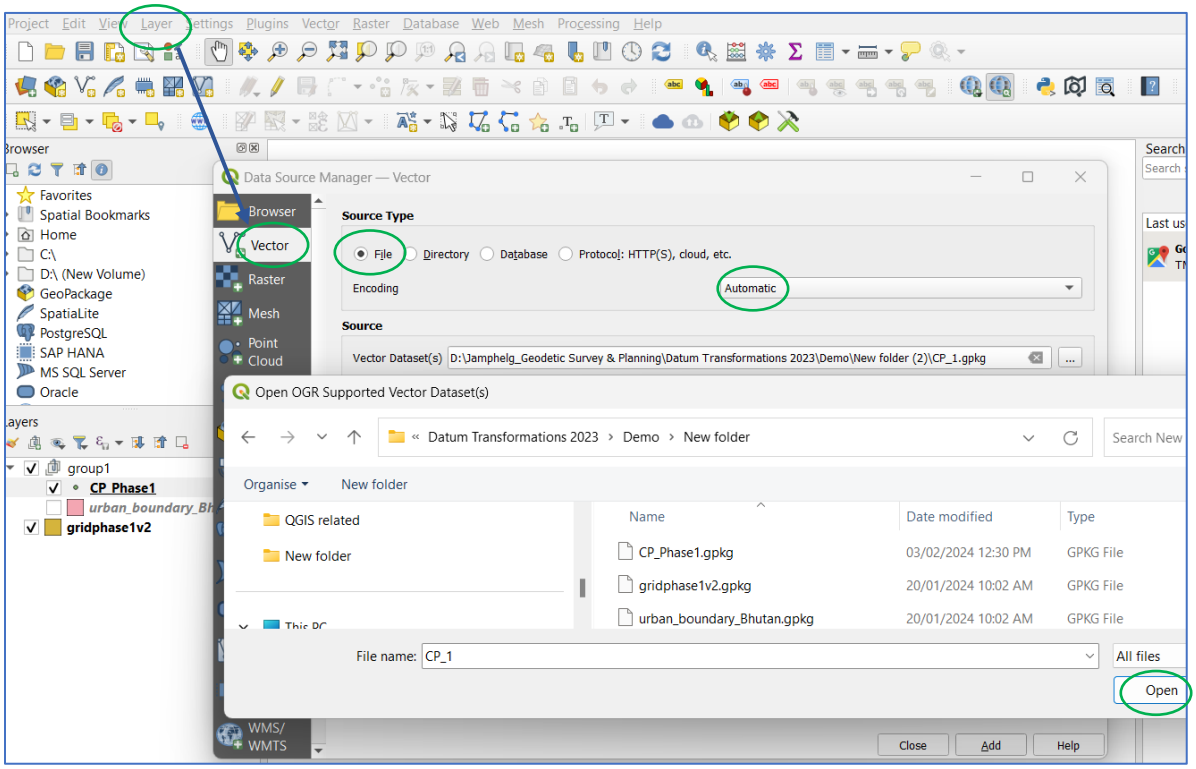


Fig 5: Shows the layers being added to QGIS.

- Layer → Vector → ⊙File →Automatic → select shapefiles from the working folder → open → add → close.



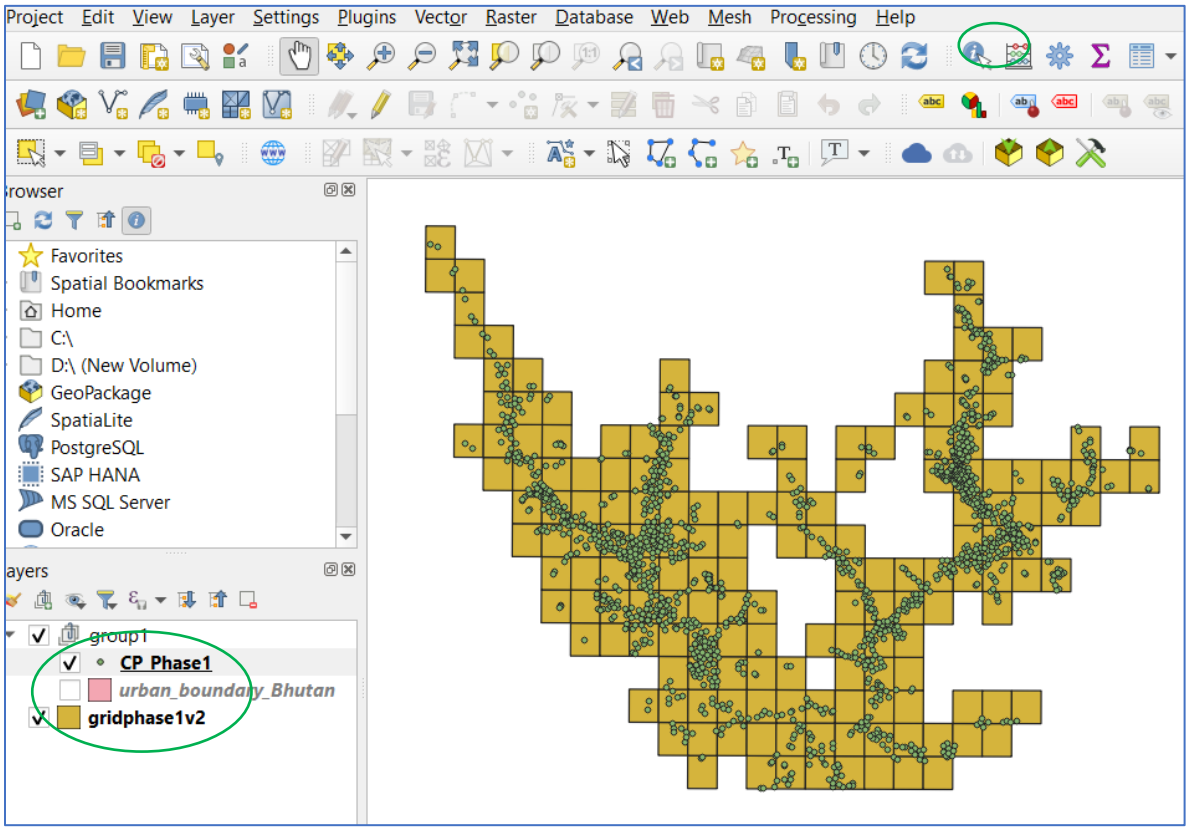


Fig 7: Demonstrates how to add plugins in QGIS.

- Plugins → Manage and install plugins → type ‘qms’ in the search command line → ☑Quick Map Services → Install plugins → close.

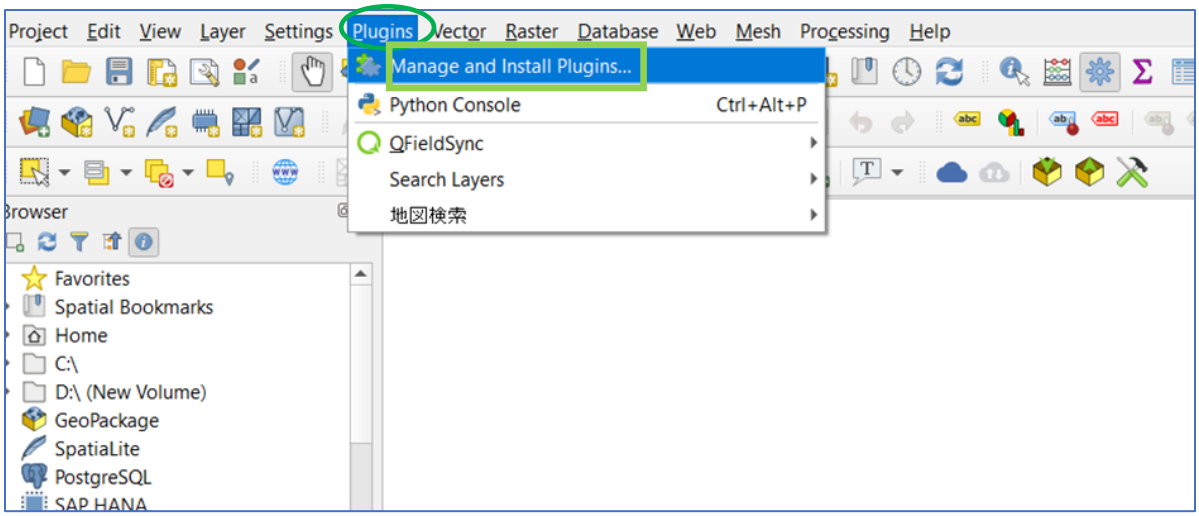


Fig 8: Displays the installed plugin tools in QGIS.

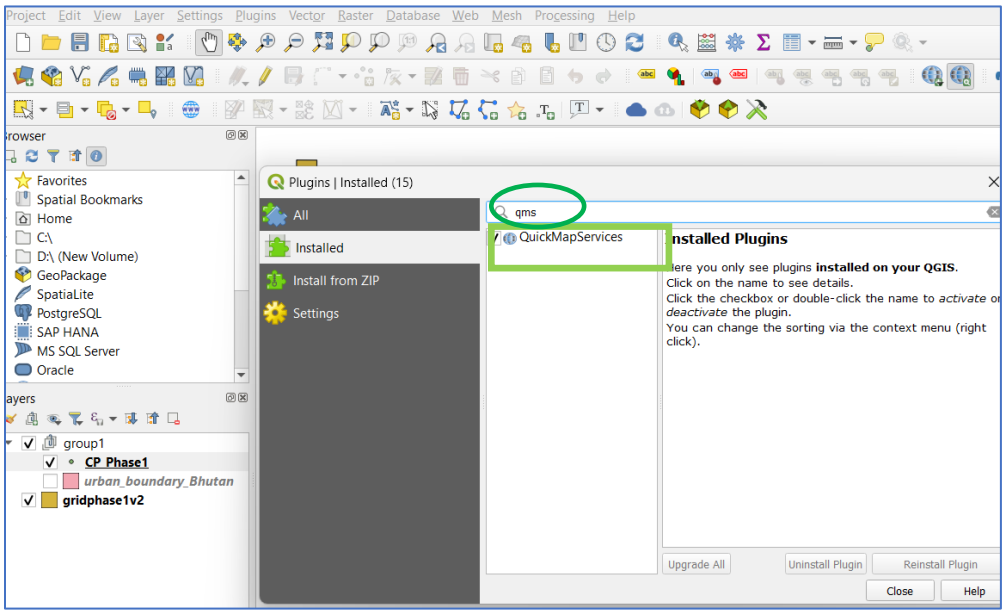


Fig 8: Demonstrates how to add the Google Satellite Hybrid layer in QGIS.

- Web → Quick Map Services → Search QMS. Then in Search QMS: → type "Google Satellite Hybrid" → add.

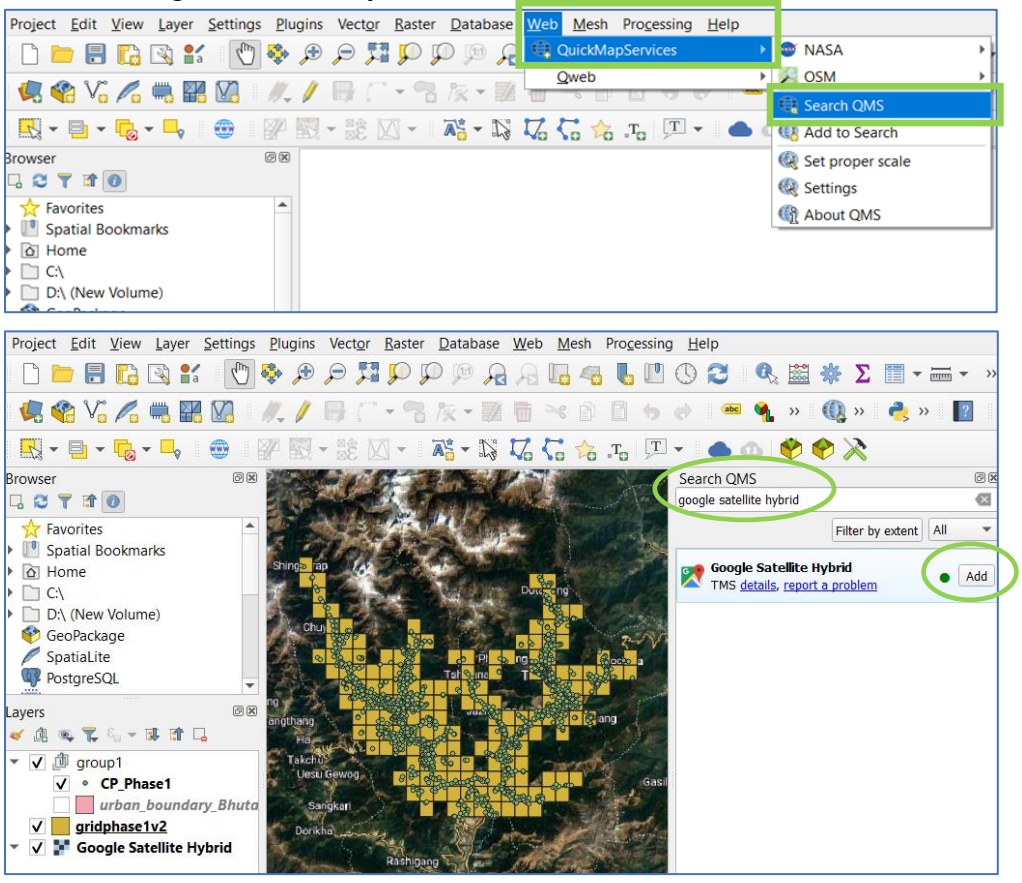


Fig 9: All layers are being ‘Packaged for Qfield’ on the laptop.

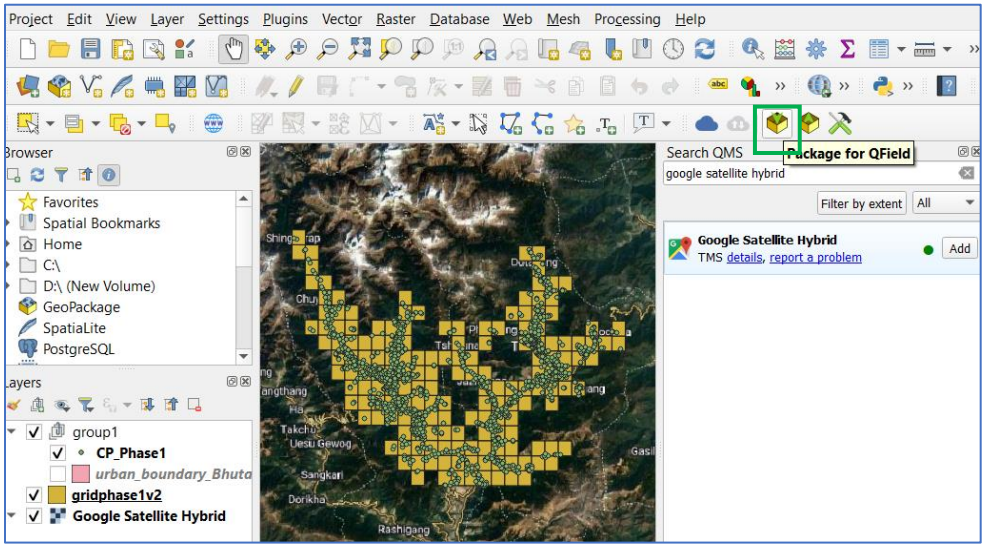


Fig 10: Displays the working folder and the layers being prepared for packaging for QField.

- Select working folder → create a new folder as ‘Datum Field Data’→ just click on the folder → Directory: select require layers → create.

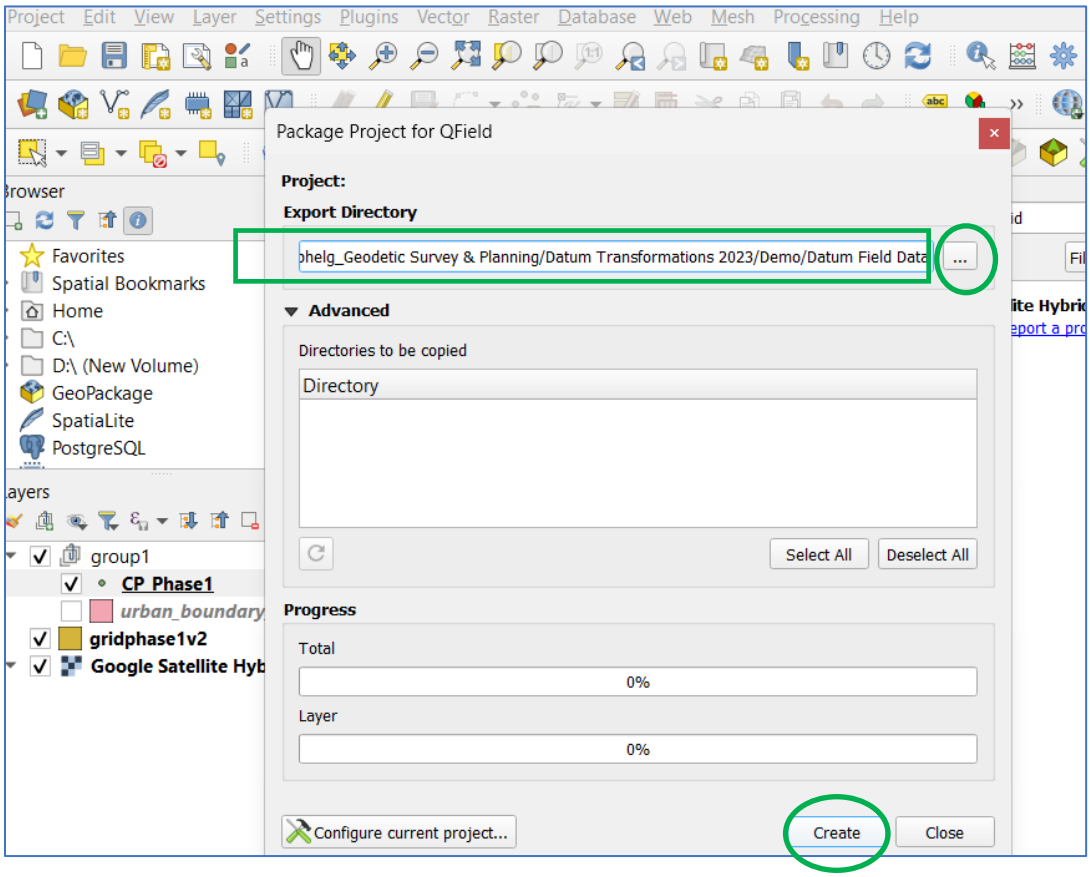
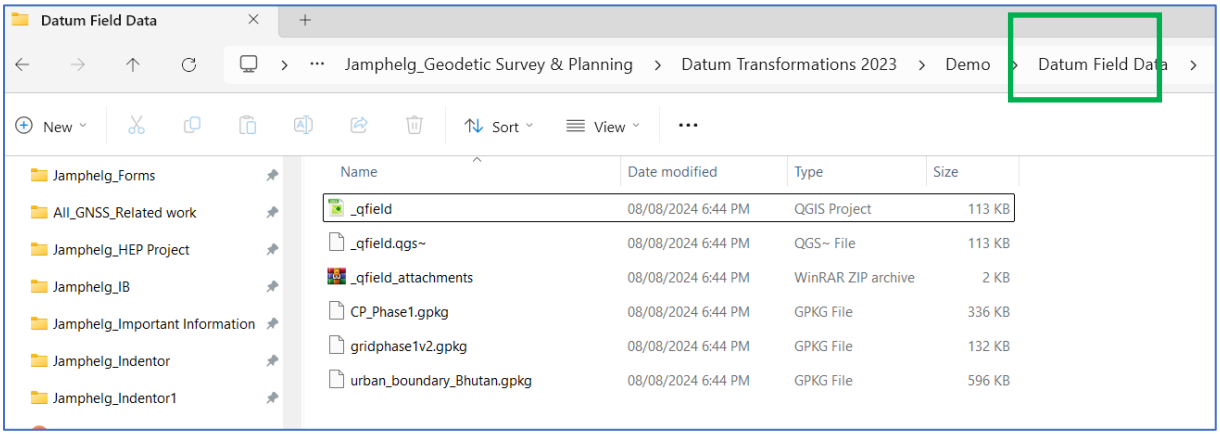


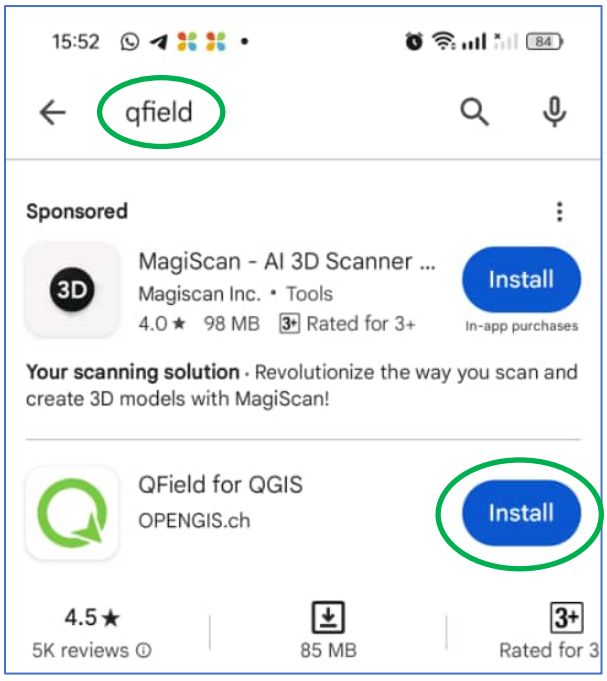
Fig 11: Demonstrates how to copy the 'Package for QField' folder and paste it into the mobile phone's internal memory or SD card.



