

ZONING PROCESS DOCUMENT

Project on Climate Resilient Agriculture



APRIL 26, 2017

PARTH GUPTA
Project Research Engineer

Table of Contents

1	Preamble	1
2	Delineation of watersheds	1
2.1	Downloading the DEM	1
2.2	Clipping the DEM	2
2.3	Extraction of watersheds	3
2.4	Conversion of raster to vector file	5
3	Intersection process Issues and resolution	6
3.1	Intersection Command	6
3.2	Error while running intersection algorithm	8
3.3	Cause of error	8
3.4	Output of Intersection Process	9
4	Drainage Generation	10
5	Cleaning of intersected file	11
5.1	Splitting geographically discontinuous but single Polygons	11
5.2	Merging the output of splitted Polygons.....	12
6	Manual Delineation of watershed	13
7	Zone Creation Process	14
7.1	Calculating the area of individual feature.....	14
7.2	Identification of Polygons needs to be merged.....	16
7.3	Merging of smaller watersheds	18
7.4	Splitting of bigger watersheds	19
8	Addition of Zone name in attribute table	20

Table of Figures

Figure 1 Sample DEM	2
Figure 2 Clipping the DEM	3
Figure 3 Processing Toolbox	4
Figure 4 r. Watershed Dialogue Box	5
Figure 5 Delineated Watershed Raster	5
Figure 6 r.to.vect Dialogue Box.....	6
Figure 7 Intersection Command	7
Figure 8 Intersection Dialogue Box.....	7
Figure 9 Error during intersection algorithm	8
Figure 10 Problem with using r. Watershed command	9
Figure 11 Output of Intersection	10
Figure 12 Drainage network	10
Figure 13 Shapefile in Editing Mode	11
Figure 14 Splitting Discontinuous Polygon	12
Figure 15 Merging of Splitted Polygon.....	13
Figure 16 Contour and Google Earth Map.....	14
Figure 17 Opening Attribute Table	14
Figure 18 Opening Field Calculator	15
Figure 19 Field Calculator Dialogue Box	15
Figure 20 Attribute Table with Area Added.....	16
Figure 21 Polygons Need Merging.....	16
Figure 22 Opening Query Builder	17
Figure 23 Query Builder Dialogue.....	17
Figure 24 Output of Query.....	18
Figure 25 Watersheds Spread Across Village.....	18
Figure 26 Merging Smaller Watersheds.....	19
Figure 27 Splitting Bigger Watershed	19
Figure 28 Zone File.....	20

1 Preamble

This document describes the process of zoning within a village. This is one of the many pre-processing steps required to run the plugin. This document is extension of document “Plugin Description Document (Phase III Deliverable) [pdf](https://www.cse.iitb.ac.in/~pocra/)” available at <https://www.cse.iitb.ac.in/~pocra/>. Zoning makes an important step of the whole water budgeting exercise and then micro planning exercise. Within the village itself temporal and spatial variation can be found in terms of cropping pattern, availability of water surface or ground, type of storage and conservation structures. The cause of this variation is due to factors like rainfall, variation in type of soils and its depth, topography and slope. Due to this within a village or cluster of villages patches of land can be easily seen with variation in availability of groundwater and surface storage structures and hence variation in cropping pattern. This further leads to inequality in distribution as well utilization of natural resources. The people with high availability of storage structures or groundwater can benefit more than the those with the less. It is highly important to identify such zones. Planning of cropping as well as structures in such zones will depend on such zones.

This document describes the process used for zoning. Description about the steps used in the process is given below. First and foremost, user needs to download the dem and extract watersheds from the dem. In the second step, user needs to intersect the extracted watersheds with the cluster boundary. Before intersecting user needs to clean watershed file. User needs to merge the small polygons with the near ones to avoid any error during intersection process. Third step, user needs to create drainage with basin size of 100-200 to get the extensive drainage network. This will help in zone creation process. Fourth step, user needs to clean the intersected file by splitting the geographically discontinuous but single polygons and merging them with the near ones. The next step is the process of zone creation which requires the understanding of watershed delineation process. Description of same and links to resources for understanding delineation process are provided in this document. Understating this process will help the user in creation of the zones. After creation of zones user needs to add the attribute names for the created zones in the attribute table.

Sr.No	Summary of Steps
1	Delineation of Watersheds
2	Intersection process Issues and resolution
3	Drainage Generation
4	Cleaning of intersected file
5	Zone Creation Process
6	Addition of Zone name in attribute table

2 Delineation of watersheds

2.1 Downloading the DEM

User needs to download the DEM for the project area. Current DEM has been downloaded from the USGS earth explorer website (<https://earthexplorer.usgs.gov/>). The user needs to give the areal extent, name or shapefile of the project area at USGS website for downloading the DEM. The dataset at website contains the number of products like imageries, derived products and digital elevation model generated from various satellites. The user has number of options for the Digital Elevation Model. For the current use SRTM DEM has been used. The following video link describes the process

how to download the DEM and satellite image from USGS and Bhuvan Portal.
https://www.youtube.com/watch?v=Vky_2-SZmJI

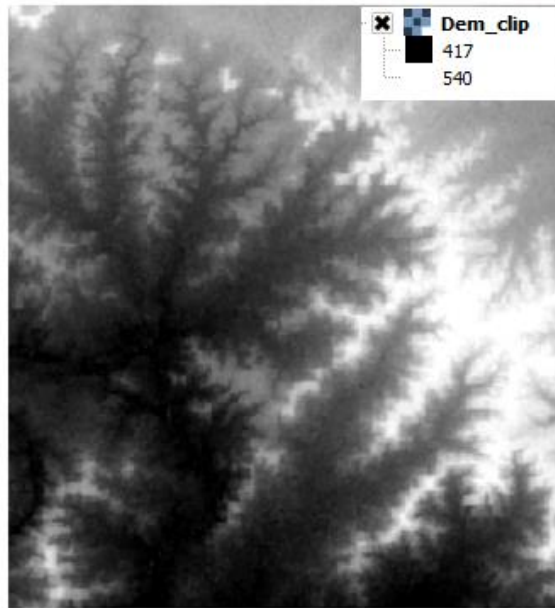


Figure 1 Sample DEM

2.2 Clipping the DEM

After downloading the DEM, we need to load the DEM to our QGIS window. Currently we are using Qgis Version 2.18.12. We also need to load our shapefile of the project area in the Qgis. This can be done through add vector layer command for shapefile and add raster command layer than browsing to your file. User can directly drag and drop the files into Qgis interface as well. After adding both the files user needs to clip the DEM according to the project area. Clipping option can be found from the **Raster->extraction->clipper** as given in the figure below. User has two options of clipping the raster through shapefile(MASK) or by giving or selecting the spatial extent from the Map canvas. A link describing the clipping process has been given below. https://www.youtube.com/watch?v=jE-1_19b5Hs

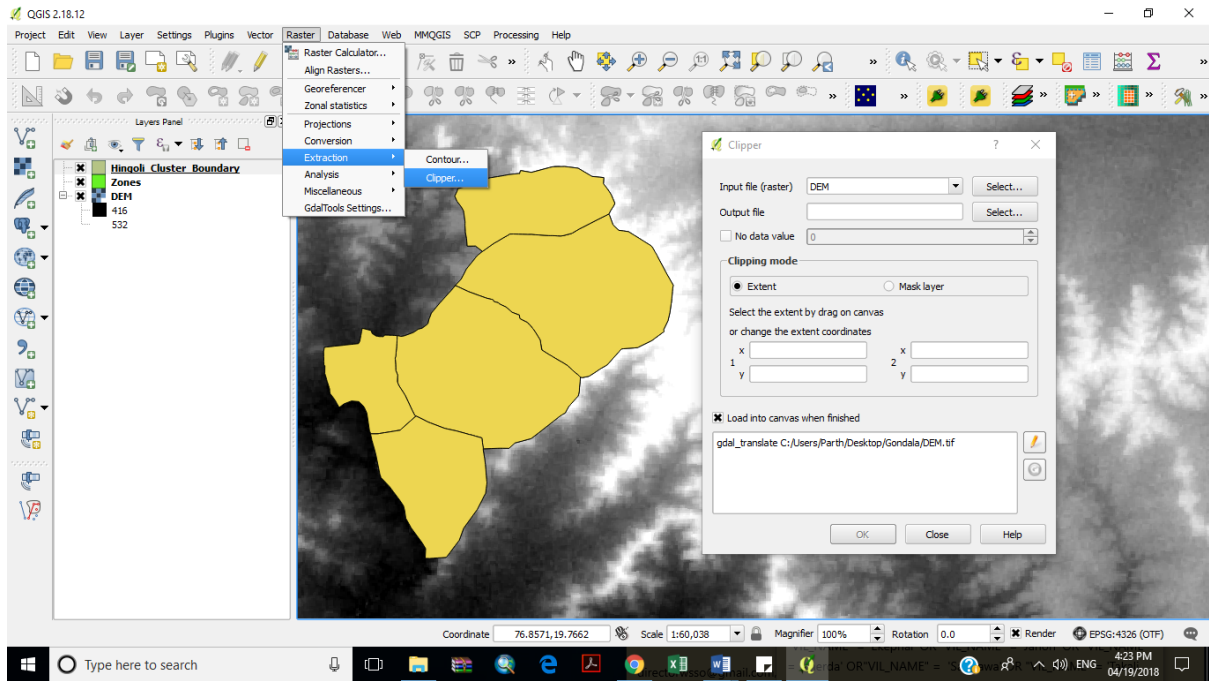


Figure 2 Clipping the DEM

2.3 Extraction of watersheds

After clipping the DEM next step is to delineate watersheds based upon the size. ***"r.watershed"*** command is used to extract sub watersheds from the DEM. This command can be found at the processing toolbox. **Processing->Toolbox->** processing toolbox dialogue will appear. Type the **r.Watershed** in the search box. Minimum size of exterior watershed basin is selected as 1500 in this case. The threshold basin size (Minimum exterior basin) is the minimum area considered to be a basin. low threshold values will dramatically increase run time and generate difficult to read basin and half basin results. This parameter also controls the level of detail in the **stream** segments map. At DEM resolution of 30x30, each cell has area equal to 900 sq.m. So, a threshold of 1500 means a minimum basin of 1350,000 sq.m or 135 hectares. By default, all the options for various output maps is turned on. We need to select only unique label for watershed basins. After running the command, it will generate the raster map consisting of various watersheds.