4. Qfield Cloud

The QfieldCloud is use in this Datum Transformation to navigate the selected points to be observe and to view a point details on the phone.

Fig 12: Demonstrates how to install the QField app from the Play Store on a mobile phone and how to set up QField for use with QGIS on the mobile device.



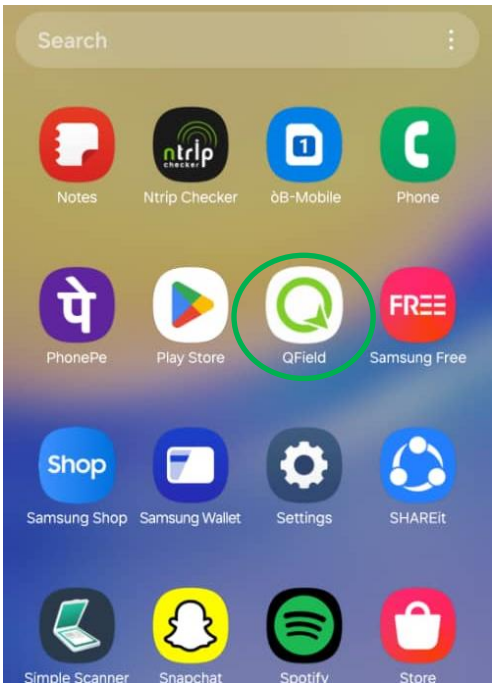


Fig13: Demonstrates how to open QField for QGIS, navigate to 'Open local file/QFieldCloud projects,' click the '+' icon, and select 'Import project from folder.

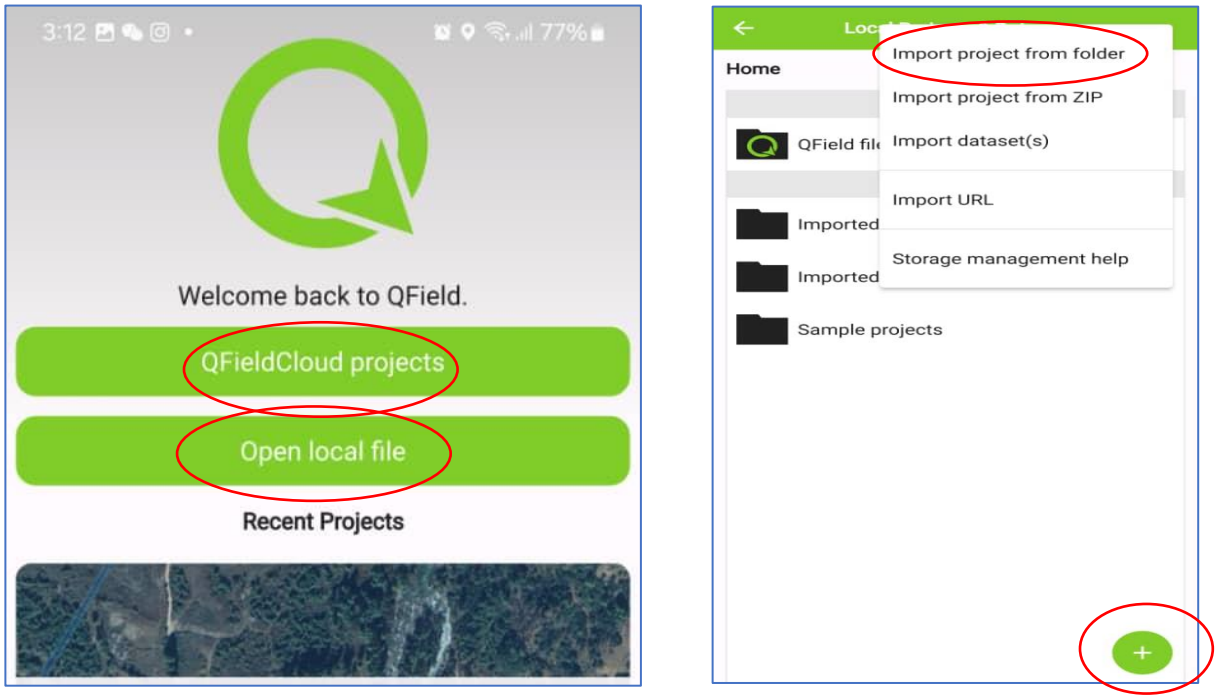


Fig 14: Click on ≡(Recent)→ select 'Datum Field data' folder in Phone Internal memory/SD card → then select created 'Package for Qfield' folder → then select main QGIS file saved with extension .qgs → Allow Qfield to access files in Datum field data → Allow.

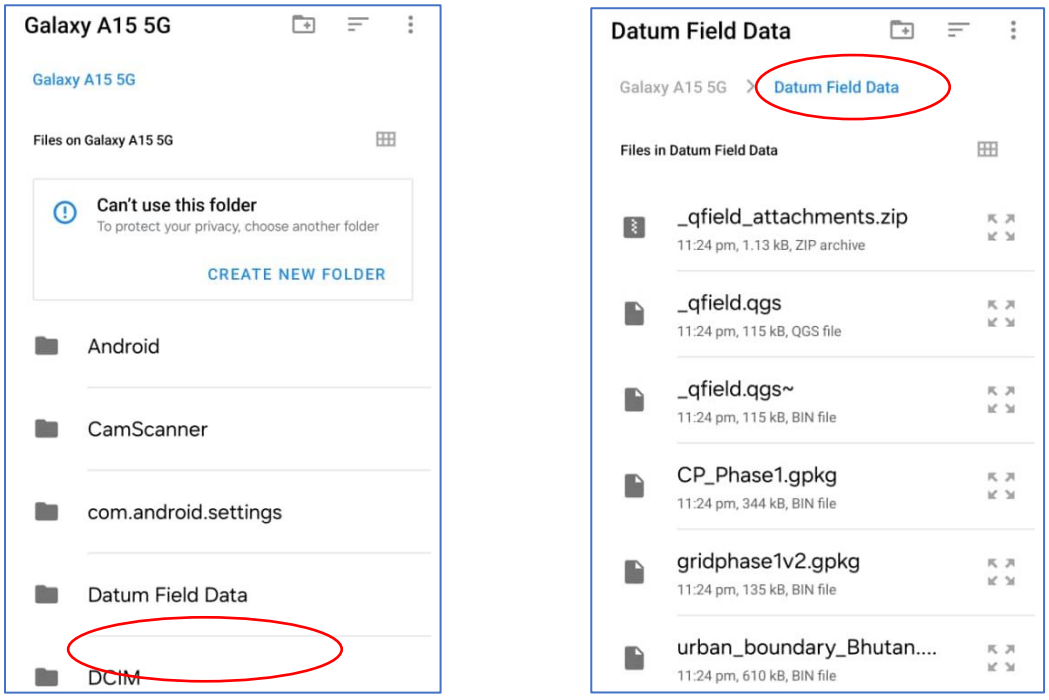
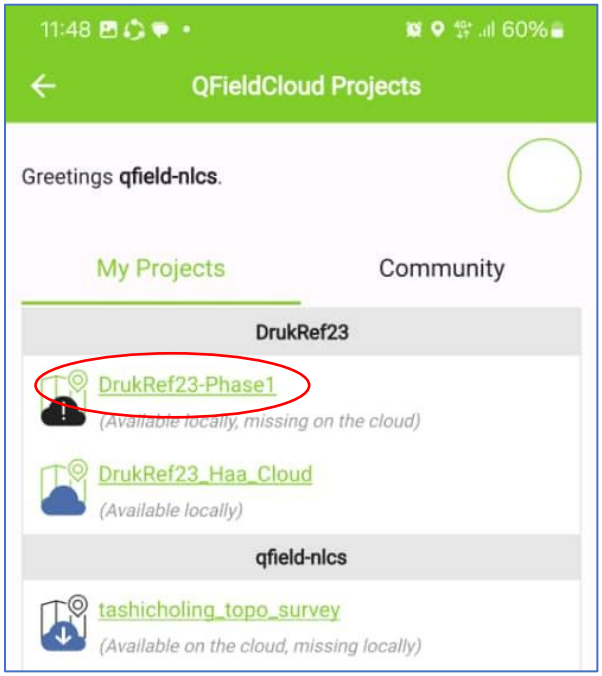
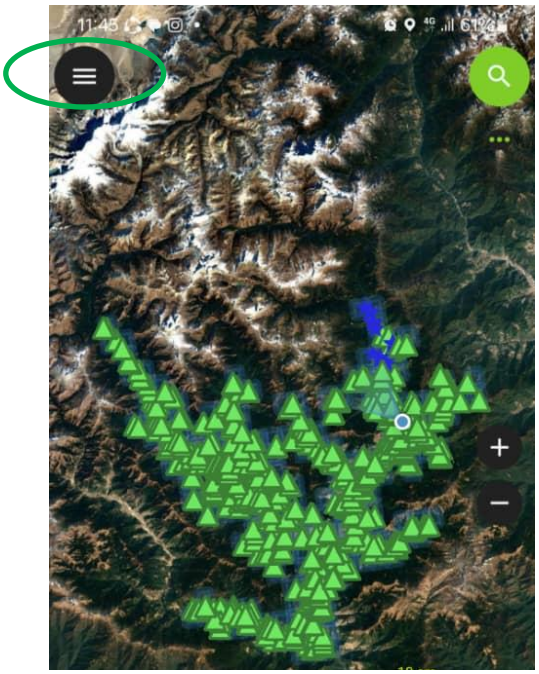


Fig 15: Shows the selection of main QGIS file saved with extension .qfield





5. Login of QfieldCloud account

- Username: qfield-nlcs
- Password: qfield@bhutan

Fig 16: Demonstrates how to navigate to the QField project and select the desired project to open.

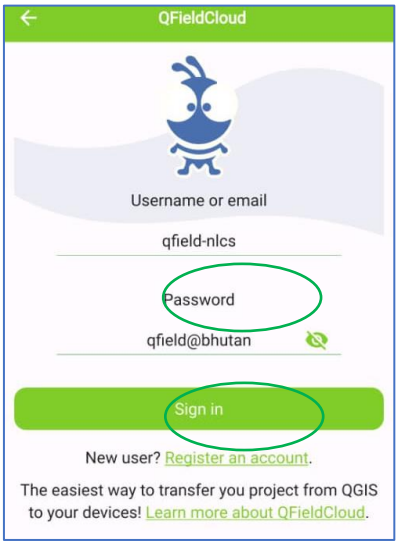
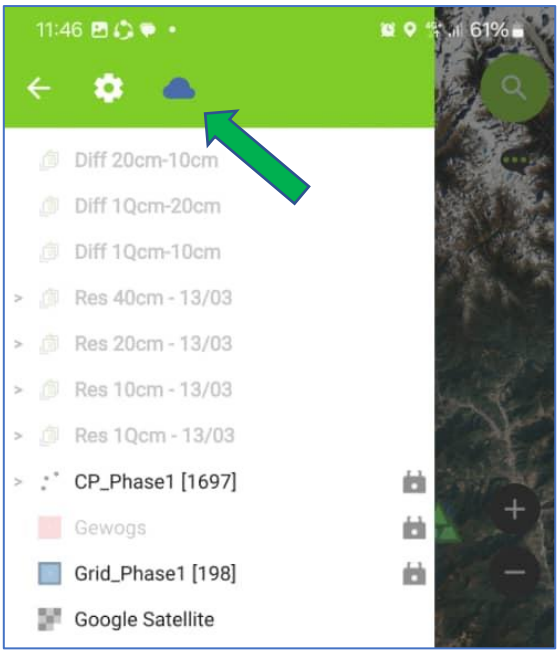
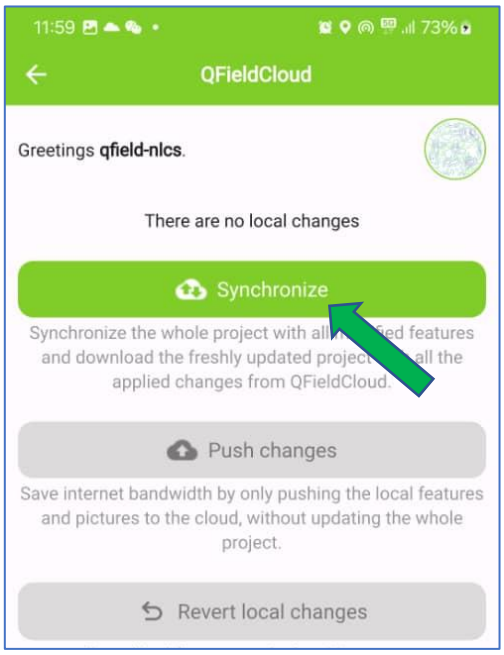


Fig 17: Click the cloud icon on the QField menu bar to synchronize. This will update all data. This process should be done daily to ensure the project is up-to-date before starting fieldwork.





6. Field Operations

Understand the objectives, scope, and methods of the fieldwork. Ensure all necessary equipment is functioning and properly calibrated. Gather materials needed for the fieldwork.

6.1 Site Reconnaissance:

Select a stable, unobstructed location with a commanding view for the base station, ensuring it is positioned away from any potential sources of interference.

6.2. Set a project

The field data will be stored in a project created in Project Manager → New → project name: “usually date”

- **Projection Parameters**

  Projection mode: Transverse Mercator

  Central meridian: E90.0

  False Northing: 0

  False Easting: 250000

Scale factor: 1

Latitude of origin: N0.0

Ellipsoid name: GRS80

6.3. Instrument Setup using Base Station

- Mount the antenna securely on a tripod.
- Attach the rover antenna to a pole.
- Establish a communication link with the base station.
- **Device** → communication → **Base** → select Base serial number.
- **DataLink** → Internal UHF.
- Elevation Mask → 10 to 15 degree
- Channel → select channel number as same as rover
- Input base coordinate of the base station → Connect
- **Device** → communication → **Rover** → select Rover serial number.
- Channel → select channel number as same as base→ connect.
- Before conducting any survey, it is the surveyor's duty to check at least two known SCP (Survey Control Points) near the base station.

6.4 Regular Checks

Table 1: Shows the field form used to check at least two known SCP (Survey Control Points) near the base station.

DrukRef23 - Check the base station coordinates against at least two other SCP points.

Dzongkhag: **Gewog**

Receiver type: **S/N:**

Known Coordinates				Observed Coordinates			Δ E	Δ N	Δ H	CORS	Baseline	Date
Point Id	Easting	Northing	Elevation	Easting	Northing	Elevation						

Surveyor Name &
Signature

7. Instrument Setup using CORS Station:

- Attach the rover antenna to a pole.
- Connect WIFI if using hotspot/Insert sim card in the controller for internet
- **Device** → communication → select Rover serial number → Connect
- **Rover** → DataLink → Phone Internet
- Elevation Mask → 10 to 15 degree
- Server/Network → CORS/NTRIP
- Set the logging interval for RTK survey → Count 60 on a station.
- CORS Setting: **IP** → ntrip.druknet.net → **Port:** 2101 → **User:** xxxxx → **Pwd:** *****
- Mount point setting: Select your nearest CORS station → Get Access Point → Apply.
- First, input the coordinates of the point to be checked using the stakeout method. If the point is found to be accurate within the tolerance, it can be considered reliable for use in the datum observation project.

Table 2: Displays the field forms that need to be completed while observing a point.

DrukRef23 – Field Data Acquisition

Dzongkhag: **Gewog:** **Date:**

Receiver type: **S/N:** **Reference Station:**

Point Code	Time (UTC)	X	Y	Z	Mast Height (m)	Error H (mm)	Error V (mm)	Fix Amb	Baseline (km)	Remarks

Surveyor Name and Sign

8. Requirements for Maintaining Important Documents in Datum Transformation Field Work:

- Fill in all required fields on the forms before moving to the next station.
- Capture clear photos and a 360-degree video of the station with the GNSS RTK position clearly marked.
- Download the CSV files for the day's work.
- Scan the forms using your mobile phone and save them in PDF format.
- Create a folder with the date and a name like '11082024_JG' to store only the scanned field forms and CSV files.
- Create another folder with the date and a name like '11082024_JG_PhotoVideo' to store only the photos and videos from the day's work.

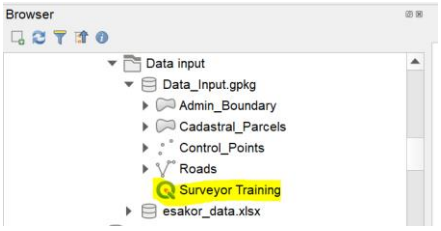
9. Data Submission:

- Every day, field surveyors will compile the required data and send it to the Datum Transformation team.
- Send the '11082024_JG' folder to the Datum Transformation team for updates.
- Keep the '11082024_JG_PhotoVideo' folder safely on your laptop. If needed for clarification or further verification, specific photos and videos can be sent to the Datum Transformation team.

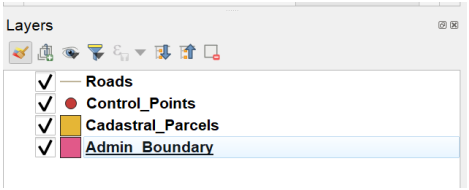
Day 3: GIS and RS for cadastral Related - Operating Manual of Practice

Open the project file

1. Download the training data https://github.com/chokila/Surveyor-Training
2. Click and download the **Training_Data.gpkg** file and paste in your computer under convenient drive.
3. Open the QGIS and Go to the Browser panel on the Left-hand side and double click on the Project file name Surveyor Training



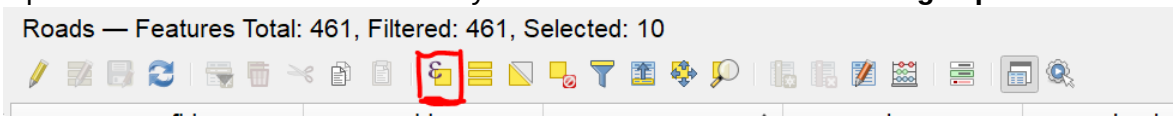
4. You can see the following points, line and polygon layers added in the map



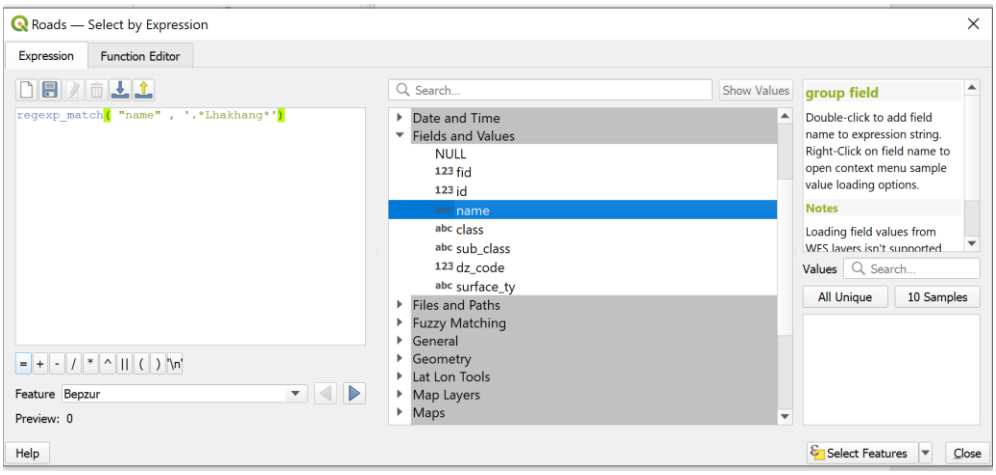
Regular Expression:

Exercise 1: Select all the road that has name with ' Lhakhang'.

1. We can use **Regular Expression** for this.
2. Open the attribute table of **Roads** layer and click **select features using expressions.**



3. Write the regular expression as below and click **Select Features**



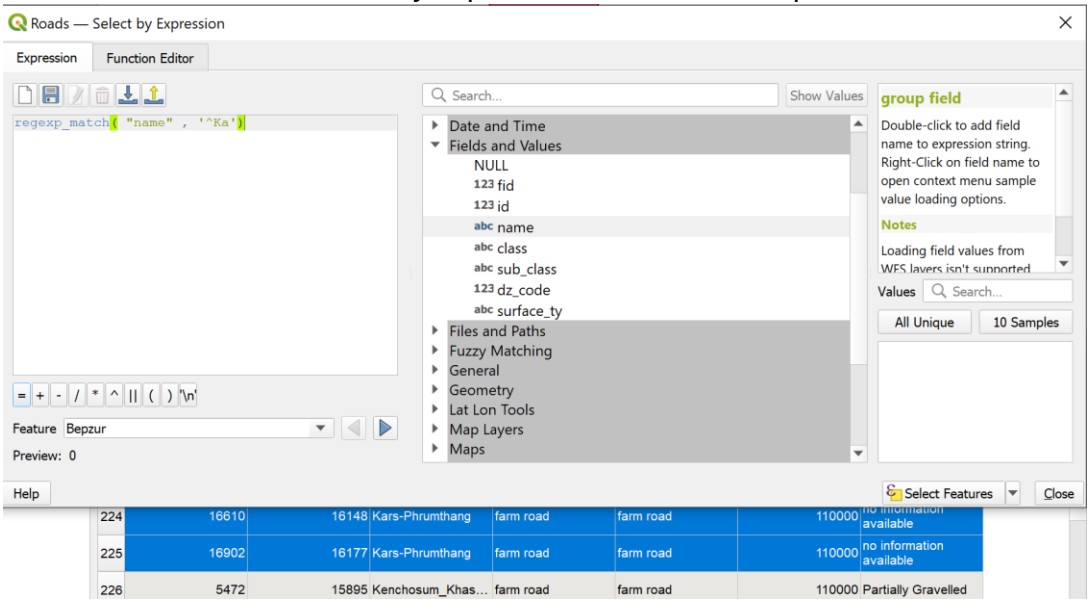
4. Note that placing **.*** before and after 'Lhakhang' ensures that it matches 'Lhakhang' appearing anywhere within the string, whether at the beginning, middle, or end.

5. The other alternative expression can be as

```
"name" LIKE '%Lhakhang%'
```

Exercise 2: Select any road names that begin with letter 'Ka'

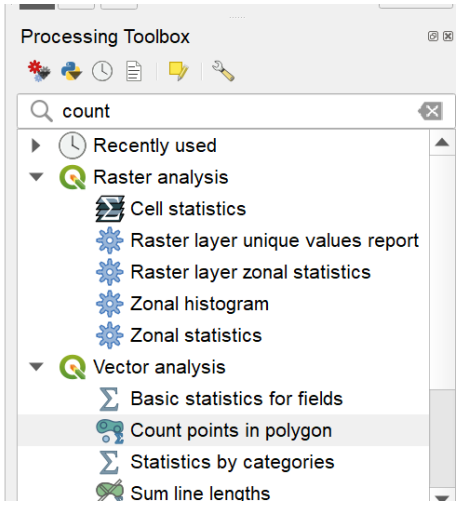
1. Click on the select feature by expression and write the expression as shown below.



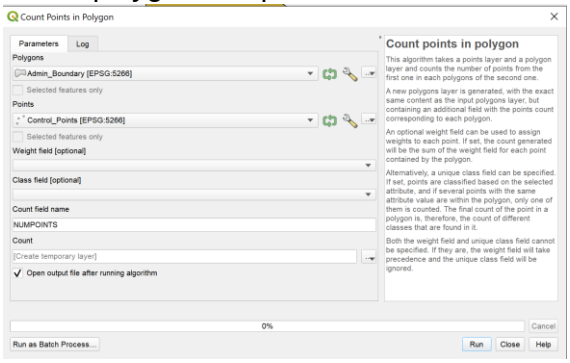
Processing Tools

Exercise 3: You are given the admin boundary polygon consisting of Gewogs and control point for whole Bumthang Dzongkhag. Find out total number of control points in each Gewog.

1. You can use the processing tools to do the task
2. Click Toolbox (Ctrl+Alt+T) > type count > select and click **Count points in polygon** tool



3. Select polygon and points as shown below and click **Run** button



4. You can see new output temporary layer **Count**> open the attribute table and see new field NUMPOINTS containing the number of control points for respective Gewog as below.

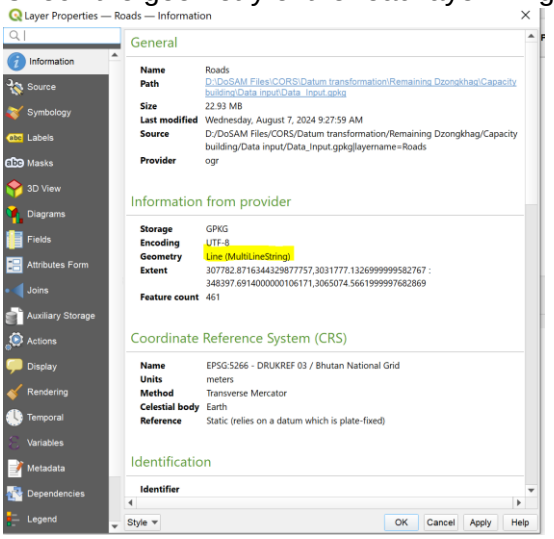
Count — Features Total: 4, Filtered: 4, Selected: 0

	fid	dzongkhag	gewog_name	NUMPOINTS
1	1	Bumthang	Ura	90
2	2	Bumthang	Chhume	180
3	3	Bumthang	Tang	185
4	4	Bumthang	Chokhor	257

Exercise 4: You are given the admin boundary polygon consisting of Gewogs and Road for whole Bumthang Dzongkhag. Find out total length of roads in each Gewog.

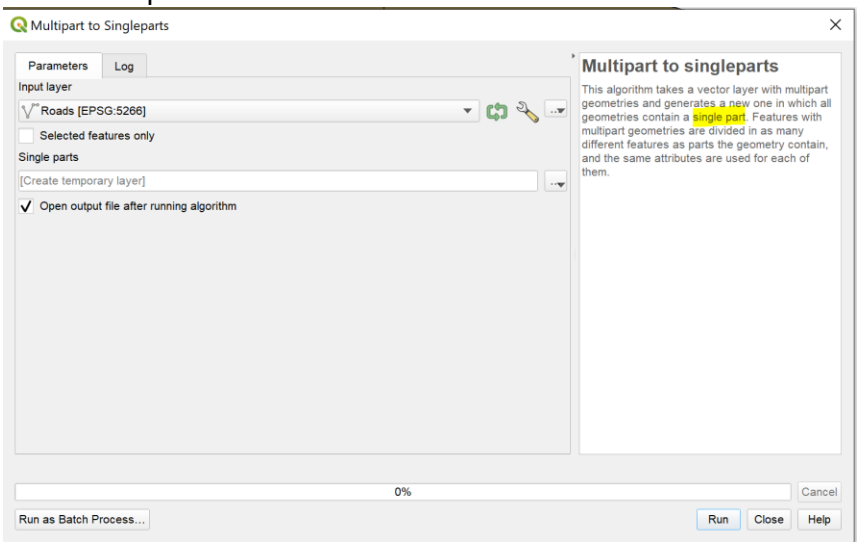
Steps:

1. Check the geometry of the road layer> Right Click on the Road layer>**Property...**>

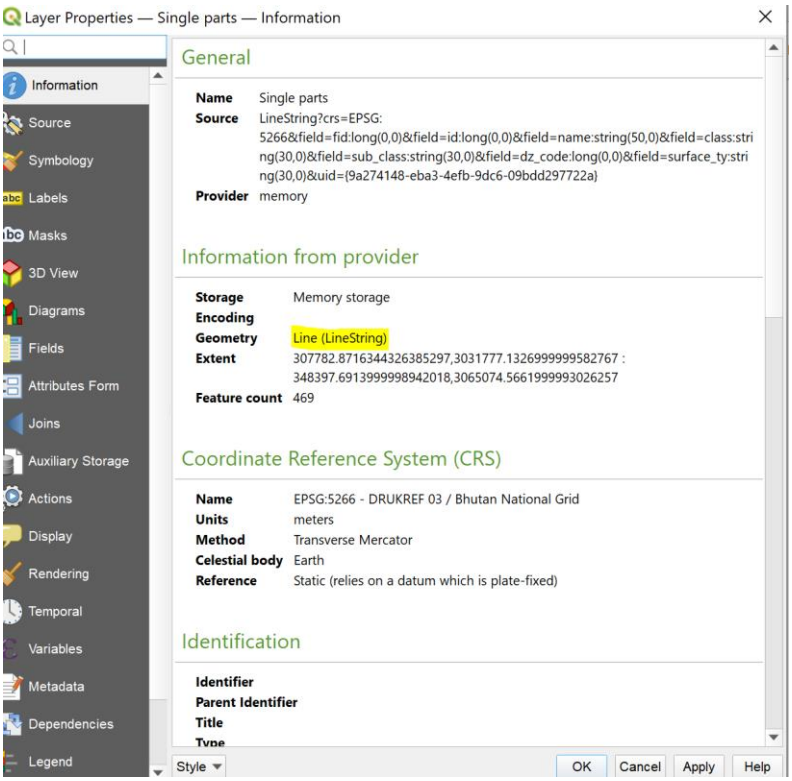


2. The geometry of the road is MultiLineString which is a collection of multiple LineString geometries grouped into a single feature.. This geometry needs to be converted to LineString to enable joining by location later.

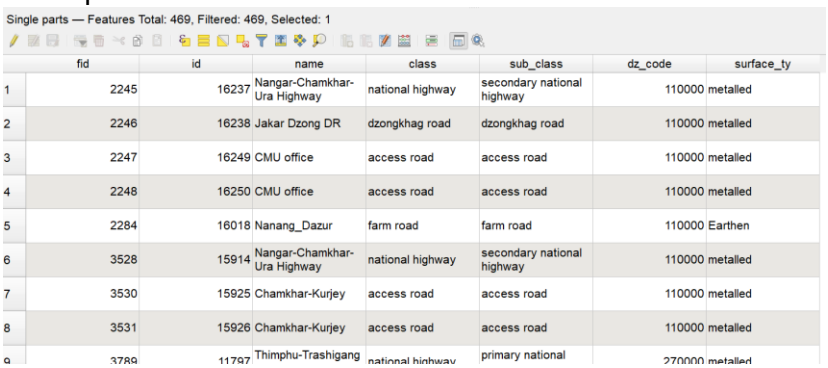
3. Go to the processing toolbox> Type single> Select **Multipart to Singleparts**>and select **Road** as input as below and Click **Run**.



4. You can see new temporary layer Single parts> check the layer geometry by clicking the layer property.

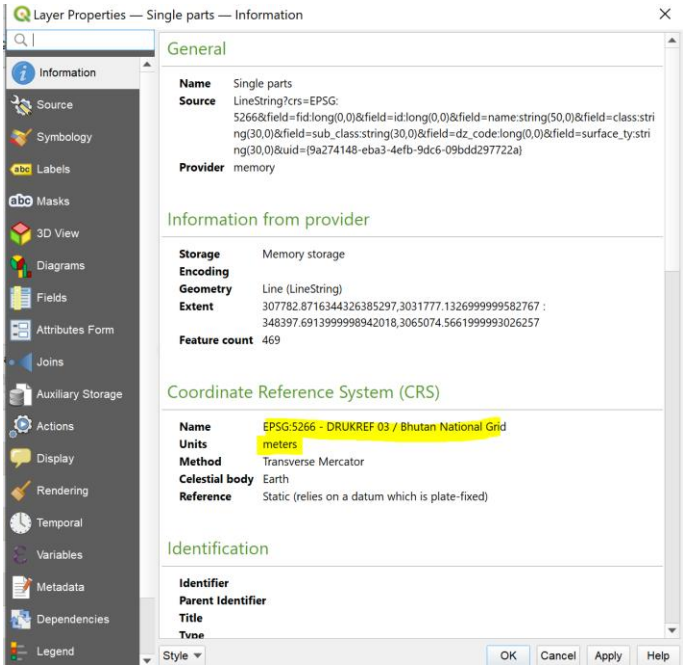


5. Also open the attribute table and see the available fields.

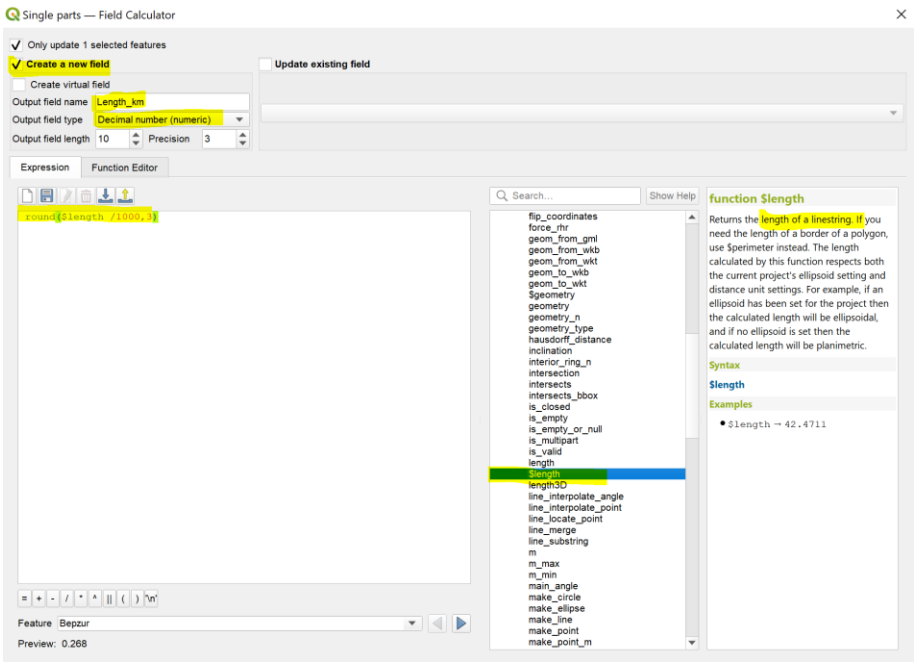


	fid	id	name	class	sub_class	dz_code	surface_ty
1	2245	16237	Nangar-Chamkhar-Ura Highway	national highway	secondary national highway	110000	metalled
2	2246	16238	Jakar Dzong DR	dzongkhag road	dzongkhag road	110000	metalled
3	2247	16249	CMU office	access road	access road	110000	metalled
4	2248	16250	CMU office	access road	access road	110000	metalled
5	2284	16018	Nanang_Dazur	farm road	farm road	110000	Earthen
6	3528	15914	Nangar-Chamkhar-Ura Highway	national highway	secondary national highway	110000	metalled
7	3530	15925	Chamkhar-Kurjey	access road	access road	110000	metalled
8	3531	15926	Chamkhar-Kurjey	access road	access road	110000	metalled
9	3789	11797	Thimphu-Trashigang	national highway	primary national	270000	metalled

6. There are total of 469 road line features for whole Dzongkhag. Now you have to calculate the length in kilometer of each line features under the new field **length_km**. Note that the layer is in projected coordinate system for distance calculation. You can check this by clicking the layer property.



7. From the attribute table, click field calculator and write the expression as follow and Click OK.



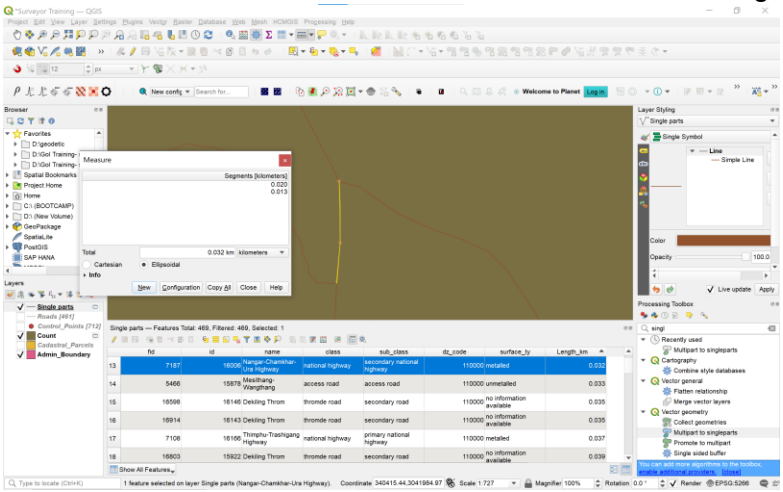
8. Note the we use $length to calculate the distance of the line feature which return in meter. By dividing with 1000 we convert into km. we also round the result up-to 3 decimal place. The attribute table is seen updated with new field.