To read more about the various options on the dialogue click on the help tab on the dialogue. A link describing the process is given below. <https://www.youtube.com/watch?v=UsMTAXrUYok>

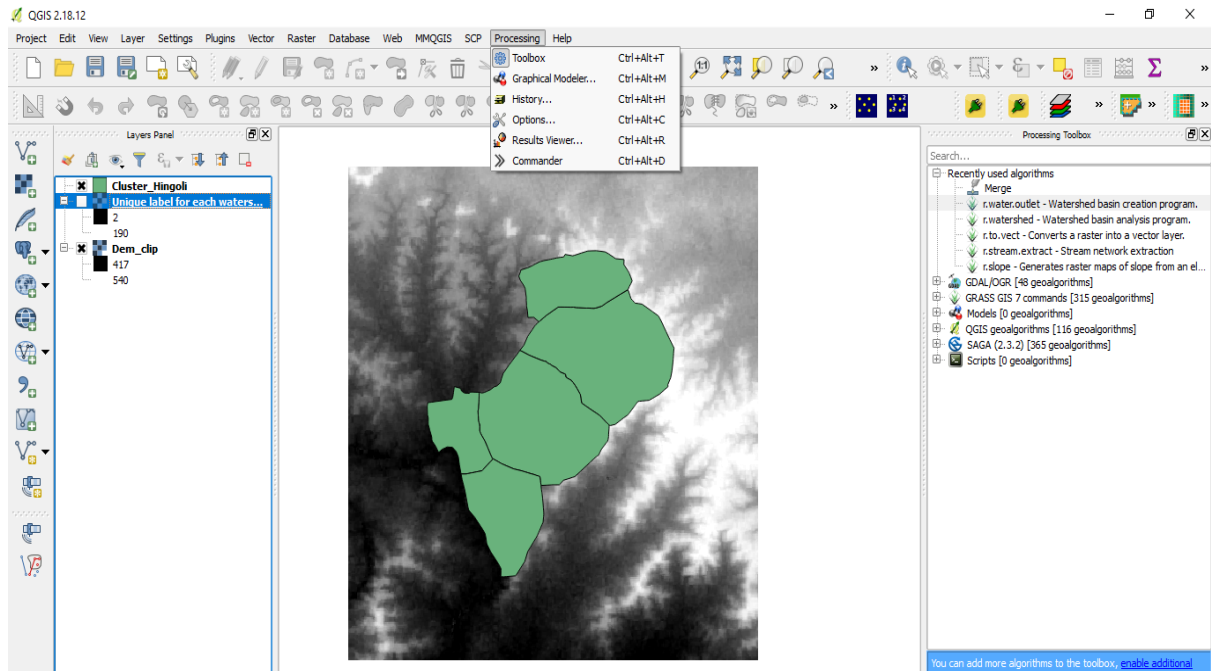


Figure 3 Processing Toolbox

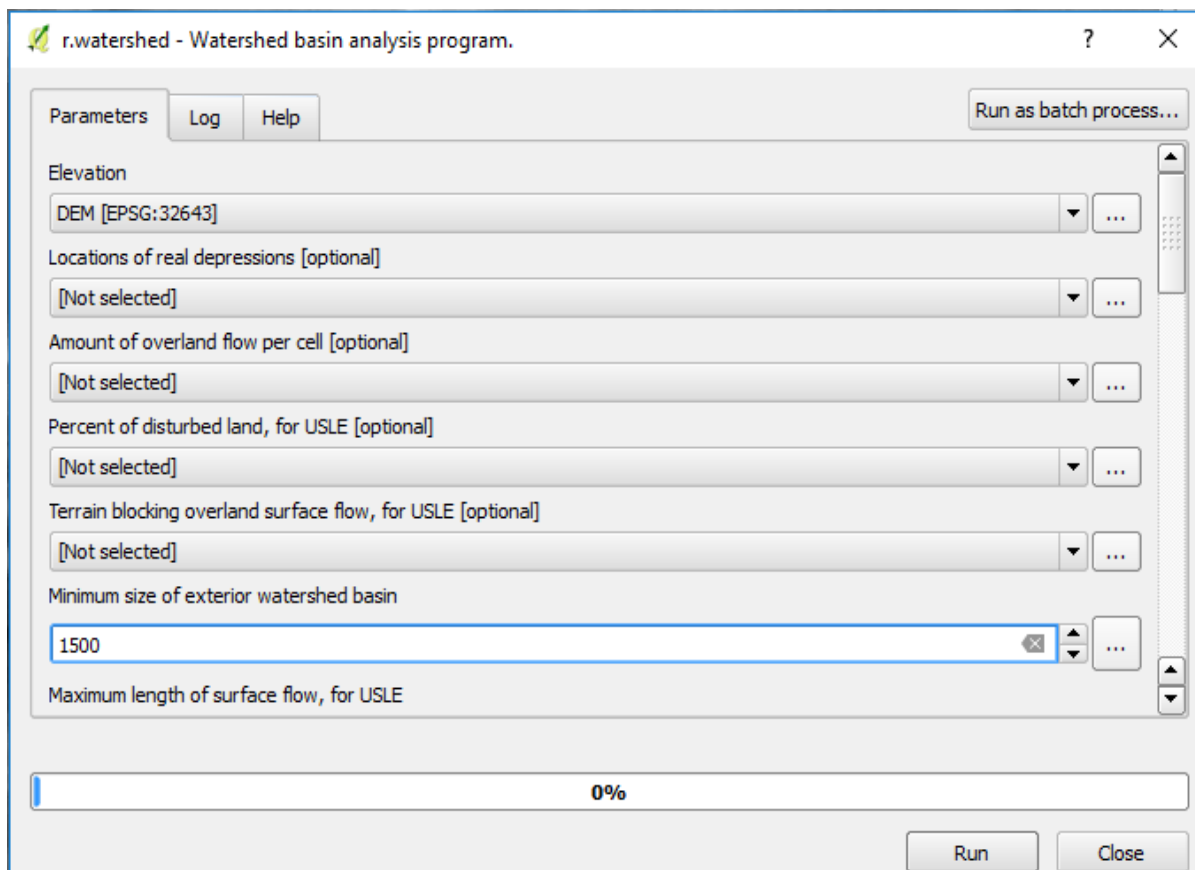


Figure 4 r. Watershed Dialogue Box

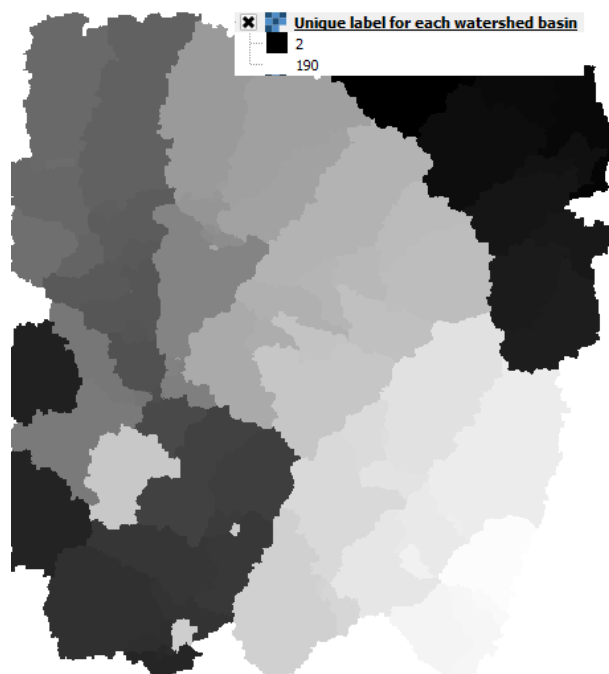


Figure 5 Delineated Watershed Raster

2.4 Conversion of raster to vector file

"r.to.vect" is used to convert the sub watersheds raster file into vector file. This command can also be found at processing tool box. User needs to select input raster layer which is the output of

r.watershed. The basin map is polygons, so feature type should be area. Help tab can be checked more doubts.