Single parts — Features Total: 469, Filtered: 469, Selected: 0

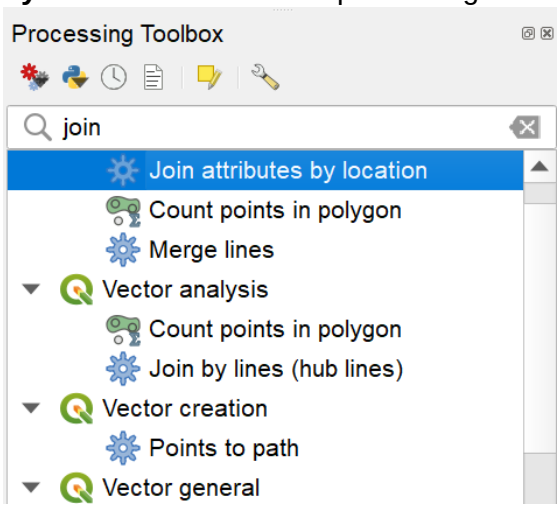
123fid = ε 123 Update All Update Selecte

	fid	id	name	class	sub_class	dz_code	surface_ty	Length_km
1	2245	16237	Nangar-Chamkhar-Ura Highway	national highway	secondary national highway	110000	metalled	0.554
2	2246	16238	Jakar Dzong DR	dzongkhag road	dzongkhag road	110000	metalled	0.075
3	2247	16249	CMU office	access road	access road	110000	metalled	0.013
4	2248	16250	CMU office	access road	access road	110000	metalled	0.135
5	2284	16018	Nanang_Dazur	farm road	farm road	110000	Earthen	0.213
6	3528	15914	Nangar-Chamkhar-Ura Highway	national highway	secondary national highway	110000	metalled	0.488
7	3530	15925	Chamkhar-Kuriev	access road	access road	110000	metalled	0.027

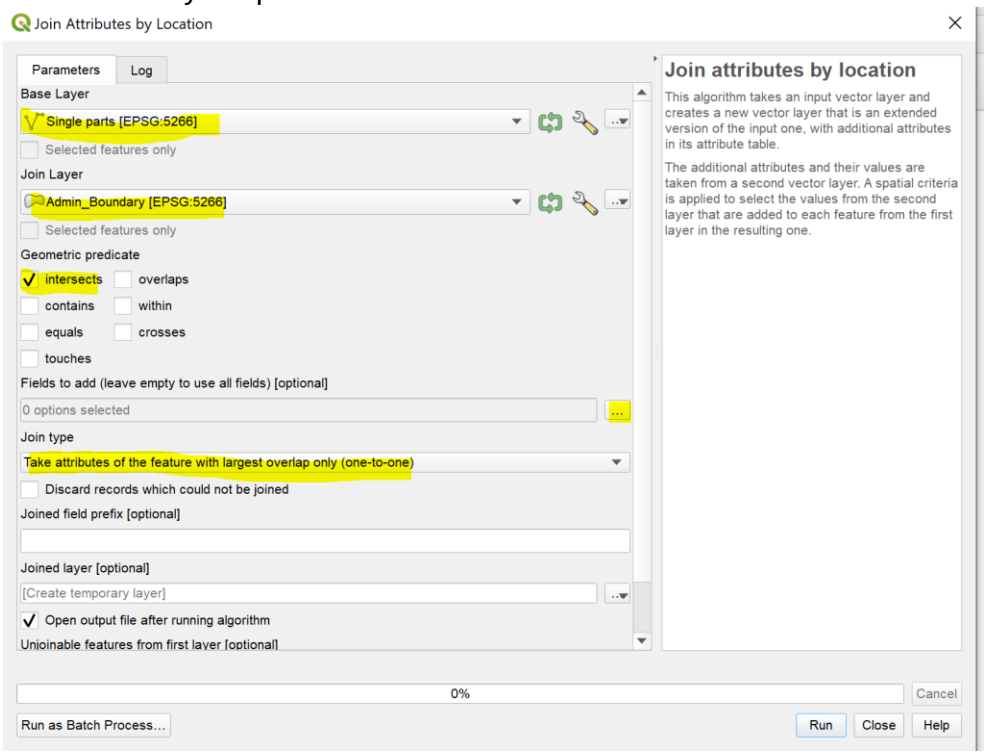
9. You can also check the calculated distance with measuring tool



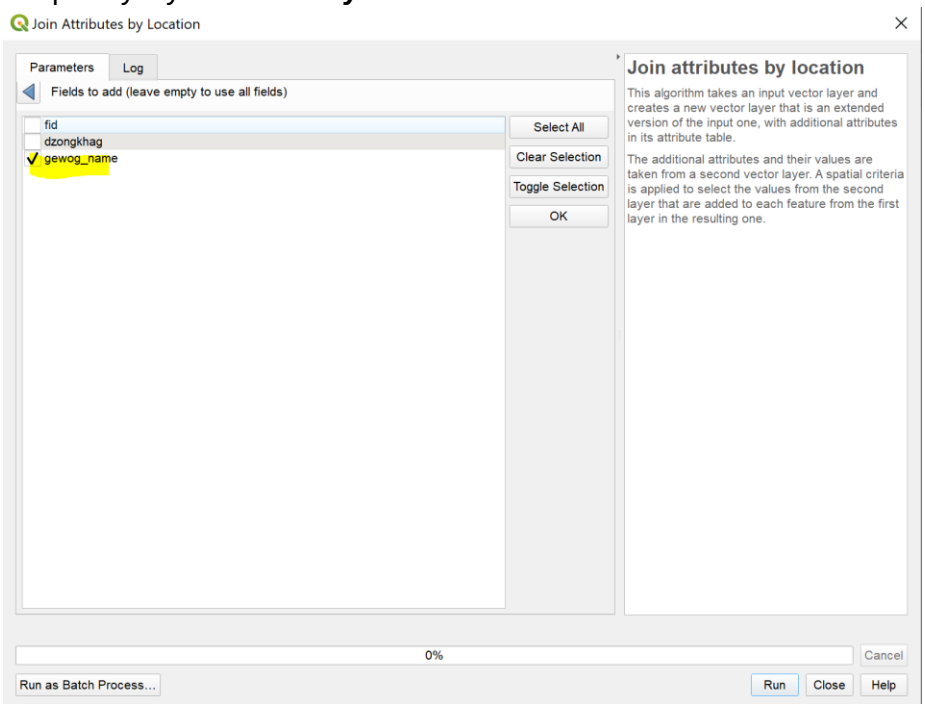
10. Next, we need to have Gewog detail for each road segment. We can use Join **attributes by location** tool from the processing tool as follow.



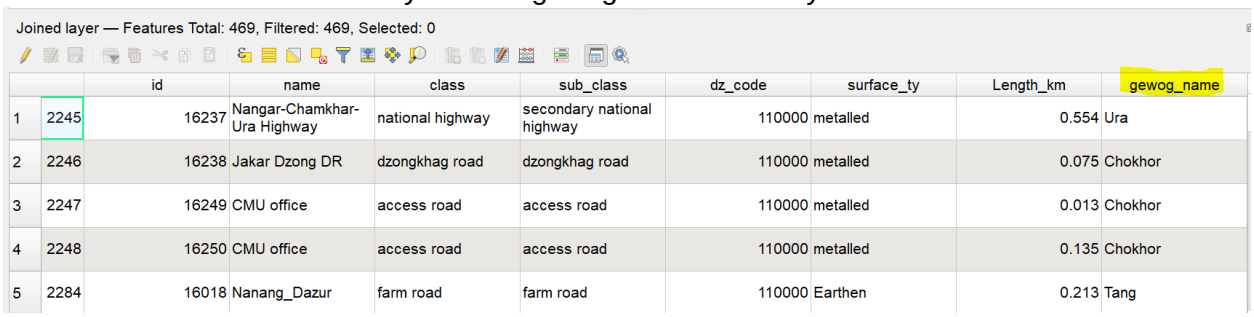
11. Choose the layer input as below



12. Choose Gewog as the Field to add by clicking the three dots and click **Run.** The new temporary layer **Joined layer** is created.

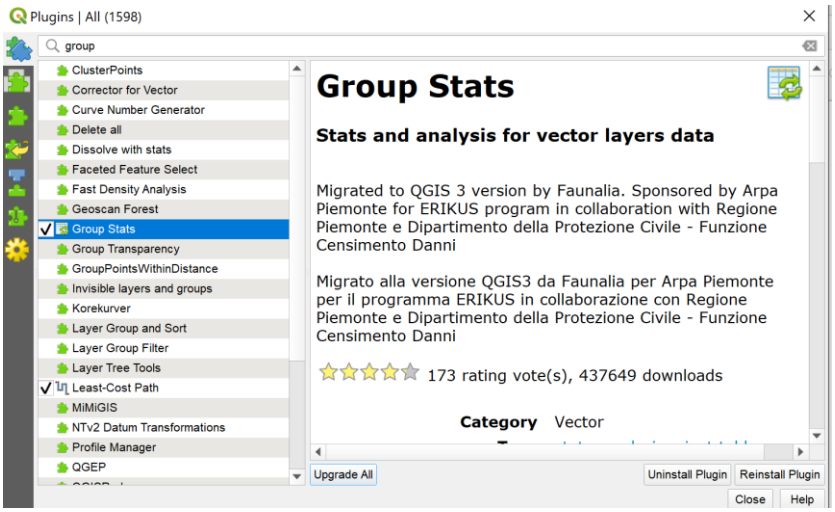


13. Check the attribute table. Now you have gewog name for every road feature.

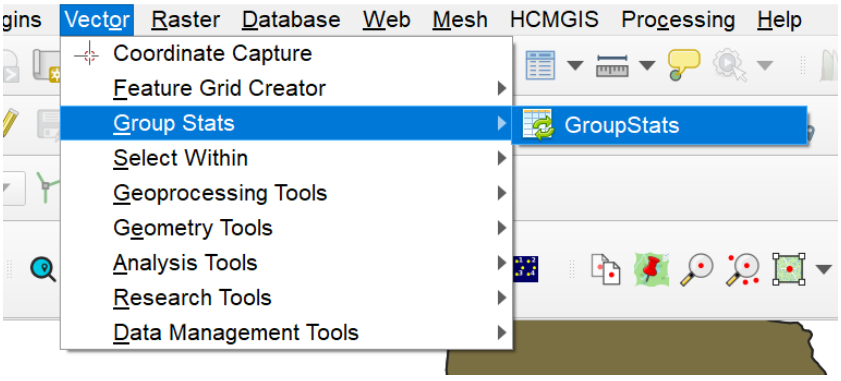

Joined layer — Features Total: 469, Filtered: 469, Selected: 0

	id		name	class	sub_class	dz_code	surface_ty	Length_km	gewog_name
1	2245	16237	Nangar-Chamkhar-Ura Highway	national highway	secondary national highway	110000	metalled	0.554	Ura
2	2246	16238	Jakar Dzong DR	dzongkhag road	dzongkhag road	110000	metalled	0.075	Chokhor
3	2247	16249	CMU office	access road	access road	110000	metalled	0.013	Chokhor
4	2248	16250	CMU office	access road	access road	110000	metalled	0.135	Chokhor
5	2284	16018	Nanang_Dazur	farm road	farm road	110000	Earthen	0.213	Tang

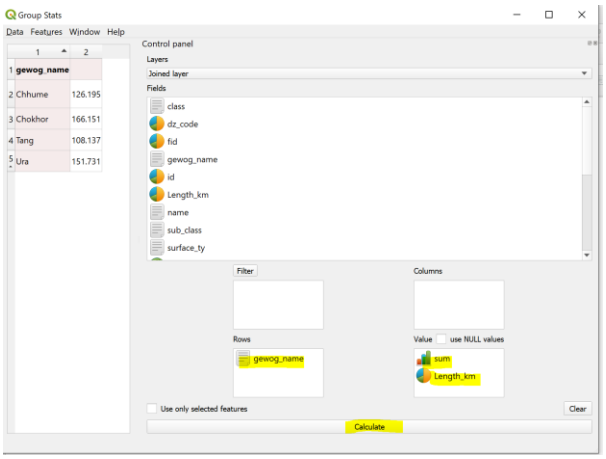
14. Now, there are different ways to generate report of total road length for every gewog. For this exercise we can use tools available through Plugins. Go to Plugins>Manage and install Plugins..>type **group** and select **Group Stats**>click install button.



15. Once installed its available under Vector menu as shown below.



16. Select Group Stats. Select the layer as Joined Layer. And drag and drop the control elements are shown below and click **Calculate**.

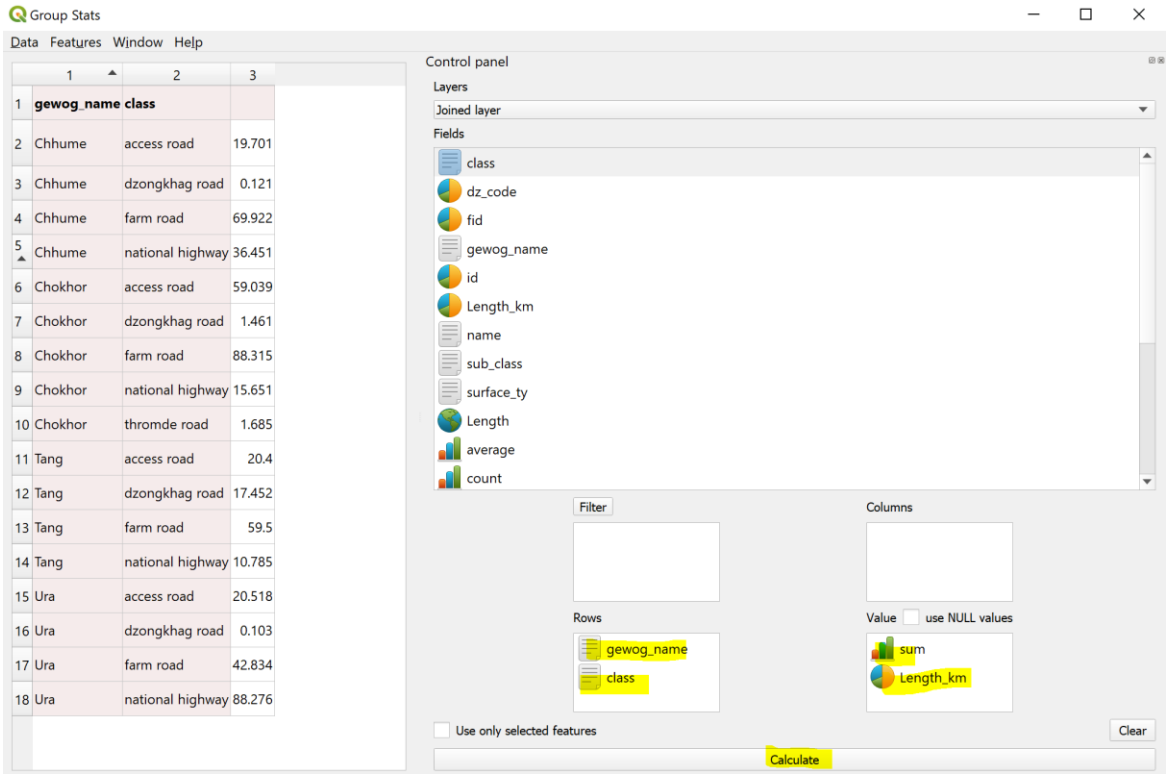


17. The desired result generated on the left-hand side.

Exercise 5: Generate gewog wise total road length categorized based on road class.

1. Since all the required fields are in the **Joined layer**, we can use the Group Stats.

2. Select the layer as Joined Layer. And drag and drop the control elements are shown below and click **Calculate**.

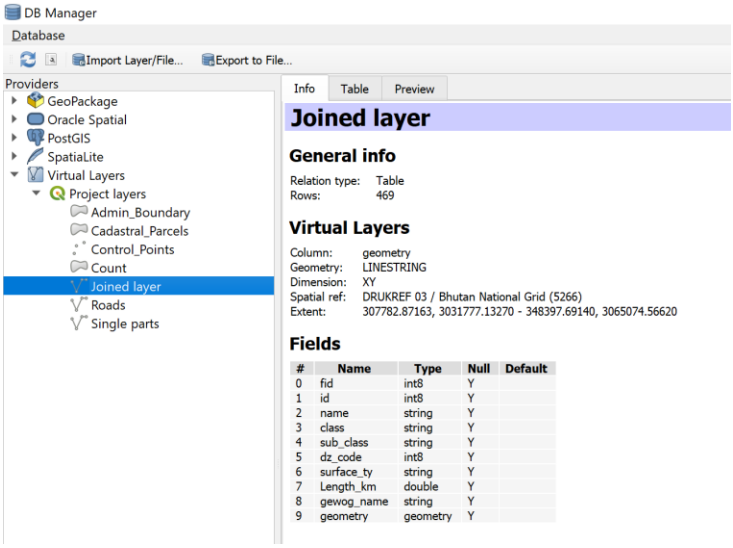


	1	2	3
1	gewog_name	class	
2	Chhume	access road	19.701
3	Chhume	dzongkhag road	0.121
4	Chhume	farm road	69.922
5	Chhume	national highway	36.451
6	Chokhor	access road	59.039
7	Chokhor	dzongkhag road	1.461
8	Chokhor	farm road	88.315
9	Chokhor	national highway	15.651
10	Chokhor	thromde road	1.685
11	Tang	access road	20.4
12	Tang	dzongkhag road	17.452
13	Tang	farm road	59.5
14	Tang	national highway	10.785
15	Ura	access road	20.518
16	Ura	dzongkhag road	0.103
17	Ura	farm road	42.834
18	Ura	national highway	88.276

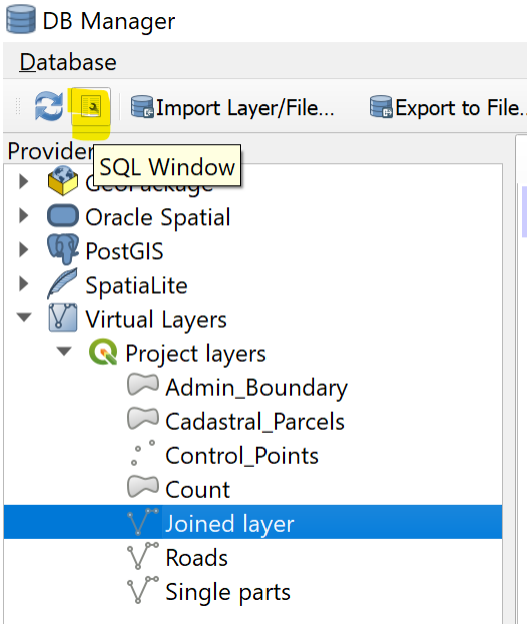
3. You can save the report in csv **Data>Save all to csv file**

Introducing SQL in QGIS

1. Go to **Database** under the Menu Toolbar>DB Manager…>Virtual Layer>Project layers>Joined layer



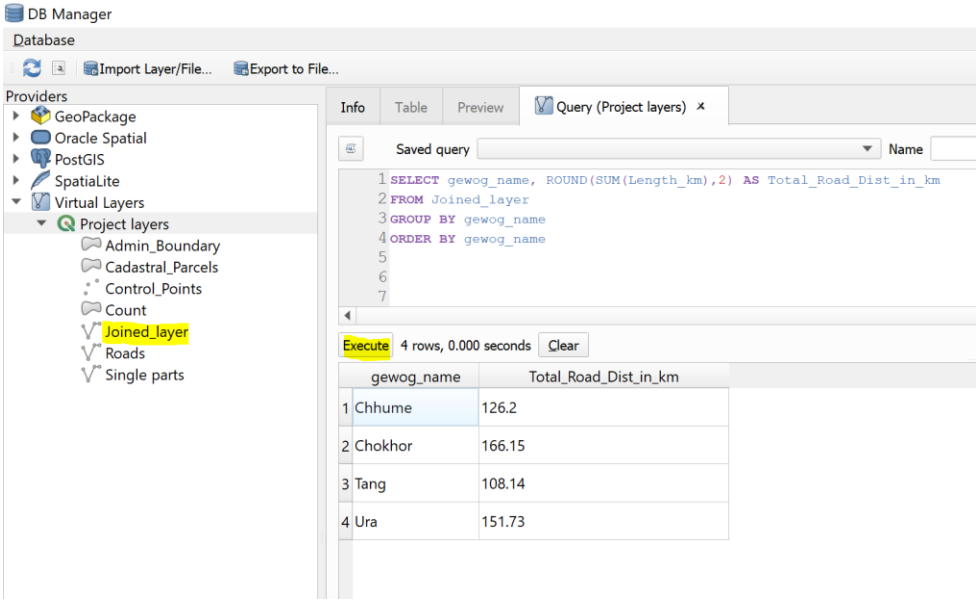
2. Click SQL window



3. Note that all the table name (here layer name) should be one word. Words can be joined by underscore. Therefore, **Joined layer** can be renamed as **Joined_layer**.