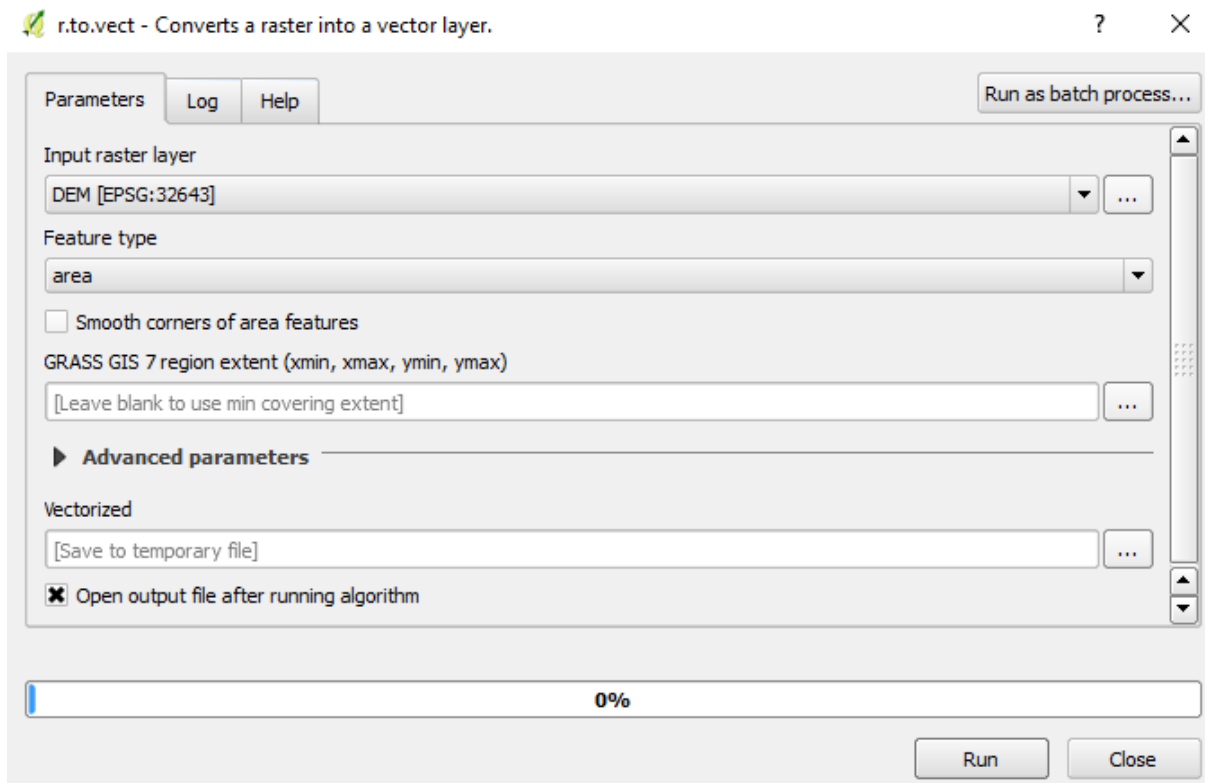


Figure 6 r.to.vect Dialogue Box

3 Intersection process Issues and resolution

After

3.1 Intersection Command

Intersection command can be found at **Vector->Geoprocessing Tools->Intersection**. The same command can be used from the processing toolbox as well. In the intersection dialogue box select the two layers to be intersected. In this case it will be watersheds file and project area file. Video link for doing the process given below. <https://www.youtube.com/watch?v=b2RxI34CiSO>

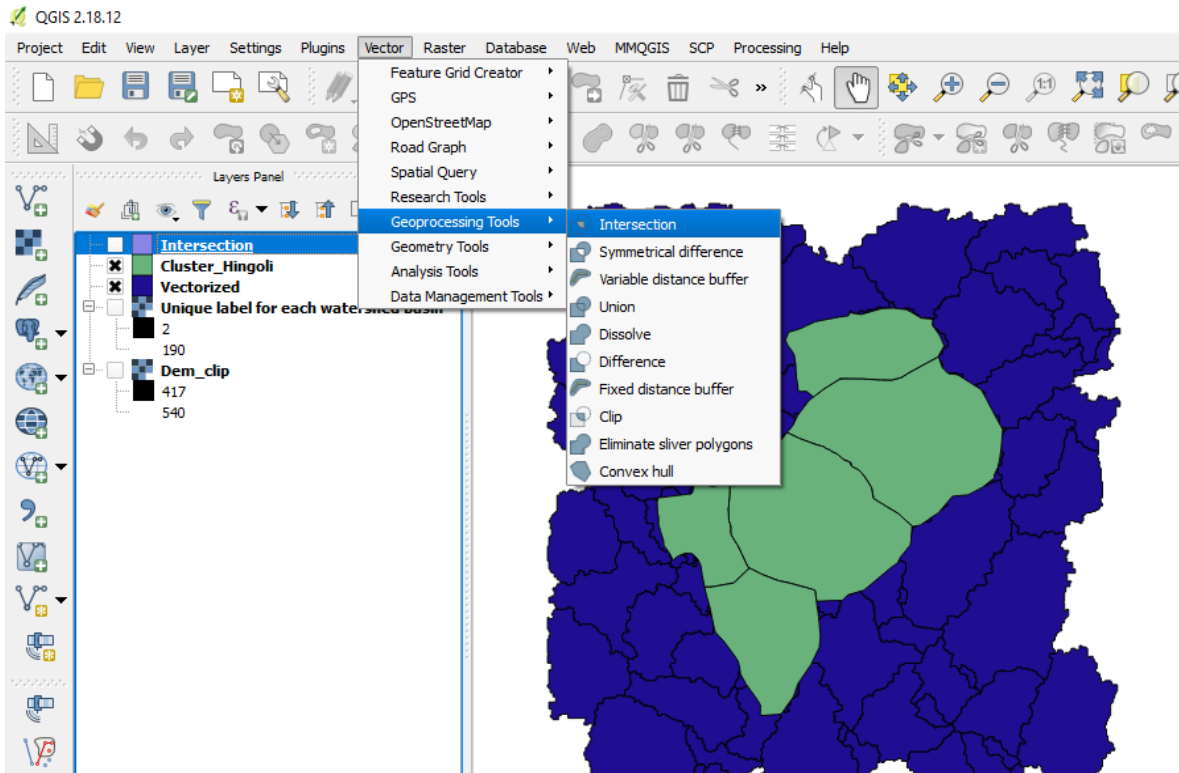


Figure 7 Intersection Command

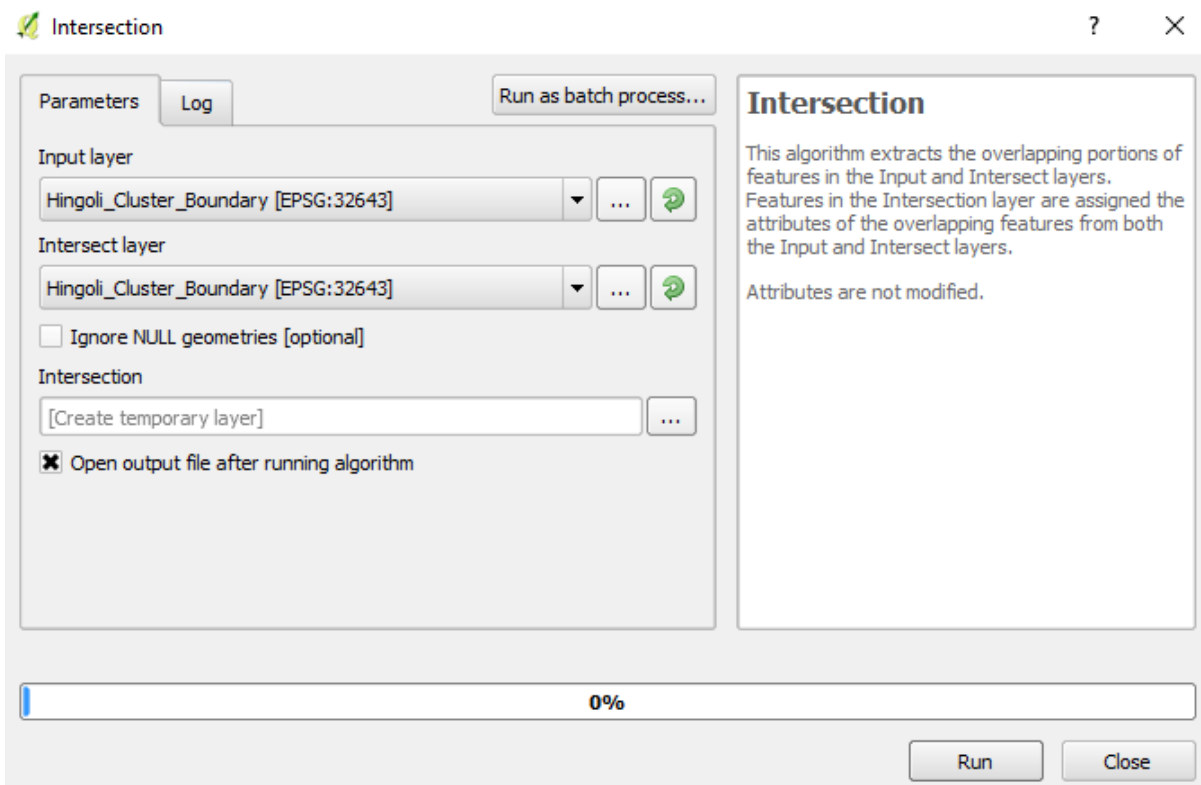


Figure 8 Intersection Dialogue Box

3.2 Error while running intersection algorithm

Sometimes while automatically generating sub watersheds using r. Watershed smaller polygons do form. Such polygons need to be merged with other sub watersheds. User can delete the watersheds lying outside the project shapefile. A dialogue box showing the same has been given below.