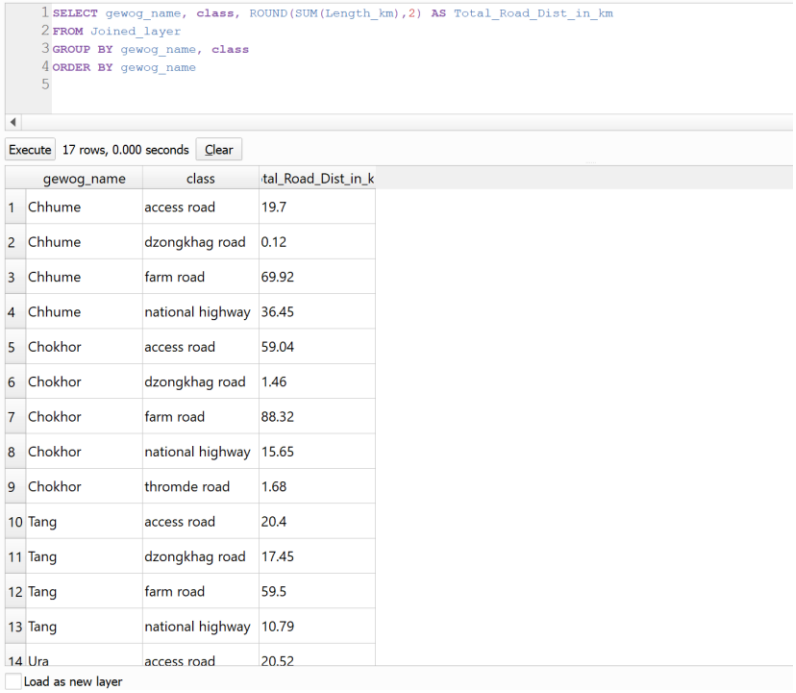
Exercise 6: In this exercise, we are going to perform the earlier task to find out total length of roads in each Gewog using the SQL command.

1. You can write few lines of sql codes as shown below. Click **Execute** button to run the script as below.

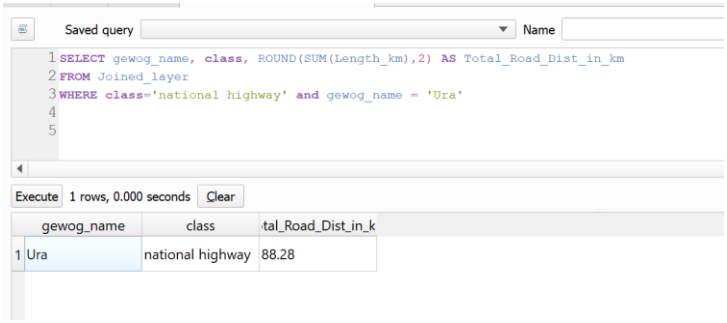


Exercise 7: Similarly, the second task of generating gewog wise total road length categorized based on road class.

1. This can be performed by writing few lines of code as shown below.



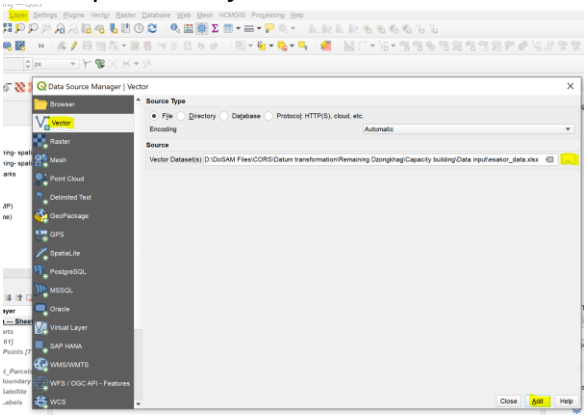
Exercise 8: Find out the total length of national highway in Ura gewog?



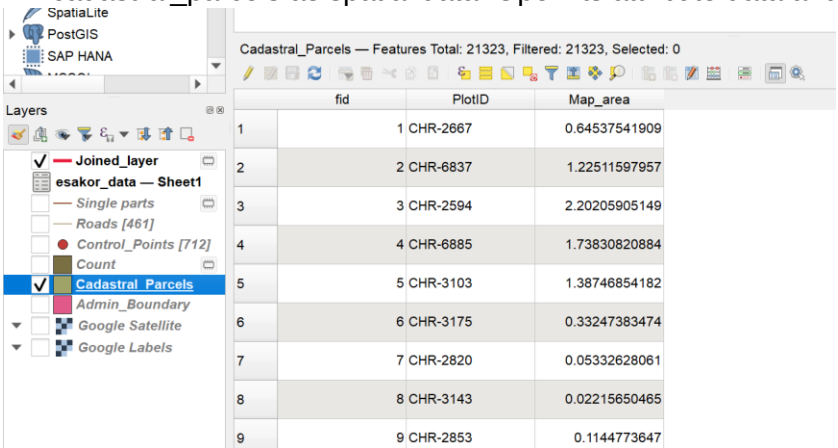
Joining Table

Next, we will learn how to join the tables

1. Add the excel file (navigate to your folder and select esakor_data.xlsx and add in the map as the layer



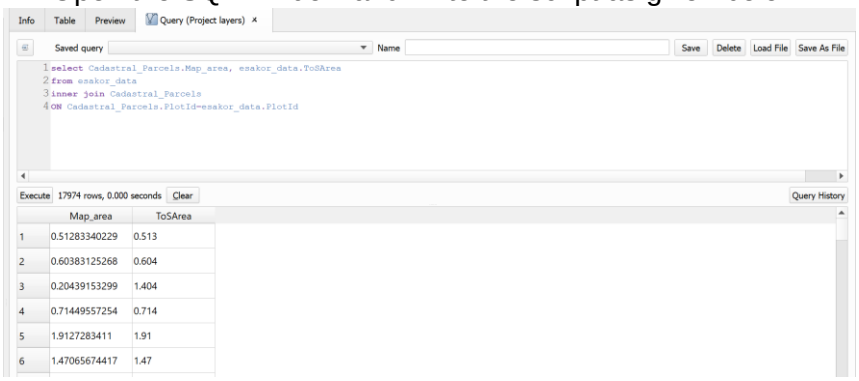
2. Open the attribute table and explore the data. This layer is not spatial. You are given cadastral_parcels as spatial data. Open its attribute data and explore the data.



	fid	PlotID	Map_area
1	1	CHR-2667	0.64537541909
2	2	CHR-6837	1.22511597957
3	3	CHR-2594	2.20205905149
4	4	CHR-6885	1.73830820884
5	5	CHR-3103	1.38746854182
6	6	CHR-3175	0.33247383474
7	7	CHR-2820	0.05332628061
8	8	CHR-3143	0.02215650465
9	9	CHR-2853	0.1144773647

3. We now want to join the two tables : esakor_data to the Cadastral_Parcels

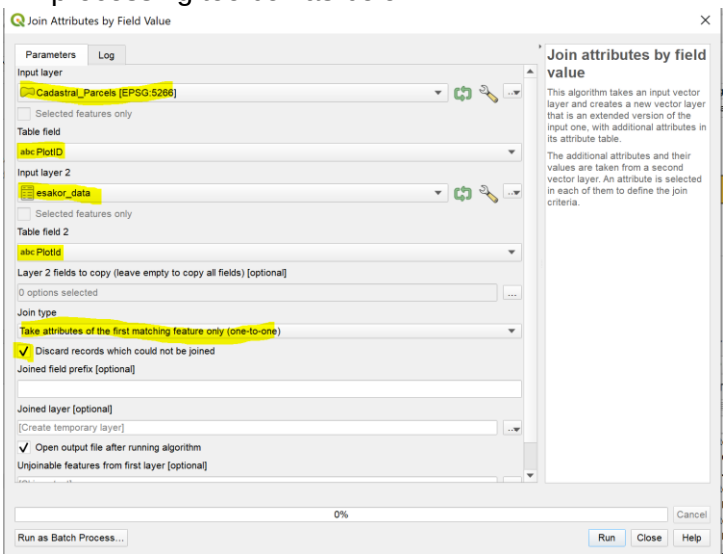
4. Open the SQL window and write the script as given below



5. The script extracts Map_area from cadastral_Parcels and ToSArea from esakor_data by joining the two tables.

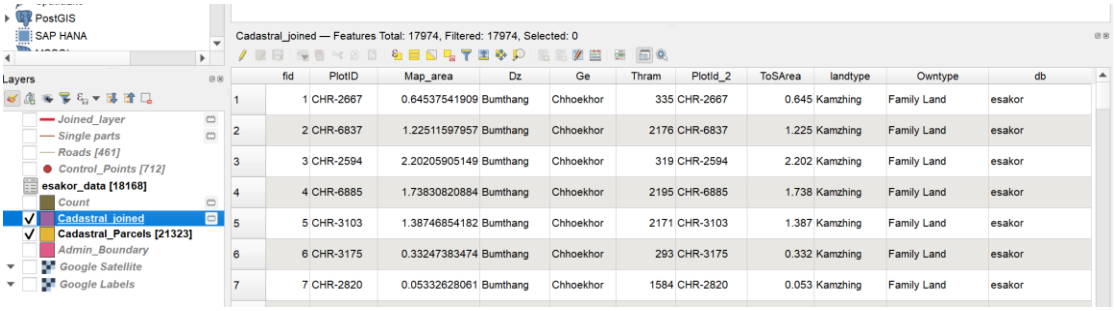
6. It is noted that given the number of records, it takes time depending on your processing capability of your computer.

7. Another way to join the tables are using the Join attributes by field values from the processing toolbox as below.



8. Hit the Run button and new layer **Joined layer** is created. Rename the layer as **Cadastral_joined**.

9. Open the attribute table and check joined data. All the esakor_data is appended to the cadastral_parcels matching the primary key (PlotID) in both the tables. Note that its has correctly discarded the unmatched records.



	fid	PlotID	Map_area	Dz	Ge	Thram	PlotId_2	ToSArea	landtype	Owntype	db
1	1	CHR-2667	0.64537541909	Bumthang	Chhoekhor	335	CHR-2667	0.645	Kamzhing	Family Land	esakor
2	2	CHR-6837	1.22511597957	Bumthang	Chhoekhor	2176	CHR-6837	1.225	Kamzhing	Family Land	esakor
3	3	CHR-2594	2.20205905149	Bumthang	Chhoekhor	319	CHR-2594	2.202	Kamzhing	Family Land	esakor
4	4	CHR-6885	1.73830820884	Bumthang	Chhoekhor	2195	CHR-6885	1.738	Kamzhing	Family Land	esakor
5	5	CHR-3103	1.38746854182	Bumthang	Chhoekhor	2171	CHR-3103	1.387	Kamzhing	Family Land	esakor
6	6	CHR-3175	0.33247383474	Bumthang	Chhoekhor	293	CHR-3175	0.332	Kamzhing	Family Land	esakor
7	7	CHR-2820	0.05332628061	Bumthang	Chhoekhor	1584	CHR-2820	0.053	Kamzhing	Family Land	esakor

Exercise 9: using SQL generate gewogwise landtypes and their total map area. Use **cadastral_joined** layer for query.

1. The SQL can be written as

```
select Ge,landtype, round(sum(Map_area),2) as Total_area from cadastral_joined
group by Ge, landtype
order by Ge
```

Execute 26 rows, 0.000 seconds Clear

	Ge	landtype	Total_area
1	Chhoekhor	Apple	53.62
2	Chhoekhor	Commuinty Land	2.95
3	Chhoekhor	Industrial Land	0.8
4	Chhoekhor	Institutional Land	375.84
5	Chhoekhor	Kamzhing	4787.34
6	Chhoekhor	Residential Land	41.01
7	Chhumig	Any Other CC	1.89
8	Chhumig	Apple	45.48
9	Chhumig	Cardamom	0.06
10	Chhumig	Chhuzhing	0.76

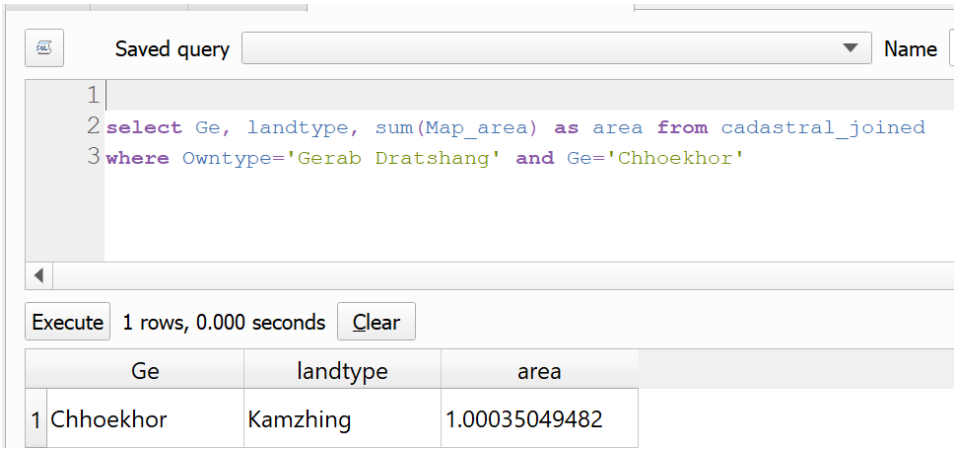
Exercise 10: What are the land ownership types in Bumthang Dzongkhag?

```
select distinct Owntype from cadastral_joined
```

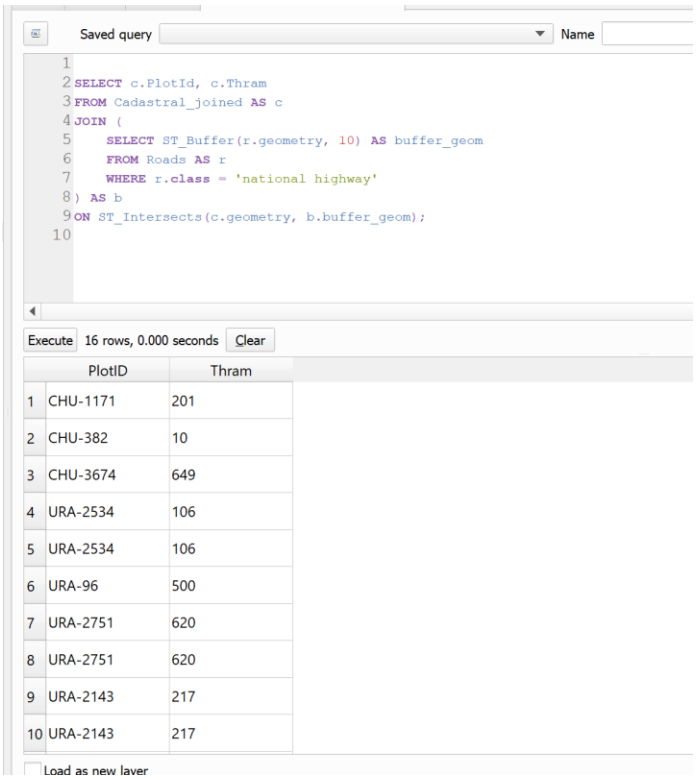
Execute 11 rows, 0.000 seconds Clear

	Owntype
1	Family Land
2	Individual Person
3	Religious Institutions
4	Joint Owners
5	Government Institutions
6	Community Land
7	Private Institutions
8	Corporations
9	Civil Society Organizations
10	Crown Property
11	Gerab Dratshang

Exercise 11: What is the total map area of land registered as Gerab Dratshang under Urahh gewog?



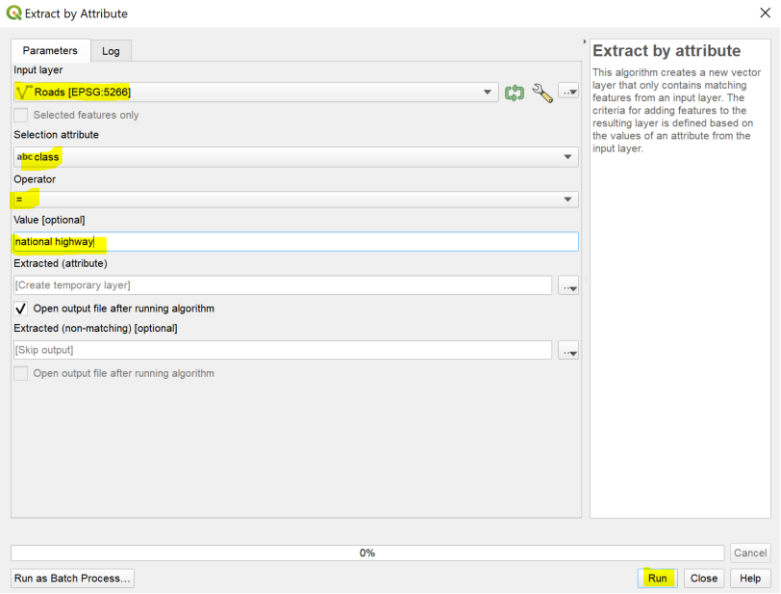
Exercise 12: Select plotID and thram No of plots falling within the 10m buffer distance of national highway.



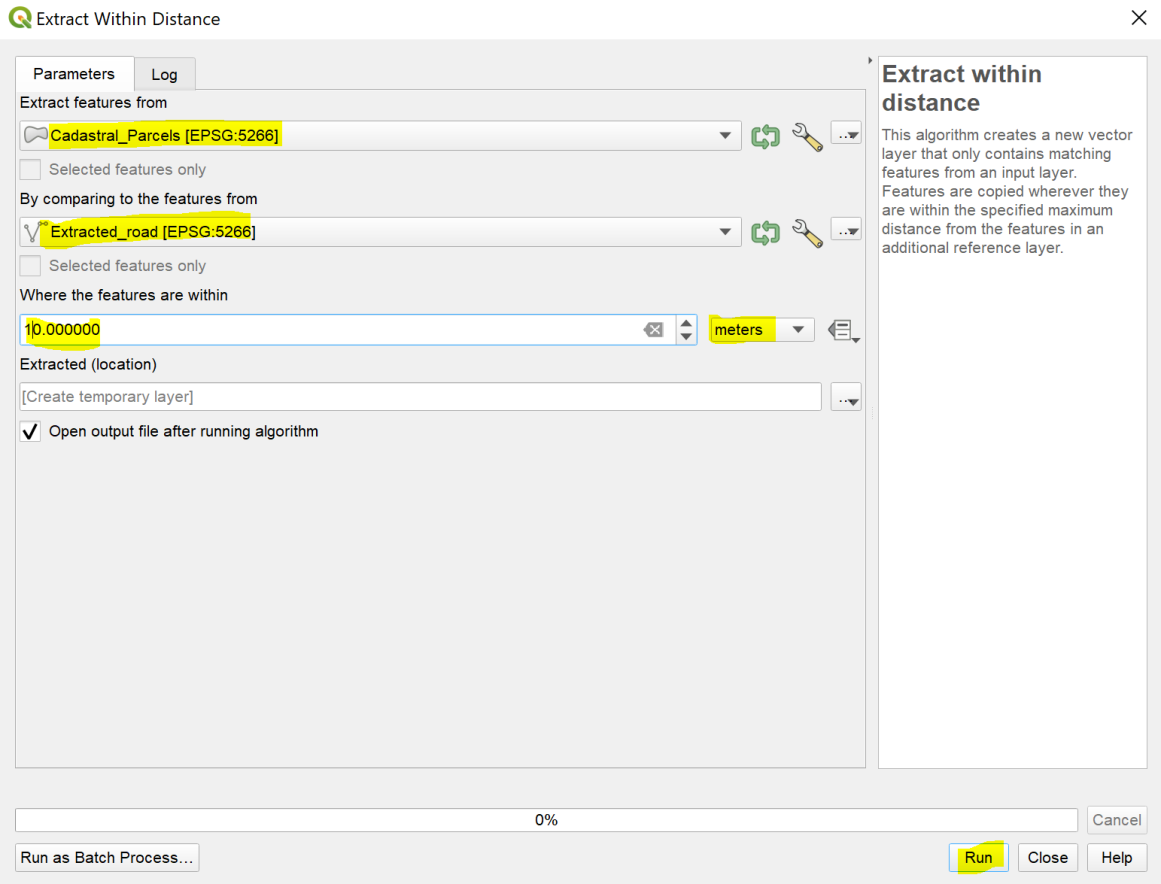
Another alternative way of doing this exercise is using the tool from the processing toolbox.