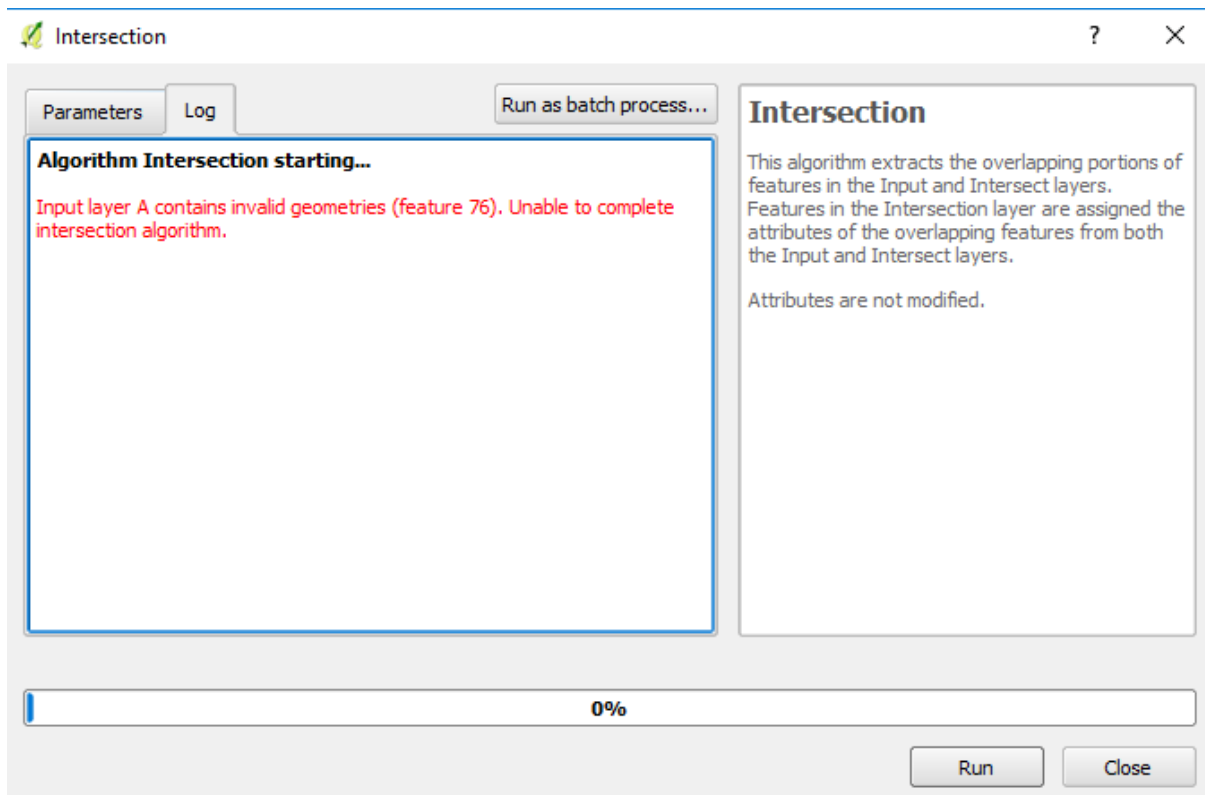


Figure 9 Error during intersection algorithm

3.3 Cause of error

The reason for error is invalid geometry due to which intersection process is remaining incomplete. In the image below, it can be clearly seen some polygons are of very small size. Such polygons are creating problems during intersection process.

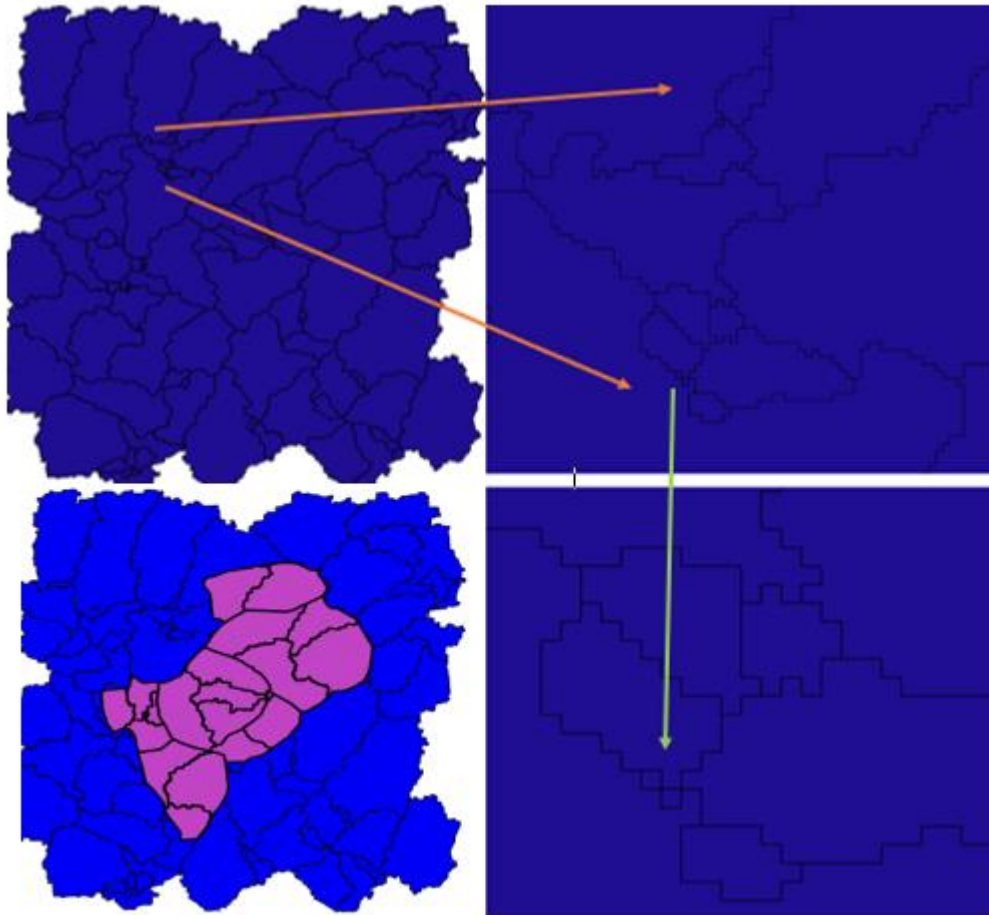


Figure 10 Problem with using r. Watershed command

3.4 Output of Intersection Process

Output of intersection file needs to be carefully analyzed. small watersheds will come in this file as well because one of our input file was sub watersheds file which is output of watershed. After finding drainage network and contour map we will start merging these watersheds with nearby watersheds.

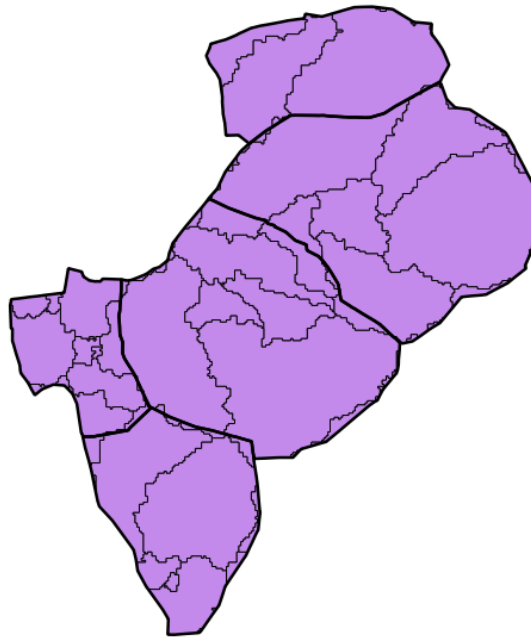


Figure 11 Output of Intersection

4 Drainage Generation

After completing the above process. Run the **r.watershed** again. This time with much lower threshold around 100 or 200. We need to generate the denser drainage network. Select only the stream Map from the dialogue box. This will generate the stream raster. Use the **r.to.vect** command to convert the drainage into vector file. This time select feature type as line.