It involves following process:

Extracting the road class as national highway



Extracting cadastral_Parcel falling within 10m



Exercise 13: You need to provide quick detail report on the plots affected by the farm roads. Your detail should include the following:

- Gewog wise plots affected by the farm road (consider the size of farm road as 5m width)
- Total affected area of plots based on land types

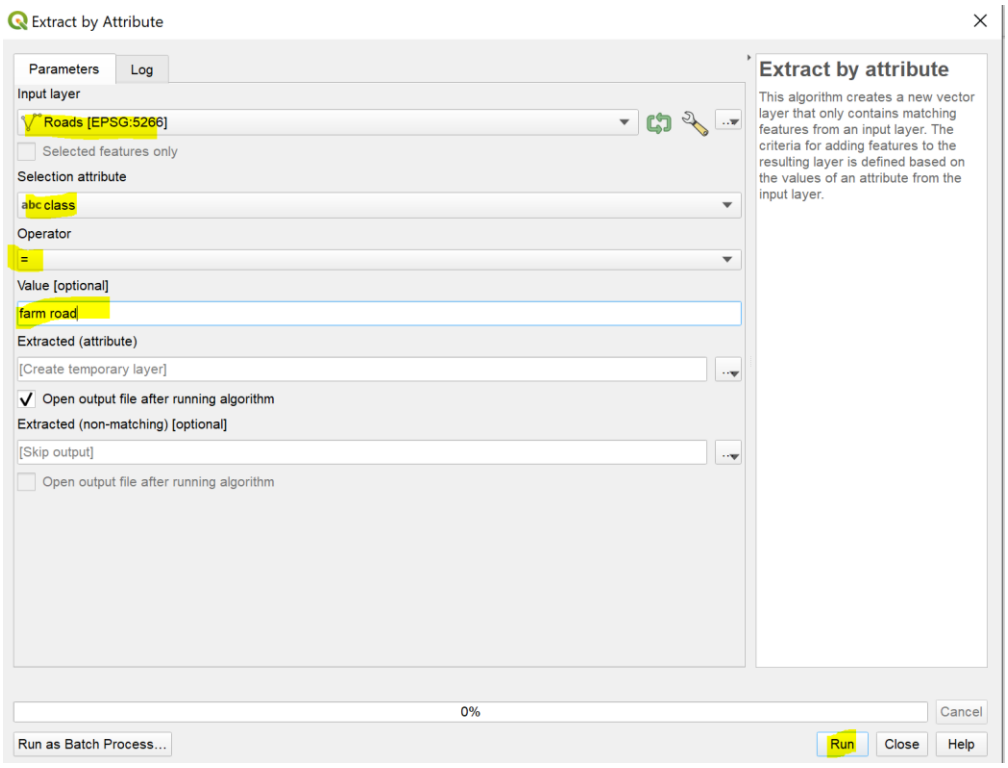
Your result should look like below:

Gewog	landtype	Total affected Area (ac)
Chhoekhor	Apple	0.01
	Commuinty Land	0.01
	Institutional Land	0.20
	Kamzhing	2.17
	Residential Land	0.03
Chhumig	Any Other CC	0.00
	Apple	0.07
	Commuinty Land	0.00
	Industrial Land	0.01
	Institutional Land	0.06
	Kamzhing	0.93
	Recreational Land	0.00
	Residential Land	0.03
Tang	Institutional Land	0.59
	Kamzhing	1.46
	Residential Land	0.01
Urahh	Apple	0.00
	Institutional Land	0.15
	Kamzhing	1.85
	Residential Land	0.02
Total affected area in Bumthang		**7.60**

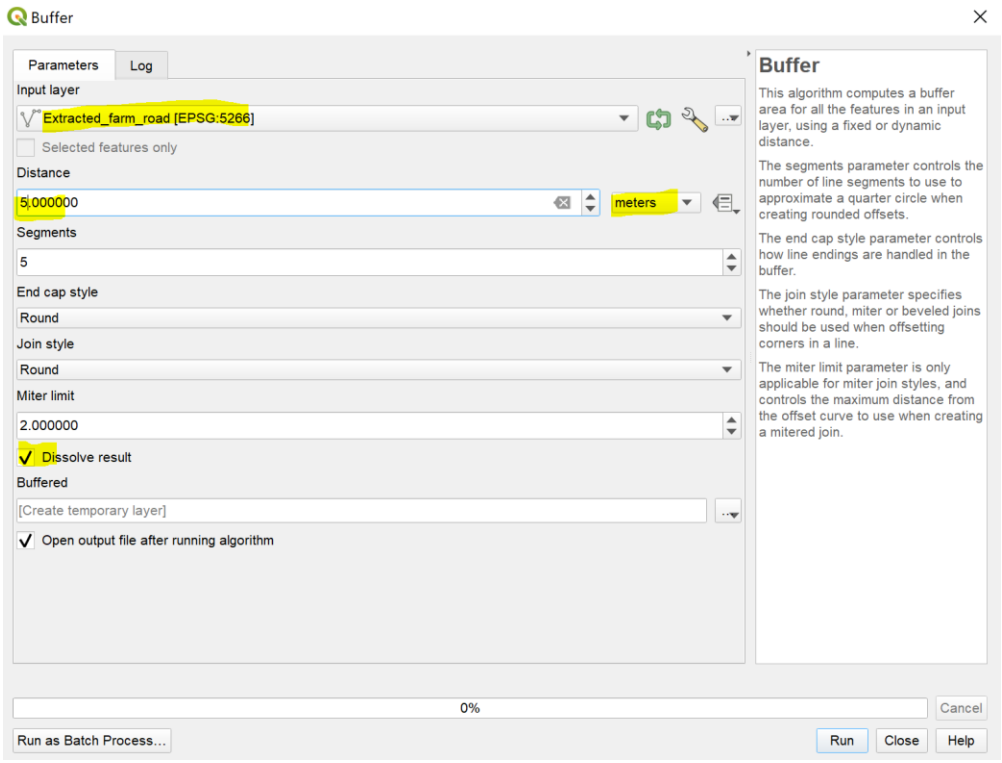
Hints:

- Use **Buffer** and **Intersection** tool under the **Vector** from the **Menu toolbar**
- Use field calculator to calculate the area in acres (1 ac = 43560 m^2)
- Use Group stats or SQL cmd to generate the required data

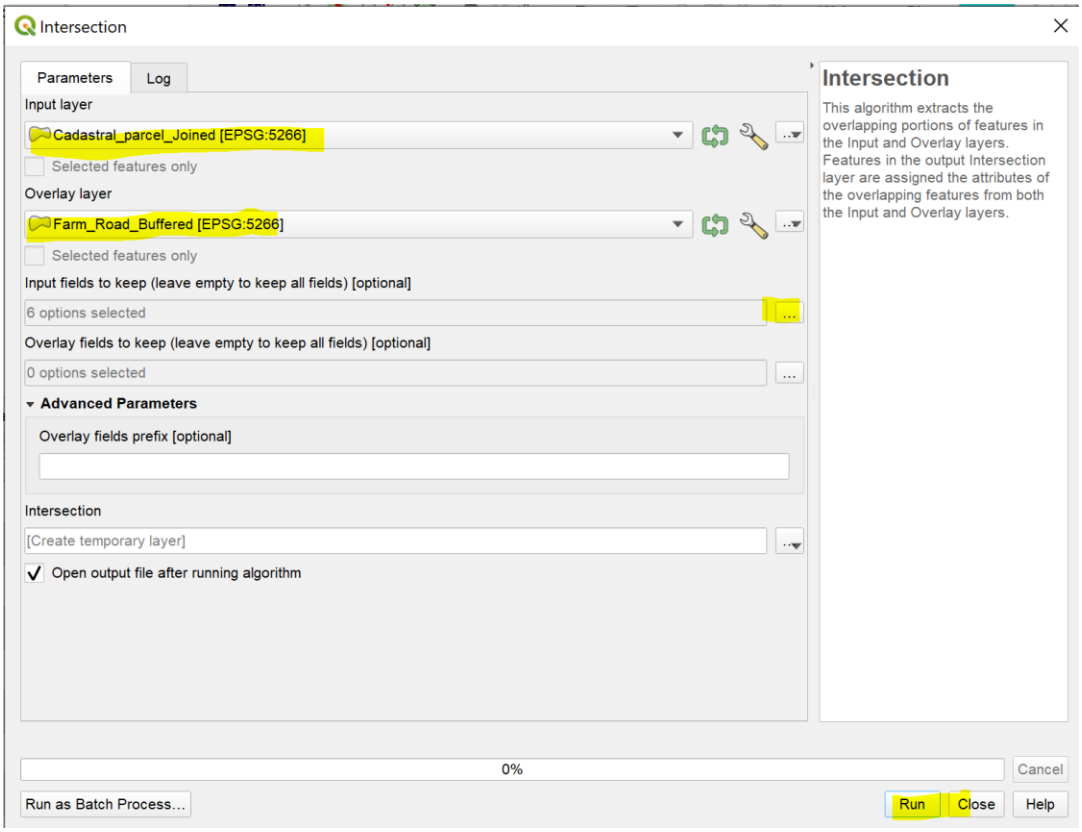
Step1:

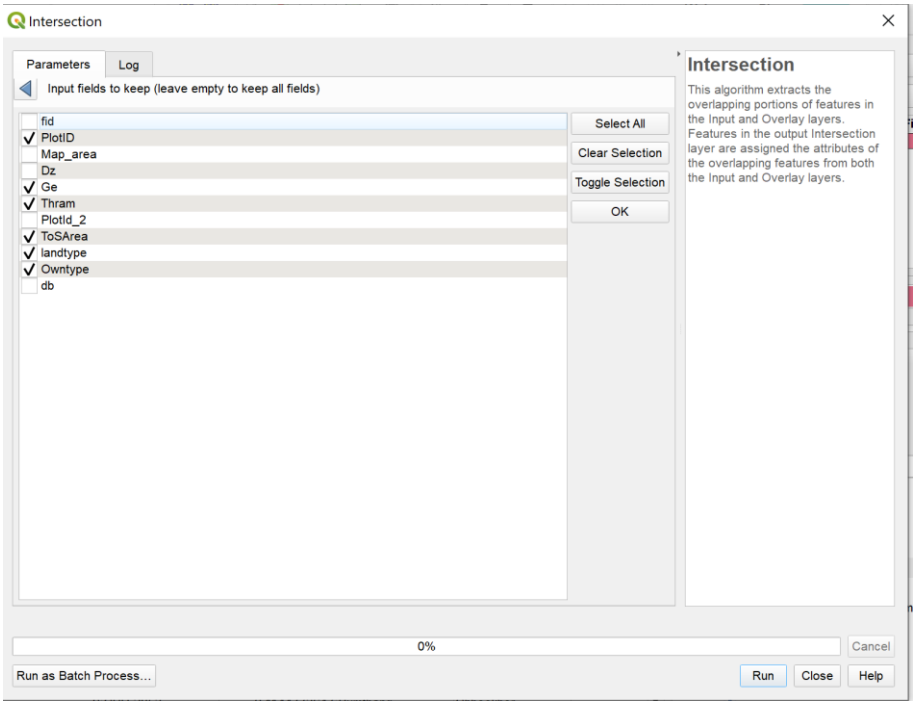

Extract by Attribute
Parameters
Log
Input layer
Roads [EPSG:5266]
Selected features only
Selection attribute
abc class
Operator
=
Value [optional]
farm road
Extracted (attribute)
[Create temporary layer]
Open output file after running algorithm
Extracted (non-matching) [optional]
[Skip output]
Open output file after running algorithm
Extract by attribute
This algorithm creates a new vector layer that only contains matching features from an input layer. The criteria for adding features to the resulting layer is defined based on the values of an attribute from the input layer.
0%
Cancel
Run as Batch Process...
Run
Close
Help

Step 2:


Buffer
Parameters
Log
Input layer
Extracted_farm_road [EPSG:5266]
Selected features only
Distance
5.000000
meters
Segments
5
End cap style
Round
Join style
Round
Miter limit
2.000000
Dissolve result
Buffered
[Create temporary layer]
Open output file after running algorithm
Buffer
This algorithm computes a buffer area for all the features in an input layer, using a fixed or dynamic distance.
The segments parameter controls the number of line segments to use to approximate a quarter circle when creating rounded offsets.
The end cap style parameter controls how line endings are handled in the buffer.
The join style parameter specifies whether round, miter or beveled joins should be used when offsetting corners in a line.
The miter limit parameter is only applicable for miter join styles, and controls the maximum distance from the offset curve to use when creating a mitered join.
0%
Cancel
Run as Batch Process...
Run
Close
Help

Step3:


Intersection
Parameters
Log
Input layer
Cadastral_parcel_Joined [EPSG:5266]
Selected features only
Overlay layer
Farm_Road_Buffered [EPSG:5266]
Selected features only
Input fields to keep (leave empty to keep all fields) [optional]
6 options selected
Overlay fields to keep (leave empty to keep all fields) [optional]
0 options selected
Advanced Parameters
Overlay fields prefix [optional]
Intersection
[Create temporary layer]
Open output file after running algorithm
Intersection
This algorithm extracts the overlapping portions of features in the Input and Overlay layers. Features in the output Intersection layer are assigned the attributes of the overlapping features from both the Input and Overlay layers.
0%
Cancel
Run as Batch Process...
Run
Close
Help


Intersection
Parameters
Log
Input fields to keep (leave empty to keep all fields)
fid
PlotID
Map_area
Dz
Ge
Thram
PlotId_2
ToSArea
landtype
Owntype
db
Select All
Clear Selection
Toggle Selection
OK
Intersection
This algorithm extracts the overlapping portions of features in the Input and Overlay layers. Features in the output Intersection layer are assigned the attributes of the overlapping features from both the Input and Overlay layers.
0%
Cancel
Run as Batch Process...
Run
Close
Help

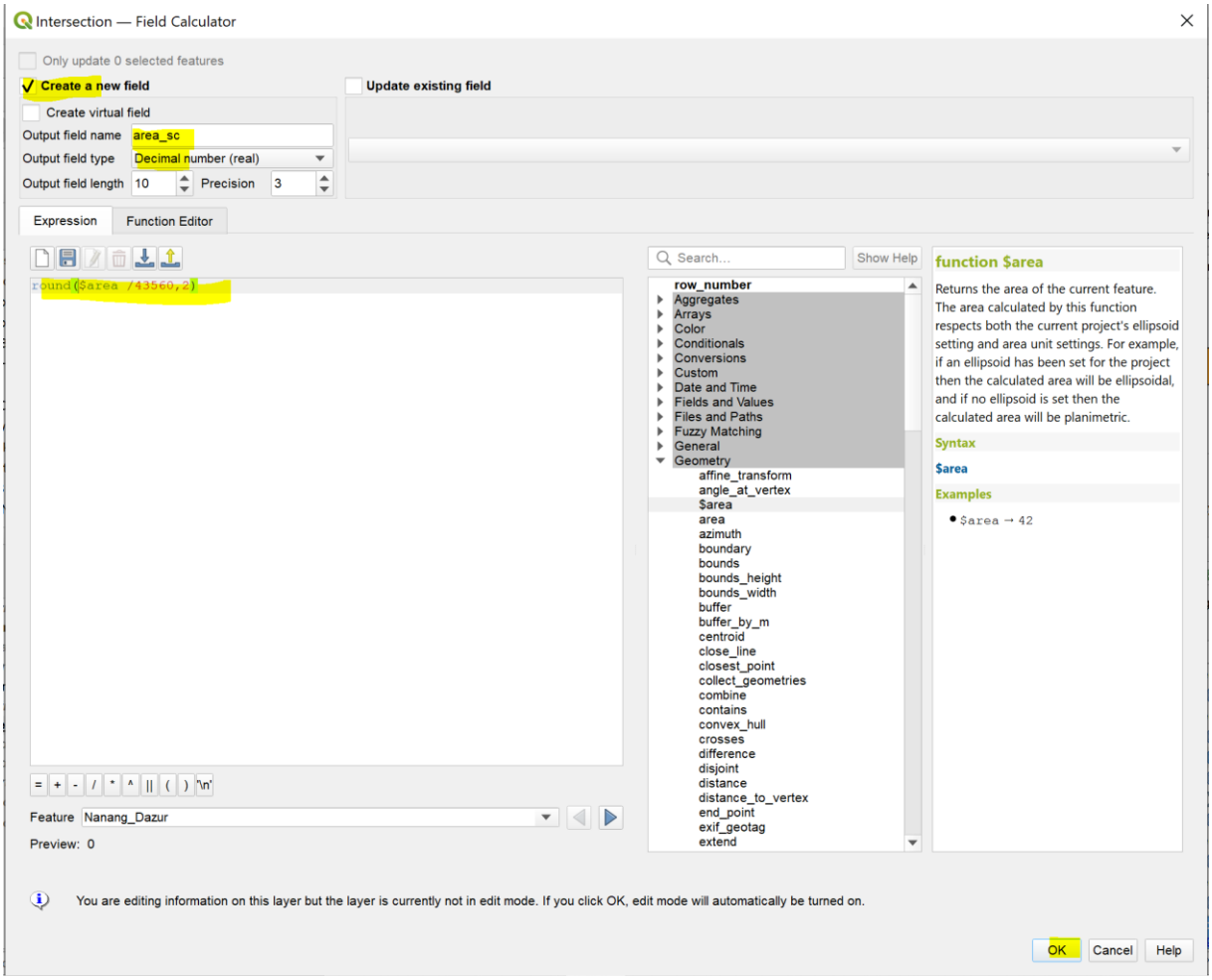
Below is the result of intersection

Intersection — Features Total: 1938, Filtered: 1938, Selected: 0

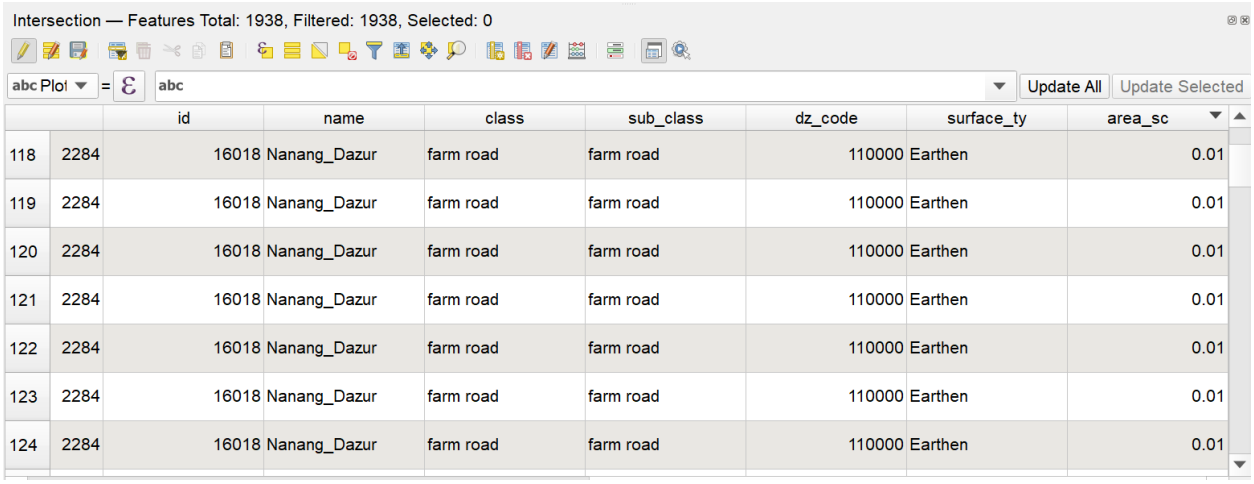
	PlotID	Ge	Thram	ToSArea	landtype	Owntype	fid
1	CHR-119	Chhoekhor	443	1.73	Kamzhing	Family Land	2284
2	CHR-127	Chhoekhor	3106	0.119	Kamzhing	Family Land	2284
3	CHR-279	Chhoekhor	1580	0.885	Kamzhing	Family Land	2284
4	TNG-2057	Tang	606	0.581	Kamzhing	Family Land	2284
5	CHU-3414	Chhumig	29	0.145	Kamzhing	Individual Person	2284
6	CHU-3459	Chhumig	22	0.076	Residential Land	Family Land	2284
7	TNG-2164	Tang	81	0.762	Kamzhing	Family Land	2284
8	TNG-2001	Tang	83	0.066	Kamzhing	Family Land	2284

Step 4:

Calculate the area



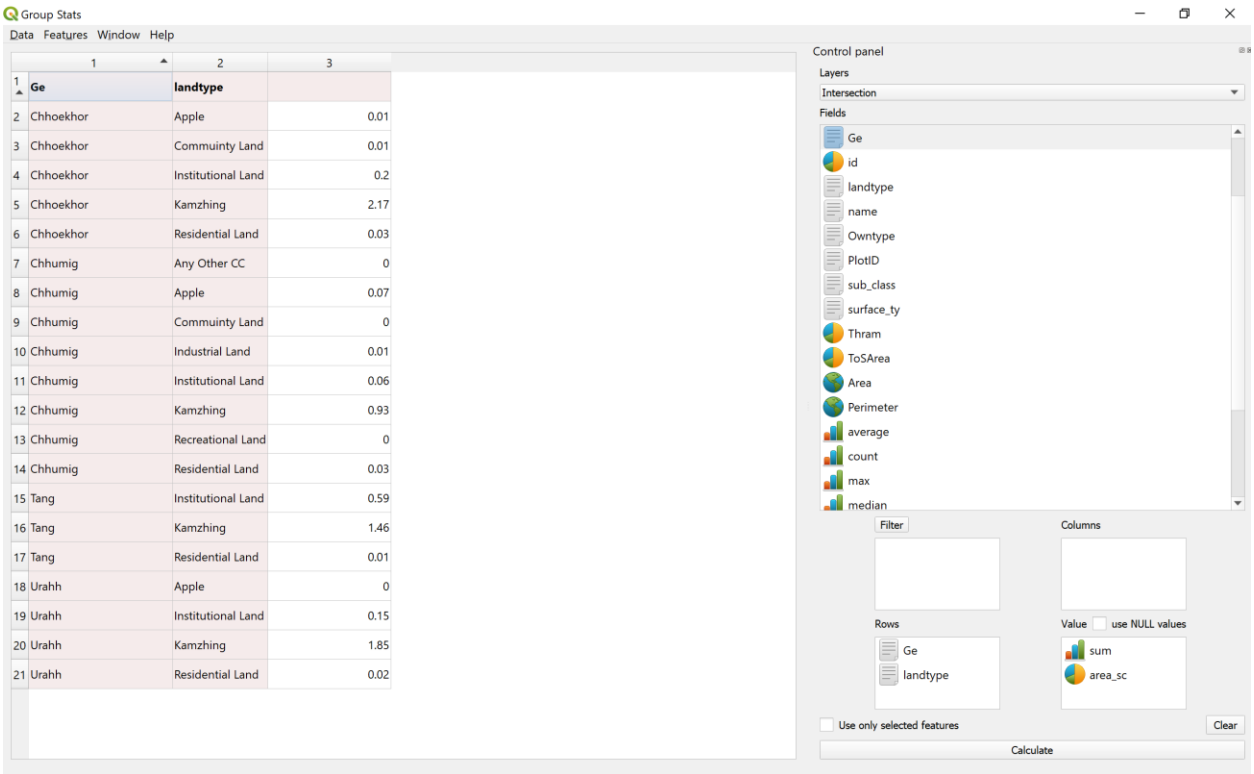
Some plots affected less than 1 dc



	id	name	class	sub_class	dz_code	surface_ty	area_sc
118	2284	16018	Nanang_Dazur	farm road	farm road	110000	Earthen	0.01
119	2284	16018	Nanang_Dazur	farm road	farm road	110000	Earthen	0.01
120	2284	16018	Nanang_Dazur	farm road	farm road	110000	Earthen	0.01
121	2284	16018	Nanang_Dazur	farm road	farm road	110000	Earthen	0.01
122	2284	16018	Nanang_Dazur	farm road	farm road	110000	Earthen	0.01
123	2284	16018	Nanang_Dazur	farm road	farm road	110000	Earthen	0.01
124	2284	16018	Nanang_Dazur	farm road	farm road	110000	Earthen	0.01

Step 5:

The result



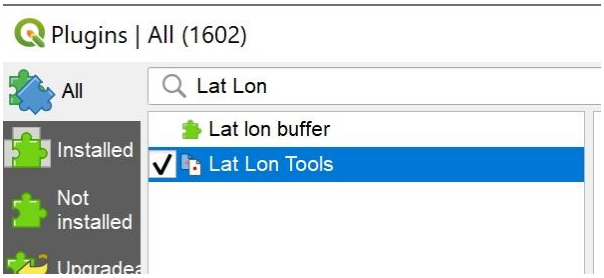
	Ge	landtype	
2	Chhoekhor	Apple	0.01
3	Chhoekhor	Commuinty Land	0.01
4	Chhoekhor	Institutional Land	0.2
5	Chhoekhor	Kamzhing	2.17
6	Chhoekhor	Residential Land	0.03
7	Chhumig	Any Other CC	0
8	Chhumig	Apple	0.07
9	Chhumig	Commuinty Land	0
10	Chhumig	Industrial Land	0.01
11	Chhumig	Institutional Land	0.06
12	Chhumig	Kamzhing	0.93
13	Chhumig	Recreational Land	0
14	Chhumig	Residential Land	0.03
15	Tang	Institutional Land	0.59
16	Tang	Kamzhing	1.46
17	Tang	Residential Land	0.01
18	Urahh	Apple	0
19	Urahh	Institutional Land	0.15
20	Urahh	Kamzhing	1.85
21	Urahh	Residential Land	0.02

Handy Tools

1. **We will learn a handy plugin tool that can perform the following**
    - Zooming QMap to Different Opensource basemap
    - Zoom to coordinates
    - Quick clipboard copy of coordinates from map
    - Coordinate conversion (National, Local, WGS84)

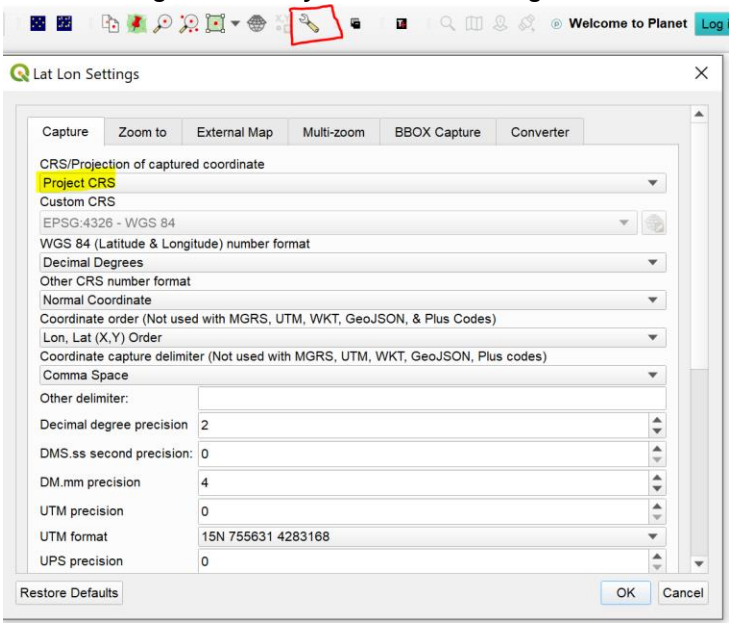
Steps:

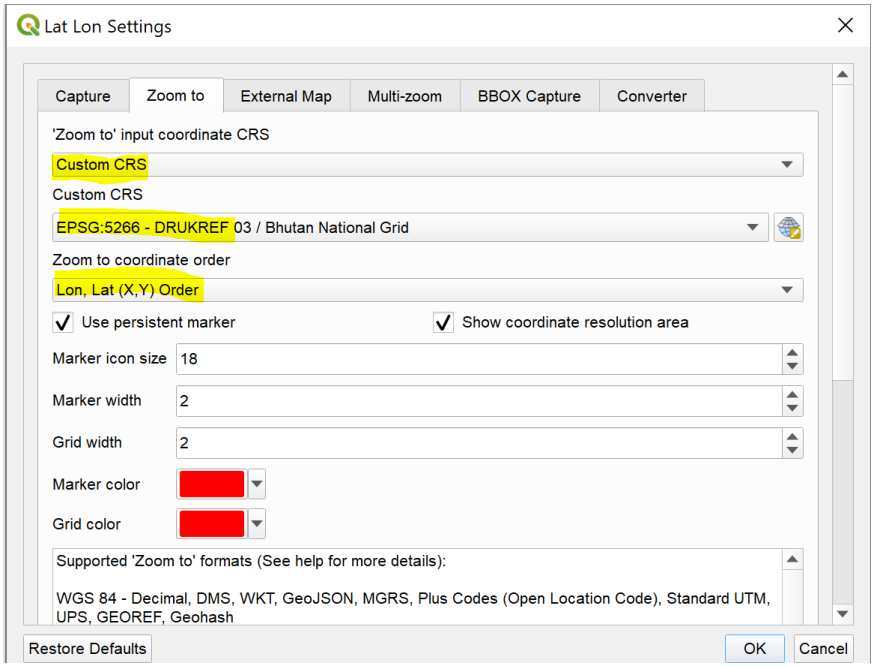
1. Install Lot Lon Tools from the plugins

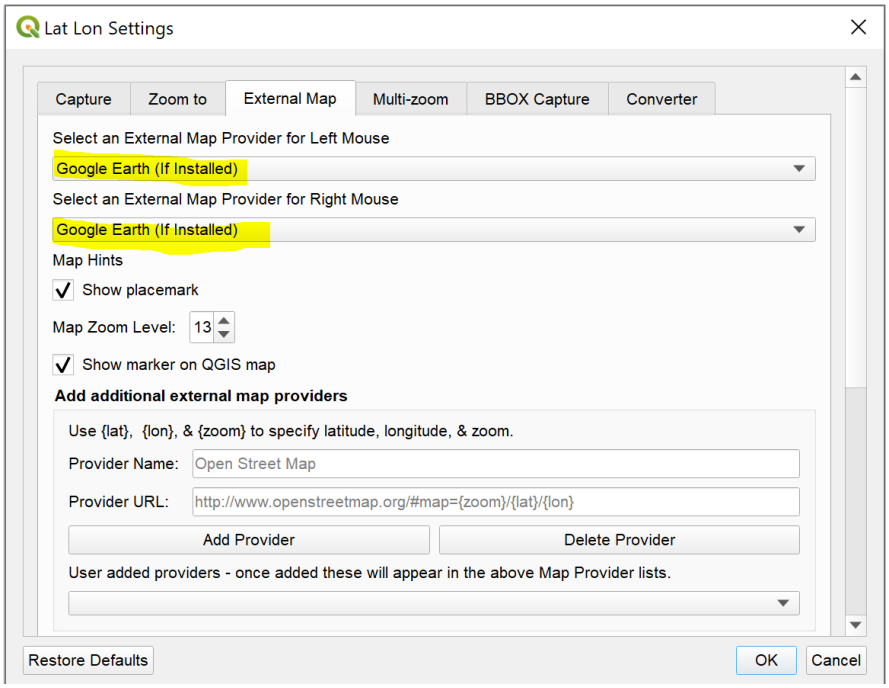


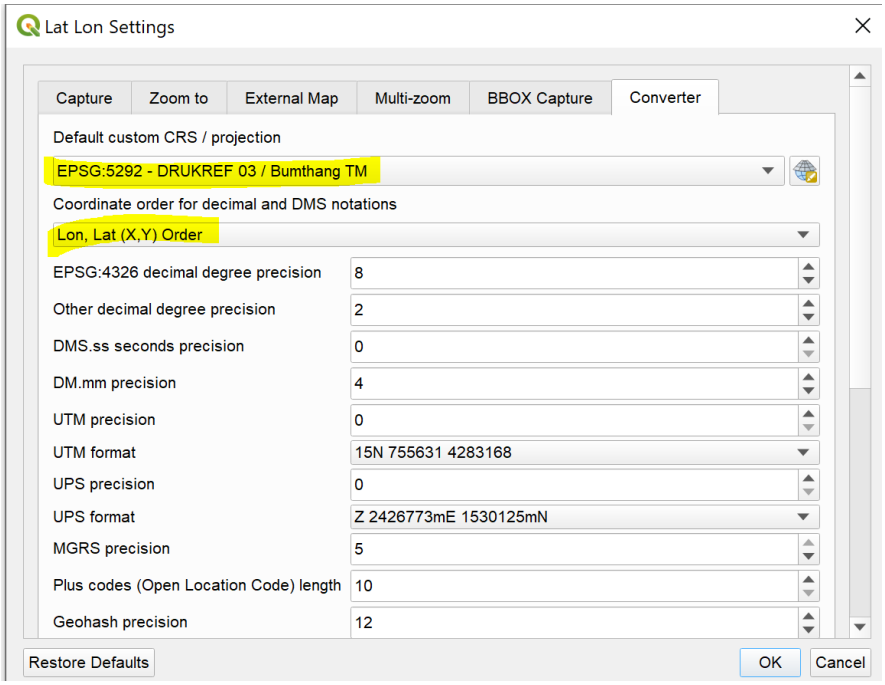
2. The installed tools is added in the Menu tool panel and looks as shown below

3. Before using the tools, you need to configure the desired setting as shown




Lat Lon Settings
Capture
Zoom to
External Map
Multi-zoom
BBOX Capture
Converter
'Zoom to' input coordinate CRS
Custom CRS
Custom CRS
EPSG:5266 - DRUKREF 03 / Bhutan National Grid
Zoom to coordinate order
Lon, Lat (X,Y) Order
Use persistent marker
Show coordinate resolution area
Marker icon size
18
Marker width
2
Grid width
2
Marker color
Grid color
Supported 'Zoom to' formats (See help for more details):
WGS 84 - Decimal, DMS, WKT, GeoJSON, MGRS, Plus Codes (Open Location Code), Standard UTM, UPS, GEOREF, Geohash
Restore Defaults
OK
Cancel


Lat Lon Settings
Capture
Zoom to
External Map
Multi-zoom
BBOX Capture
Converter
Select an External Map Provider for Left Mouse
Google Earth (If Installed)
Select an External Map Provider for Right Mouse
Google Earth (If Installed)
Map Hints
Show placemark
Map Zoom Level:
13
Show marker on QGIS map
Add additional external map providers
Use {lat}, {lon}, & {zoom} to specify latitude, longitude, & zoom.
Provider Name:
Open Street Map
Provider URL:
http://www.openstreetmap.org/#map={zoom}/{lat}/{lon}
Add Provider
Delete Provider
User added providers - once added these will appear in the above Map Provider lists.
Restore Defaults
OK
Cancel



Copy/display coordinate

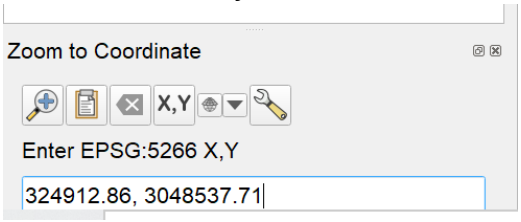
- Click  to copy the coordinate of any point you click on the map
- By clicking on the map, the coordinate is auto-copied and you can paste in your word document.

Zooming QMap to externa Opensource basemap

- Click  to open and zoom to different opensource map such as Google Earth Map. The choice of map is done in the setting.
- By clicking on the any area of your current map, another base map (eg. Google Earth Map) pointing to same location of you map can be opened as shown below.

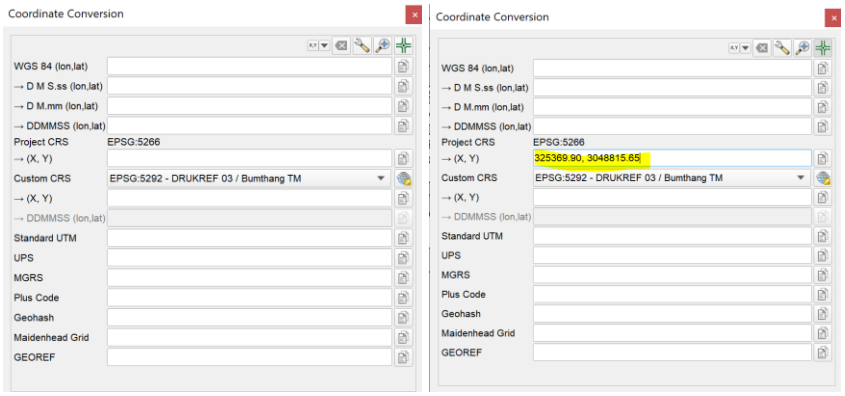
Zooming to specific coordinate

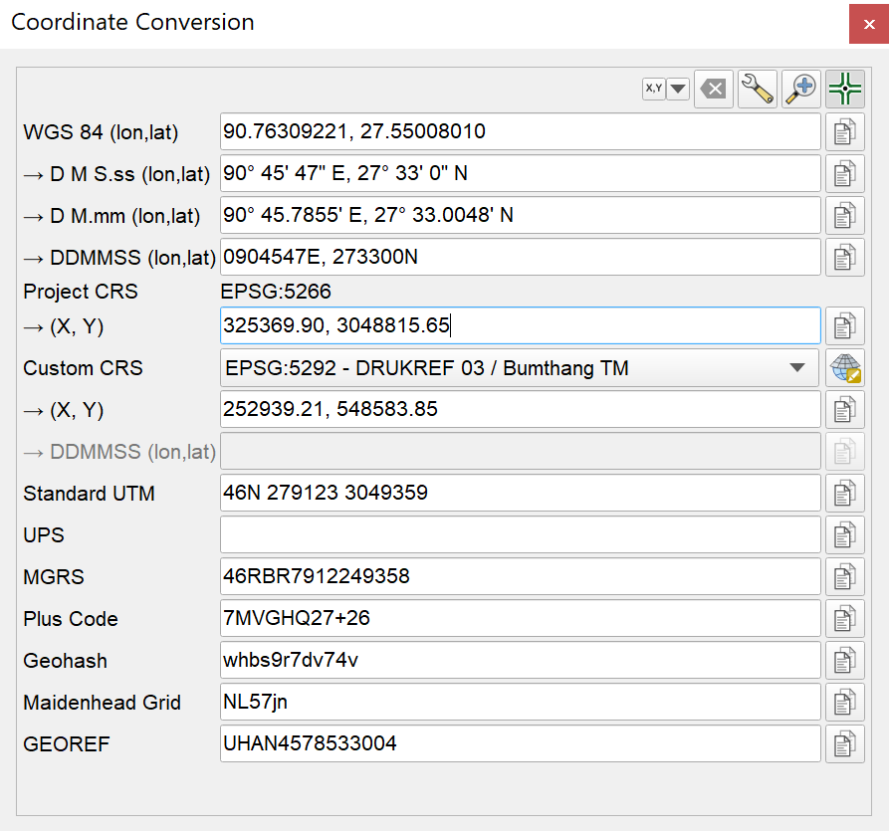
- Click  to zoom to specific coordinate in the map. By clicking on the tool, another window on the left hand side of the map panel is opened for input coordinate. Enter your coordinate and click  to zoom to that location.



Coordinate conversion

- Click  to perform the coordinate conversion from one projection to another (Example from DrukRef National to Local, WGS84 and so on). By clicking on the tool, another window for input. Enter the coordinate and hit ENTER to perform the conversion.