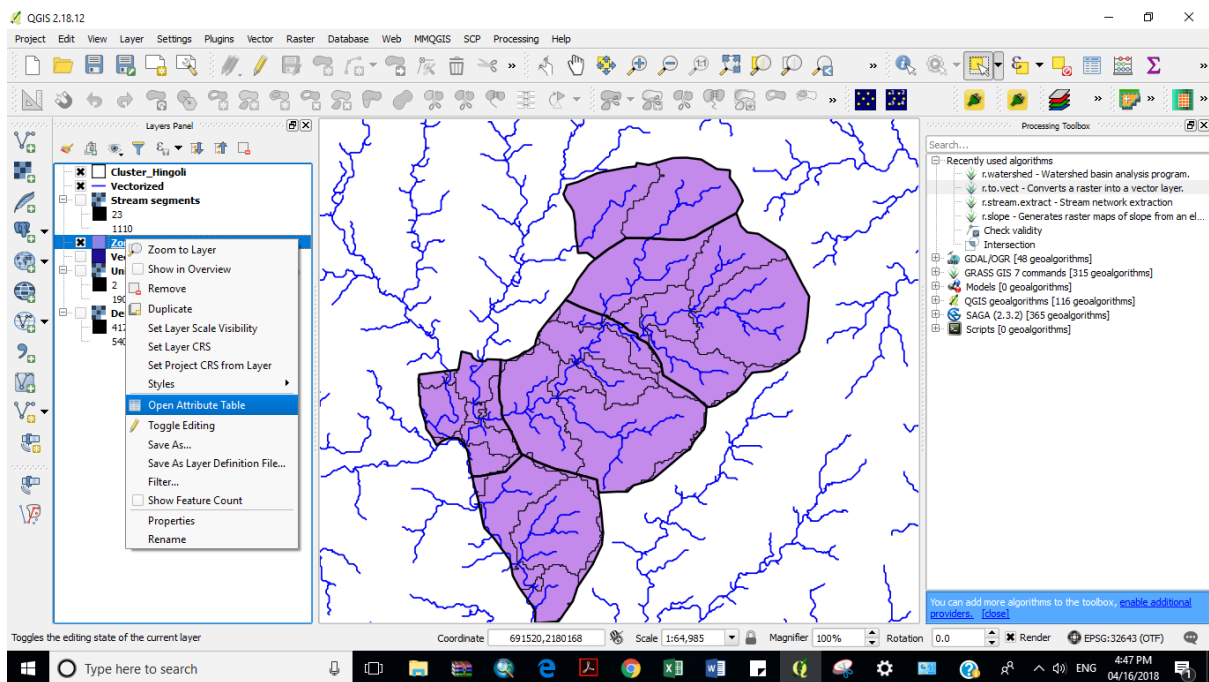


Figure 12 Drainage network

5 Cleaning of intersected file

To clean up the file obtained after intersecting village and watersheds shapefile we need to turn on the editing mode for this file. Select the shapefile in the layer panel. Turn on the editing mode by clicking on toggle editing.

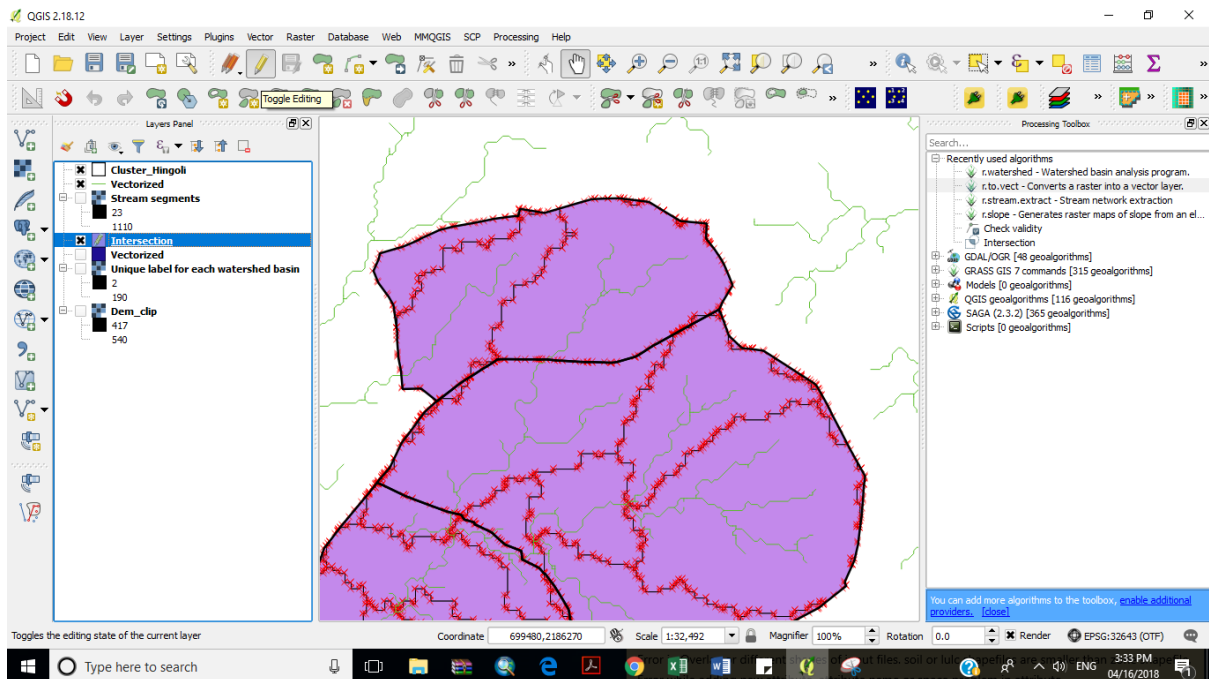
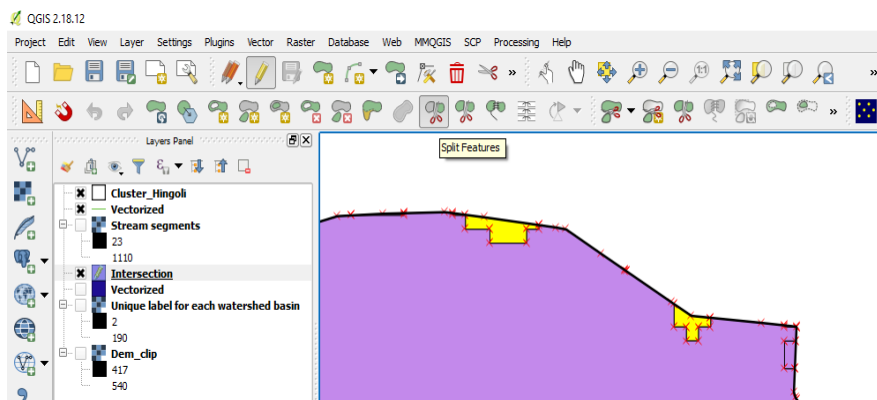


Figure 13 Shapefile in Editing Mode

5.1 Splitting geographically discontinuous but single Polygons

There may be many small interconnected polygons not geographically connected but still acting as one polygon. This may happen when we are automatically generating watersheds. We need to disconnect these polygons by splitting them into separate polygons. To do so select the polygon which needs to be split up in to two parts. After selecting the polygon select the split feature tool. Simply draw a line across the polygons which needs to be split. This will split the polygon in two parts.

Go to settings-> snapping options-> try different options for splitting the polygons. Check which one suits you.



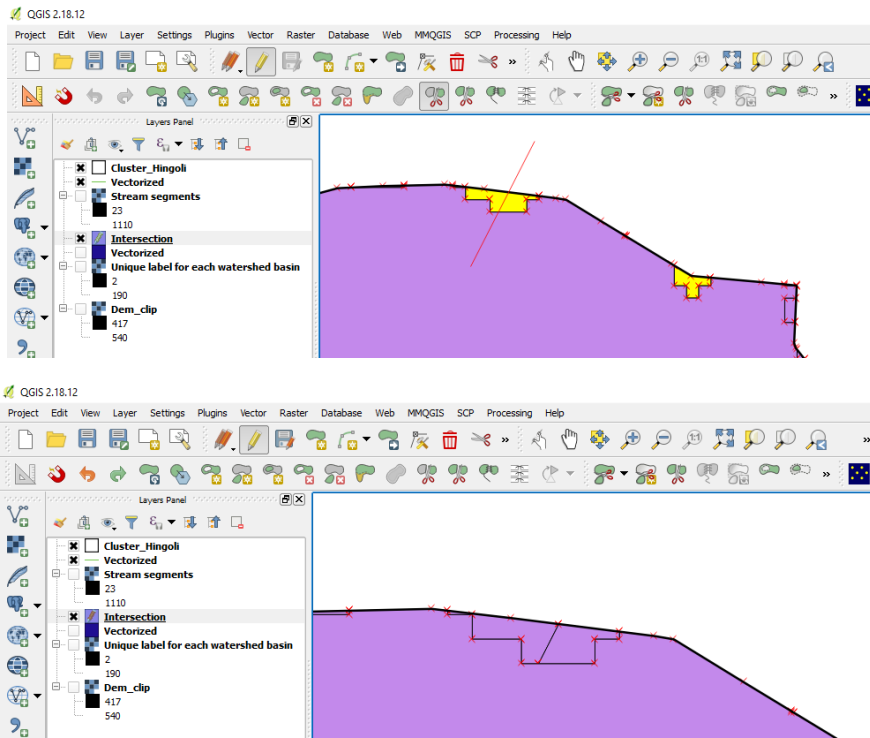
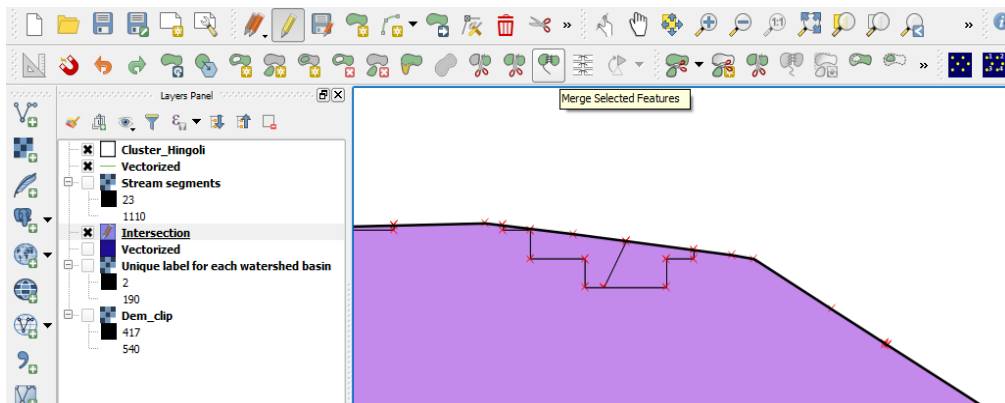


Figure 14 Splitting Discontinuous Polygon

5.2 Merging the output of splitted Polygons

Then select the features which needs to be merged. Select the merge selected feature tool. Both the polygons have separate attribute properties. A table will appear which will ask you to assign the attribute properties for merged feature. You can assign it anyone or bigger polygon attribute values. After completing this process only merged polygon will be there.