Base Maps

- Use of open source basemap (Planet, OSM, Google Map)

Norway's International Climate & Forests Initiative (NICFI)

- NICFI, users can now access Planet's high-resolution, analysis-ready mosaics of the world's tropics in order to help reduce and reverse the loss of tropical forests, combat climate change, conserve biodiversity, and facilitate sustainable development for non commercial uses.

  https://www.planet.com/nicfi/#sign-up

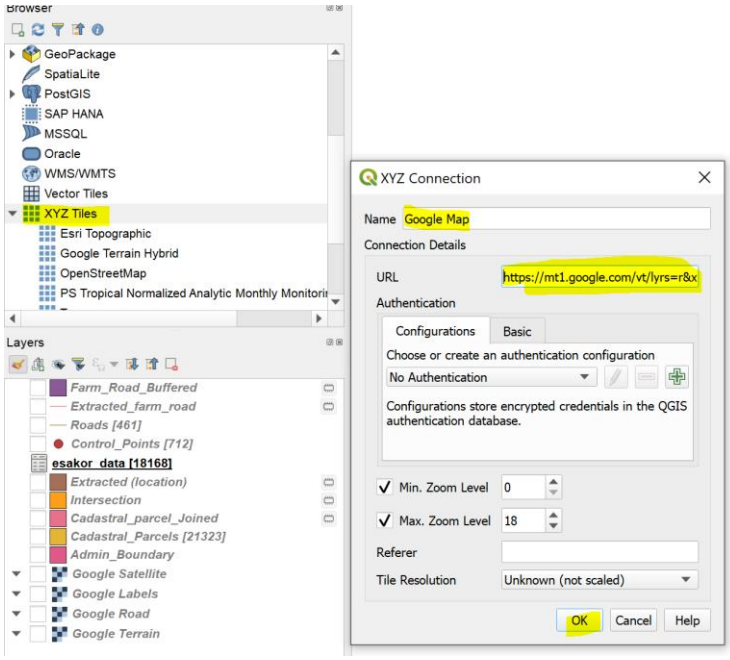
OSM

- Download data from OSM

  https://download.geofabrik.de/

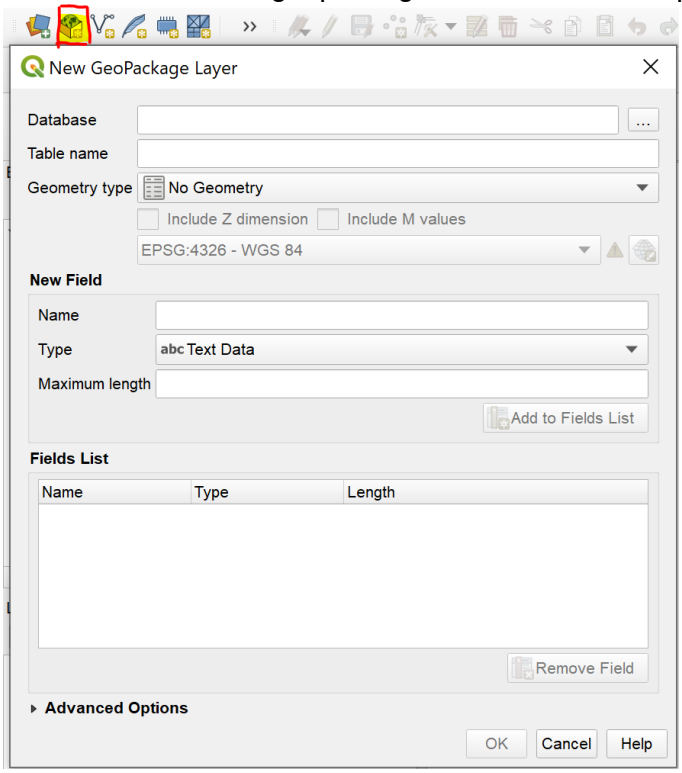
Google Maps: Add as XYZ tiles from the QGIS browser

https://mt1.google.com/vt/lyrs=r&x={col}&y={row}&z={level}

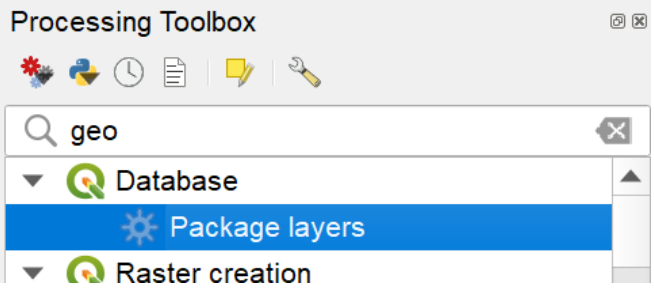


Managing files in geopackage

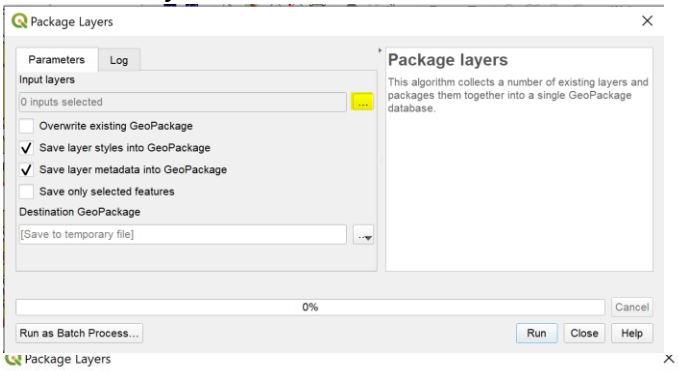
- You can create new geopackage data similar to shape files.

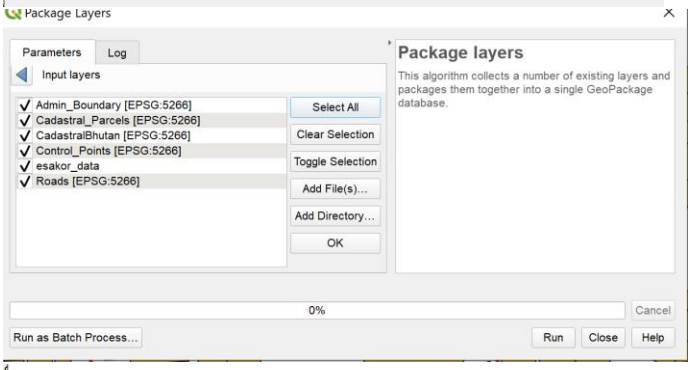


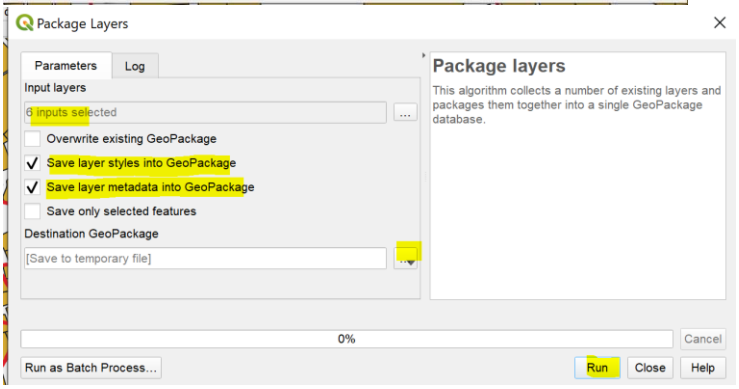
- The feature layers (Shape features) of can also be converted and saved in geopackage format using the package layer tool from the processing toolbox.



- Select the layers and save to

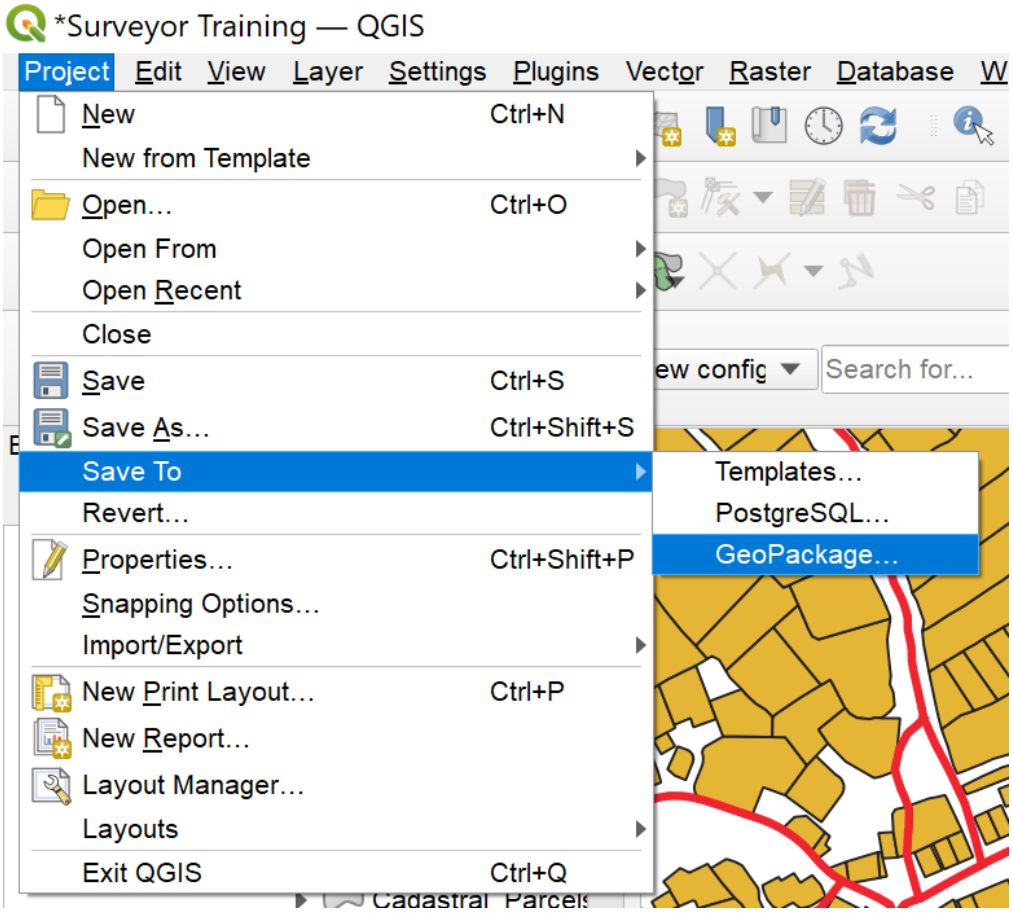




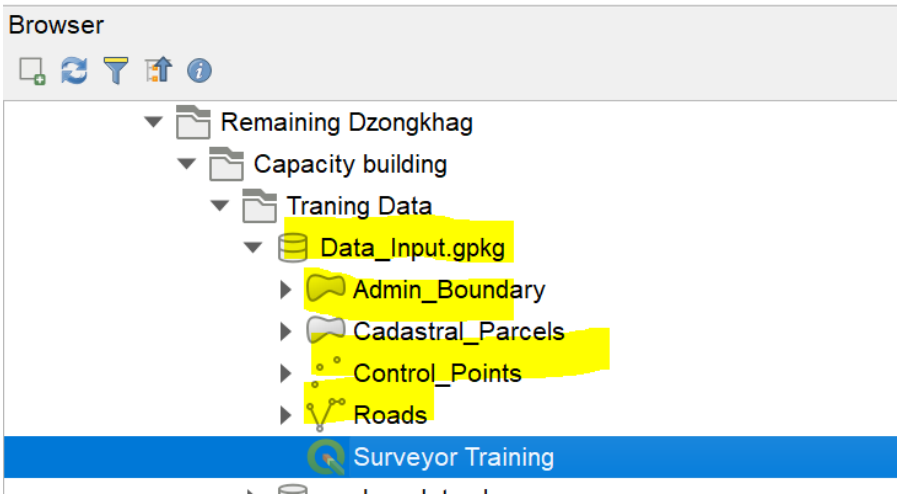


Saving the project.

You can also save the entire project files in a geopackage. This would help to preserve the layer settings and styles when sharing the project document in a single geopackage file.



Once saved, the project map can be opened in the same setting.



Resource Persons

Sl No	Name	Designation/Div	Role
1	Chokila	Supt. Survey Engineer	Training Coordinator/Resource Person
2	Phuntsho Tashi	Survey Engineer	Resource Person/ Facilitator
3	Jamphel Gyalthsen	Sr. Surveyor	Instructor/Facilitator
4	CS Tamang	Sr. Surveyor	Instructor/ Facilitator
5	Ugyen Tshering	Survey Associate	Instructor/ Facilitator

List of trainees

Sl.No.	Name	EID No	Designation	Dzongkhag/Thromde /Drungkhag	Training Venue
1	Dechen Dema	202401926089	SA	Gasa	HQ, NLCS: 12 to 14 August 2024
2	Tshering Penjor	201109008	Surveyor	Punakha	
3	Sangay Dorji	201109005	Surveyor	Punakha	
4	Pema Tashi	20200115537	LRA/syr	Punakha	
5	Chandra Maya Gurung	201009097	LRA/syr	Punakha	
6	Ram Chandra Acharya	20181112511	SA	Trongsa	
7	Thinley Yangdon	20181112516	SA	Trongsa	
8	Pema Tshenten	201109010	Surveyor	Trongsa Thromde	
9	Tshewang Tandin	201109007	Surveyor	PhuntshoLand Inspectorng Thromde	
10	Thag Prasad Bhattarag	202407927901	SA	PhuntshoLand Inspectorng Thromde	
11	Tshewang Tenzin	20245927437	LRA/syr	Chukha	
12	Jasoda Gurung	202401926104	SA	Chukha	
13	Tshering Chedup	20170108144	LRA/syr	Chukha	
14	Upal Pradhan	20200217137	SA	Chukha	
15	Tenzin Choeda	20170108133	LRA/syr	Wangdiphodrang	

16	Kado	201109012	Surveyor	Wangdiphodrang	
17	Karma Tashi Pema	202401926084	SA	Wangdiphodrang	
18	Gyeltshen Moelam	20170108182	Land Inspector	Wangdiphodrang	
19	Palden Wangchuk	20170709503	Land Inspector	Haa	
20	Dorji Namgay	202307924243	Surveyor	Haa	
21	Ugyen Thinley	202404927074	Surveyor	Haa	
22	Pema Namgay	200208083	Sr. Surveyor	HQ, Topo	
23	Kinley Tshering	200208084	Sr. Surveyor	HQ, Topo	
24	Census Bdr. Subba	20200115524	SA	HQ, Topo	
25	Ganesh Man Ghalley	2023932433	SA	HQ, Topo	
26	Tshering Pelzang	201109006	Surveyor	HQ, Topo	
27	Tashi Lhamo	202401926082	SA	HQ, Topo	
28	Pema Wangchuk	202401926083	SA	HQ, Topo	
29	Ugyen Dorji	201311030662	Surveyor	HQ, Topo	
30	Phumtsho Namgay	202307924244	SA	HQ,CID	
31	Ngawang Phuntsho	2023079242	SA	HQ,CID	
32	Bijay Kr. Gurung	20170108172	Surveyor	HQ,CID	
33	Namgay Tashi	9901162	Surveyor	HQ,CID	
34	Dawa Tshering	200608036	Surveyor	HQ,CID	
35	Sonam Phuntsho	200610043	Surveyor	HQ,CID	
36	Provin Rai	202201920542	Surveyor	HQ,CID	
37	Palden Yeshi	8204020	Sr. Surveyor	HQ,CID	
38	Yeshi Wangmo	20180110438	SA	HQ,CID	
39	Nidup Dorji	200610044	Sr. Surveyor	Bumthang	**Mongar: 16 to 18 August 2024**
40	Chenga	20170108170	Land Inspector	Bumthang	
41	Kinzang Lethro	20170108122	LRA/syr	Bumthang	
42	Sangay Wangmo	202307924237	SA	Bumthang	
43	Sonam Tobgay	9910041	Sr. Surveyor	Mongar	
44	Karma Wangchuk	2003007	LRA/syr	Mongar	
45	Kamala Subba	20170108134	LRA/syr	Mongar	

46	Kinzang Dechen	20170108126	LRA/syr	Mongar	
47	Leki Wangdi	20170108137	LRA/syr	Mongar	
48	Pelden Yeshi	20170108166	Land Inspector	Mongar	
49	Ugyen Wangmo	20170709512	SA	Mongar	
50	Kinley Penjor	202307924239	SA	Mongar	
51	Phuntsho Dorji	202307924241	SA	Mongar	
52	Pema Chogyel	2009093	LRA/syr	Mongar	
53	Kinley Wangmo	20181112513	SA	Lhuntse	
54	Karma Yeshi	202307924240	SA	Lhuntse	
55	Ugyen Dorji	20170108138	LRA/syr	Trashigang	**Trashigang : 20 to 22 August 2024**
56	Tashi Tobgay	202307924235	SA	Trashigang	
57	Pema Khandu Sherpa	202307924234	SA	Trashigang	
58	Pema Tshedrup	202307924236	SA	Trashigang	
59	Phuntsho	20170108149	LRA/syr	Trashigang	
60	Pema Chedup	20170108142	LRA/syr	Trashigang	
61	Sonam	200309010	Sr. Surveyor	Tashi Yangtse	
62	Norbu Wangdi	2018112517	Surveyor	Tashi Yangtse	
63	Pema Lhendup	20170108178	Land Inspector	Tashi Yangtse	
64	Rinchen Tobgay	202307924242	Surveyor	Pema Gatshel	
65	Ugyen Rinzin	202304923658	Surveyor	Pema Gatshel	
66	Pema Lhamo	202209921945	Surveyor	Pema Gatshel	
67	Pema Jamyang	20170108146	LRA/syr	Pema Gatshel	
68	Deepen Gurung	20170108175	Land Inspector	Nganglam Drungkhag	
69	Kinley Tenzin	20170108146	LRA/syr	Nganglam Drungkhag	
70	Sonam Dorji	20170108120	LRA/syr	Samdrup Jongkhar	
71	Tshering Dema	202307924238	SA	Samdrup Jongkhar Thromde	
72	Ugyen Sonam	201109020	Surveyor	Samdrup Jongkhar Thromde	
73	Kinley Penjor	20170108165	Land Inspector	Zhemgang	**Gelephu: 24 to 26 August 2024**
74	Kharka Bdr. Mongar	20131103067	Surveyor	Zhemgang	
75	Sangay Tenzin	20170108119	LRA/syr	Zhemgang	
76	Dorji Wangdi	201109106	Sr. Surveyor	Dagana	
77	Leki Dorji	20170108173	Land Inspector	Dagana	

78	Anusha Darjee	202404927055	SA	TashichoLand Inspectorng Drungkhag	
79	Chador Phuntsho	20170108145	LRA/syr	Dorokha Drungkhag	
80	Kinley Tshering	202402926446	SA	Samtse	
81	Thinley Dorji	8711021	Sr. Surveyor	Tsirang	
82	Leki Choda	20170108168	Land Inspector	Tsirang	
83	Nob Tshering	9001002	Sr. Surveyor	Tsirang Thromde	
84	KB Pradhan	9102026	Sr. Surveyor	Tsirang	
85	Sonam Dorji	8605026	Sr. Surveyor	Sarpang	
86	MB Tamang	2017010818	Land Inspector	Sarpang	
87	Indra Prasad Dhal	201109004	LRA/Syr	Sarpang	
88	Jamyang Thinley	2017010816	LRA/syr	Sarpang	
89	Dorji Penjor	20170108159	LRA/syr	Sarpang	
90	Tsheten Dorji	2009080	LRA/syr	Sarpang	
91	Kinley Wangchuk	20180111360	SE	Gelephu Thromde	
92	Dorji Drolo	200210007	SA	Gelephu Thromde	
93	Tashi Tshering	20180110458	SA	Gelephu Thromde	
94	Radhika Sanyasi	202401926085	SA	Gelephu Thromde	