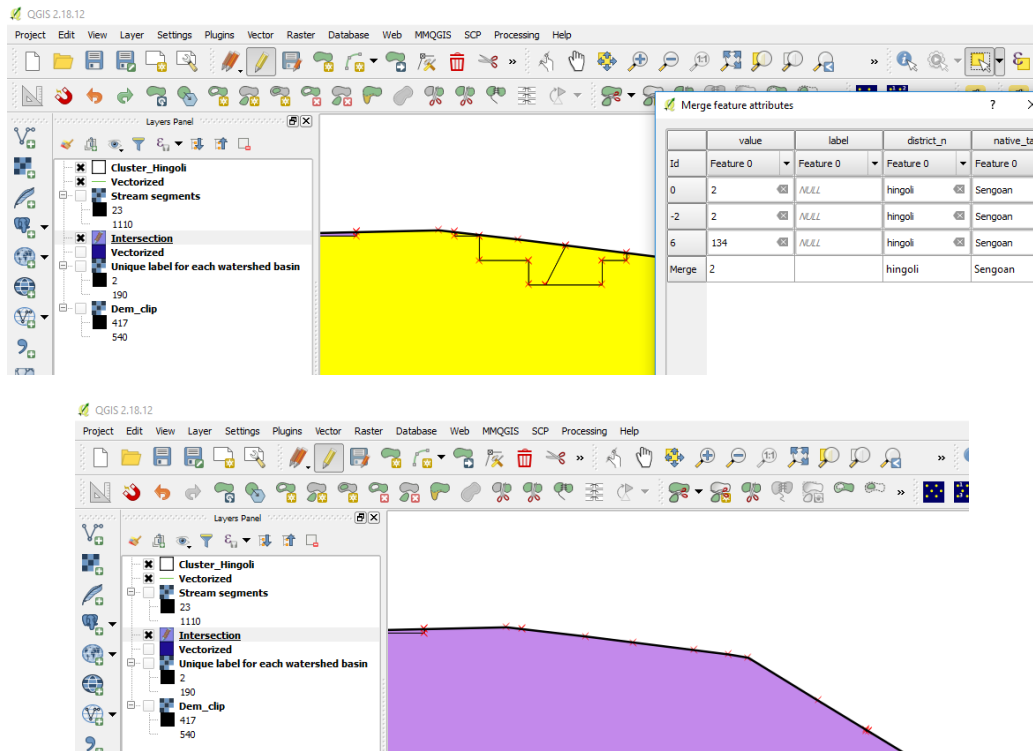


Figure 15 Merging of Splitted Polygon

6 Manual Delineation of watershed

Other way is to carefully analyze the contour map. This requires the understanding of contour maps, ridges valleys, flow lines. One can visually delineate the watershed using common outlet and then delineate the smaller watersheds on first or second order stream. This will also give an idea on which watersheds needs to be merged. While manually delineating watersheds from the contour map following points can be kept in mind.

- The watershed delineation should start from the outlet and you should work your way up on each side.
- Identify valleys and ridges on the map canvas or contour maps. Use google earth also for better understanding
- Simply follow the contours at perpendicular angles until the ridges meet.
- You can do this in the field as well, walking the boundary of the watershed, starting from the outlet and mapping each side until they converge.

A video link describing the above process is given below

<https://www.youtube.com/watch?v=pQrfi4jR1Zc>

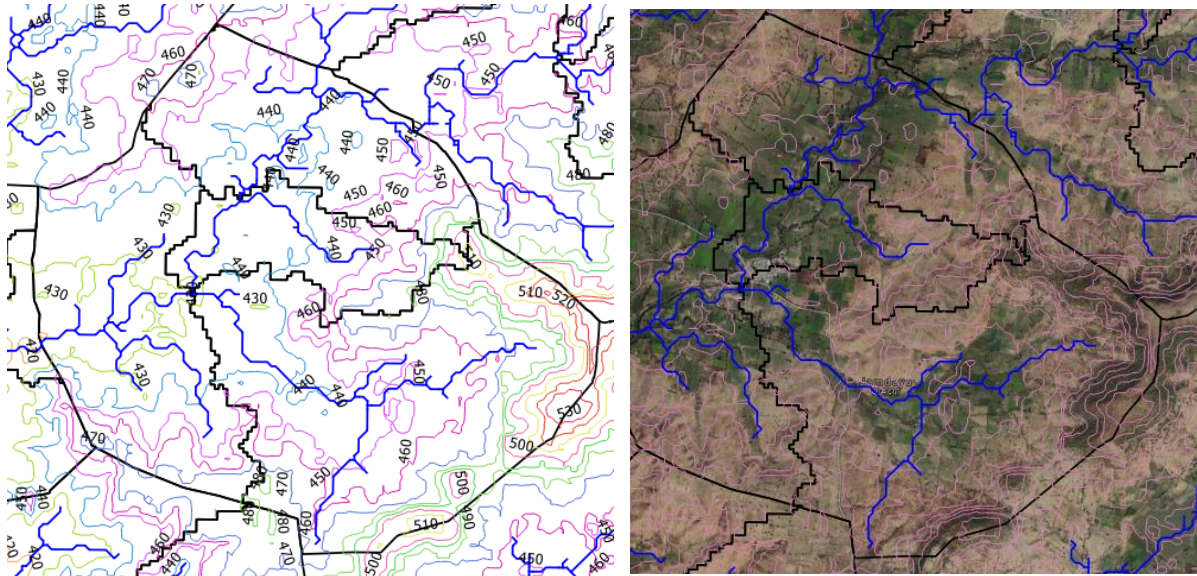


Figure 16 Contour and Google Earth Map

7 Zone Creation Process

7.1 Calculating the area of individual feature

We need to find out the size of polygons so that they can be merged with bigger ones. This step can be skipped with user experience. User can add separate attribute in the attribute table for area of each polygon. After this user can select all the polygons with smaller areas from attribute table. By **right clicking the shapefile->Open attribute table->Open Field Calculator.**

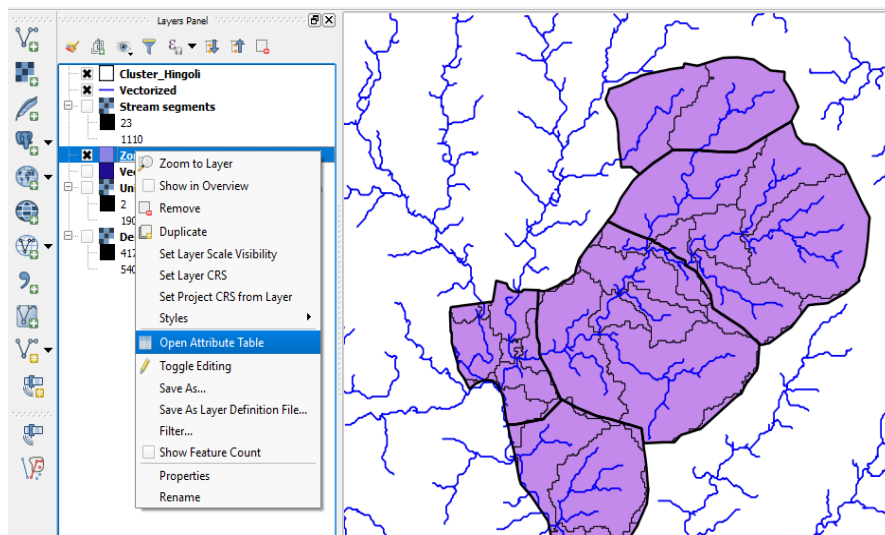


Figure 17 Opening Attribute Table

Zones :: Features total: 58, filtered: 58, selected: 0

	value	label	district_n	native_tal	village_na	Open field calculator (Ctrl+I)
1	134		hingoli	Sengoan	Jamdaya	Yes
2	100		hingoli	Sengoan	Jamdaya	Yes
3	100		hingoli	Sengoan	Hudi	Yes
4	138		hingoli	Sengoan	Gondala	Yes
5	136		hingoli	Sengoan	Gondala	Yes
6	136		hingoli	Sengoan	Jamdaya	Yes

Figure 18 Opening Field Calculator

Once the field calculator is opened user can create new field. User needs to give output field name, output field type and Output field length and precision. In the expression box user needs to write the expression to calculate the area in the desired units. This will add another attribute in attribute table named (given in field name) and area for all the polygons at once.

Field calculator ?

Only update 0 selected features

Create a new field Update existing field

Create virtual field

Output field name: value

Output field type:

Output field length: Precision:

Expression Function Editor

Search:

- row_number
- Aggregates
- Color
- Conditionals
- Conversions
- Custom
- Date and Time
- Fields and Values
- Fuzzy Matching
- General
- Geometry
 - angle_at_vertex
 - \$area**
 - area
 - azimuth
 - boundary
 - bounds

function \$area

Returns the area of the current feature. The area calculated by this function respects both the current project's ellipsoid setting and area unit settings. Eg, if an ellipsoid has been set for the project then the calculated area will be ellipsoidal, and if no ellipsoid is set then the calculated area will be planimetric.

[Syntax](#)

[\\$area](#)

[Examples](#)

Output preview: 32.5076984665639

Figure 19 Field Calculator Dialogue Box

Zones :: Features total: 58, filtered: 58, selected: 0

123 value = €

	value	label	district_n	native_tal	village_na	selected_v	Area
1	134		hingoli	Sengoan	Jamdaya	Yes	32.51
2	100		hingoli	Sengoan	Jamdaya	Yes	9.45
3	100		hingoli	Sengoan	Hudi	Yes	62.80
4	138		hingoli	Sengoan	Gondala	Yes	85.26
5	136		hingoli	Sengoan	Gondala	Yes	32.74
6	136		hingoli	Sengoan	Jamdaya	Yes	37.99
7	66		hingoli	Sengoan	Hudi	Yes	4.77
8	132		hingoli	Sengoan	Jamdaya	Yes	121.23
9	144		hingoli	Sengoan	Gondala	Yes	153.25

Figure 20 Attribute Table with Area Added

7.2 Identification of Polygons needs to be merged

From the attribute table user can sort the polygons based upon their area from ascending to descending or descending to ascending. After that user can select all the rows below an area to highlight them on map canvas. This will highlight all the polygons selected in the attribute table on the Map canvas.

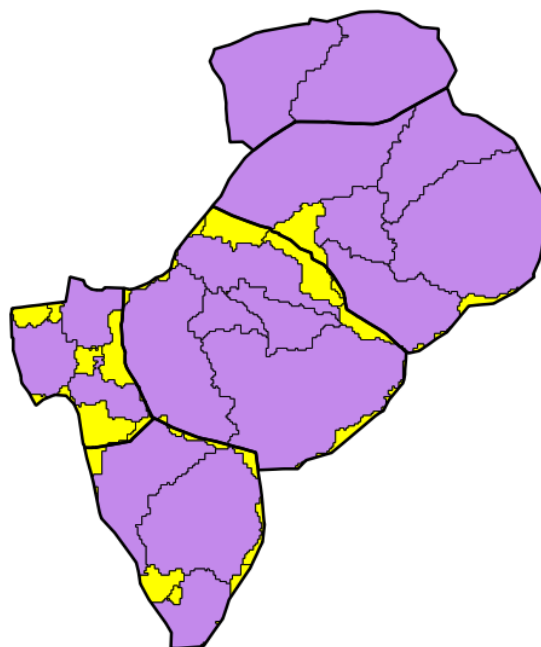


Figure 21 Polygons Need Merging

User can also use the Filter option from the attribute table. This will open the query builder. User can write an expression in the query builder to highlight only those polygons whose area is below particular area.

Query builder can also be used to highlight the polygon who is very small is size and needs to be merged with the other polygon. This polygon is sometimes hard to find, and query builder is easy to use tool to find them.

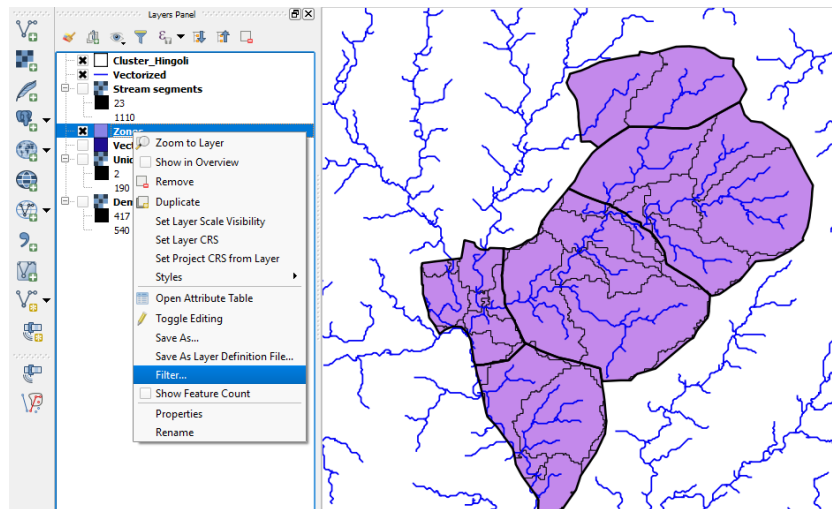


Figure 22 Opening Query Builder

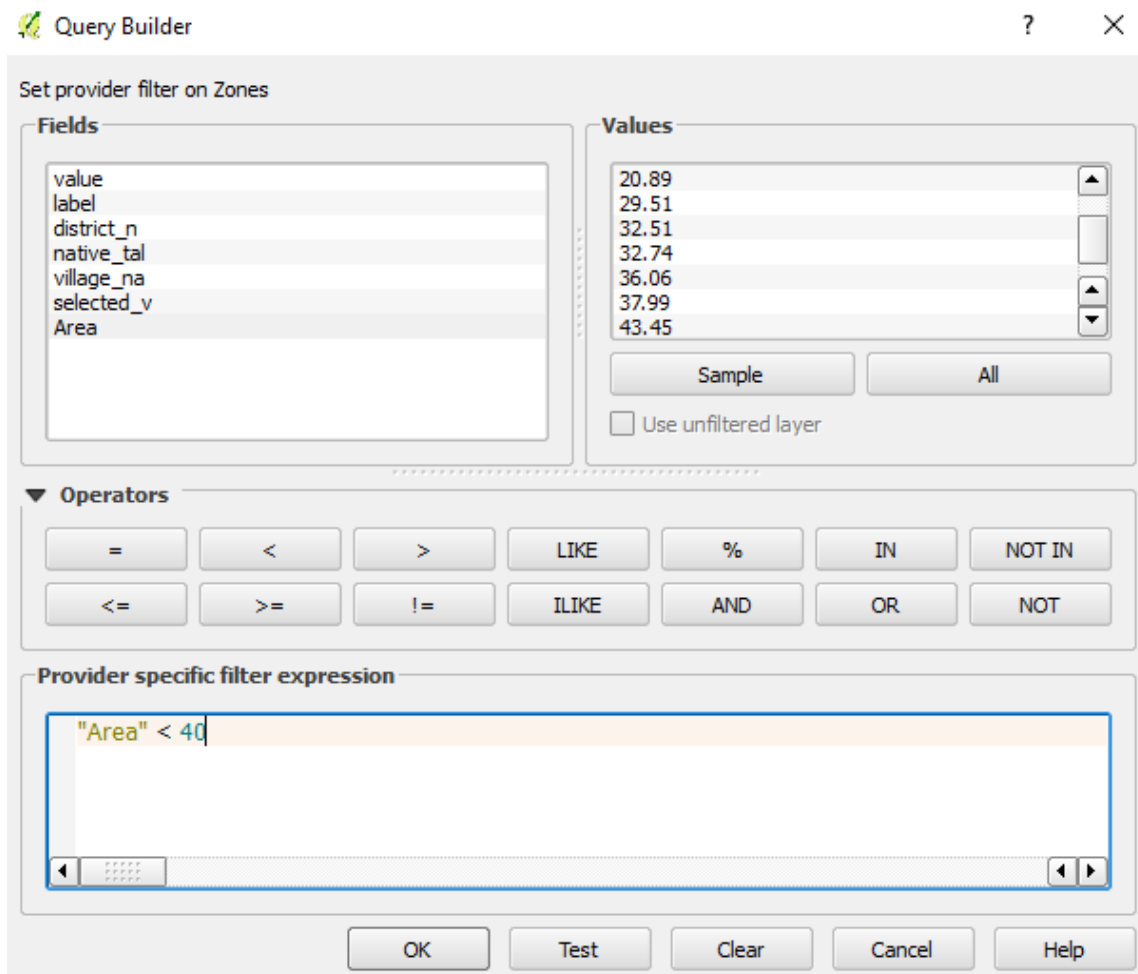


Figure 23 Query Builder Dialogue

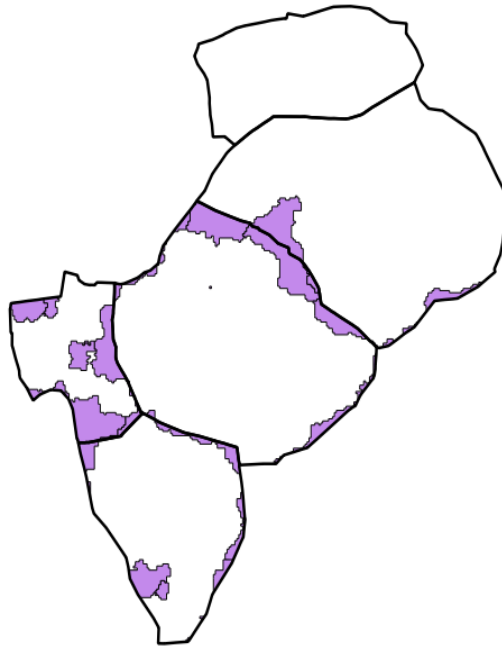


Figure 24 Output of Query

While analyzing the shapefile we can see after intersection of watershed layer with village boundary layer many watersheds which are spread across village boundary gets divided into two. Size of these split watersheds needs to be analyzed. If size is big enough it can be left as separate zone. If size is smaller than it needs to be merged with nearby watersheds.

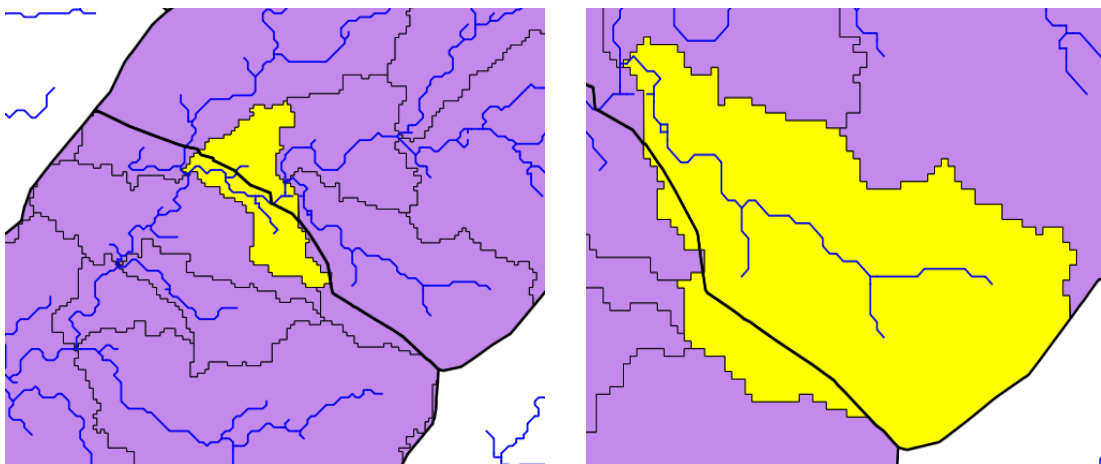


Figure 25 Watersheds Spread Across Village

7.3 Merging of smaller watersheds

Within a village itself there can be smaller watersheds which needs to be merged with other watersheds. This is very important step. It requires careful examination to decide which watershed needs to be merged. This decision can be taken with the help of drainage network layer, contour map and google earth map. Visually a common outlet on the streams can be fixed and its drainage area can be delineated. Based upon that small watersheds can be merged with bigger one.

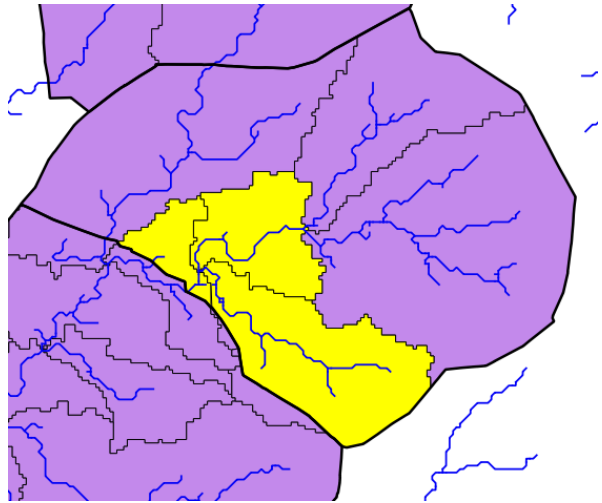


Figure 26 Merging Smaller Watersheds

7.4 Splitting of bigger watersheds

Similarly, bigger watersheds can be split up into smaller watersheds by visually inspecting the contours and streams generated. Watershed below has been divided into three small watersheds.

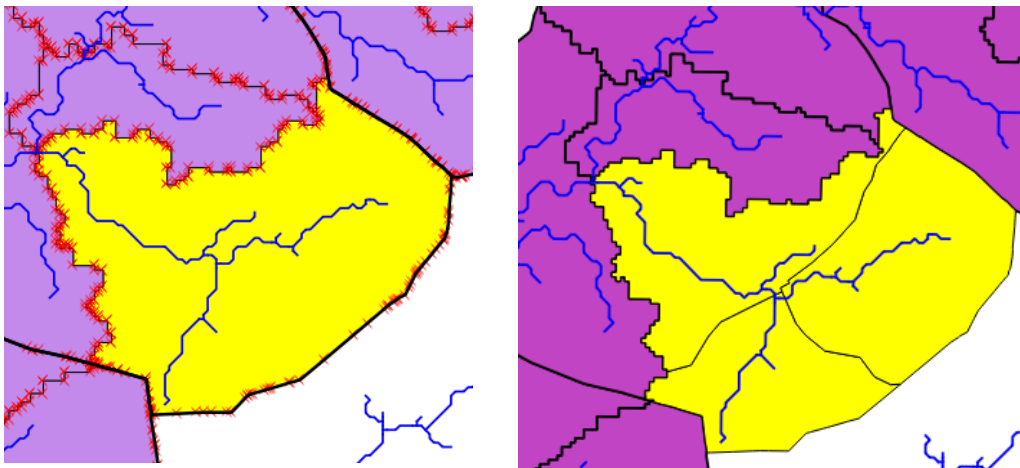


Figure 27 Splitting Bigger Watershed

After cleaning the shapefiles, the zones in the cluster appears as below.

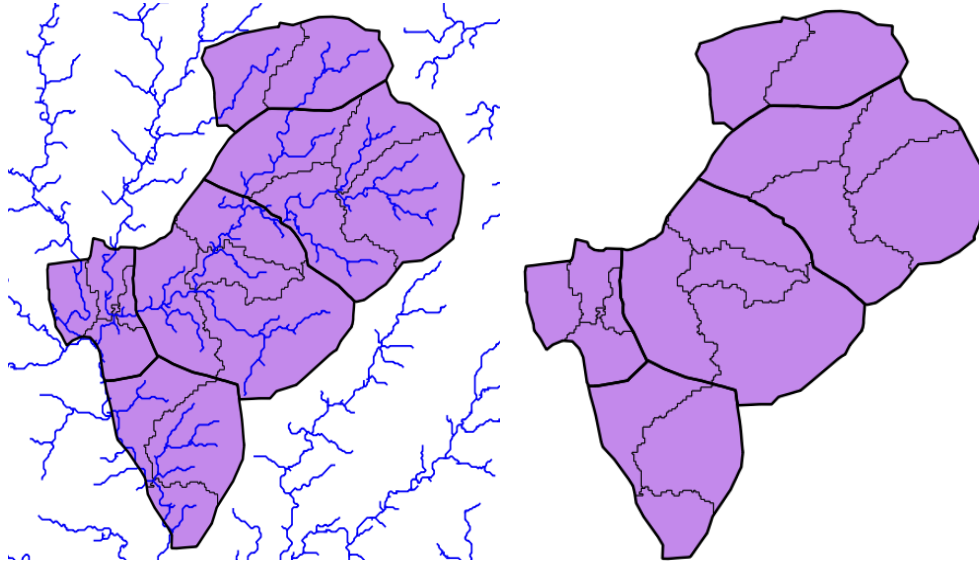


Figure 28 Zone File

8 Addition of Zone name in attribute table

After Zone creation, we need to add the attribute name in the attribute table. First step is to open the attribute table. Second step is to turn on the toggle editing mode. Third step is to add the new field by clicking the add new field. As can be seen in the image below attribute name with “Zone_name” is created. Its data type should be text and length should be equal to maximum number of characters to be given as input. In the following case it is set as 40.

Zones :: Features total: 20, filtered: 20, selected: 0

id	value	label	district_n	native_tal	village_na	selected_v	Area	Zone_name
1	134		hingoli	Sengoan	Gondala	Yes	253.91	Gondala-1
2	18		hingoli				164.46	Gondala-2
3	168		hingoli				358.15	Gondala-3
4	136		hingoli				273.65	Gondala-4
5	64		hingoli				98.29	Hudi-1
6	128		hingoli				28.51	Hudi-2
7	96		hingoli				93.84	Hudi-3
8	98		hingoli				74.73	Hudi-4
9	48		hingoli				0.03	Jamdaya-1
10	134		hingoli	Sengoan	Jamdaya	Yes	197.51	Jamdaya-2
11	130		hingoli	Sengoan	Jamdaya	Yes	113.90	Jamdaya-3
12	100		hingoli	Sengoan	Jamdaya	Yes	255.17	Jamdaya-4
13	144		hingoli	Sengoan	Jamdaya	Yes	416.43	Jamdaya-5