

Module 4: Buffer, Difference, Clip

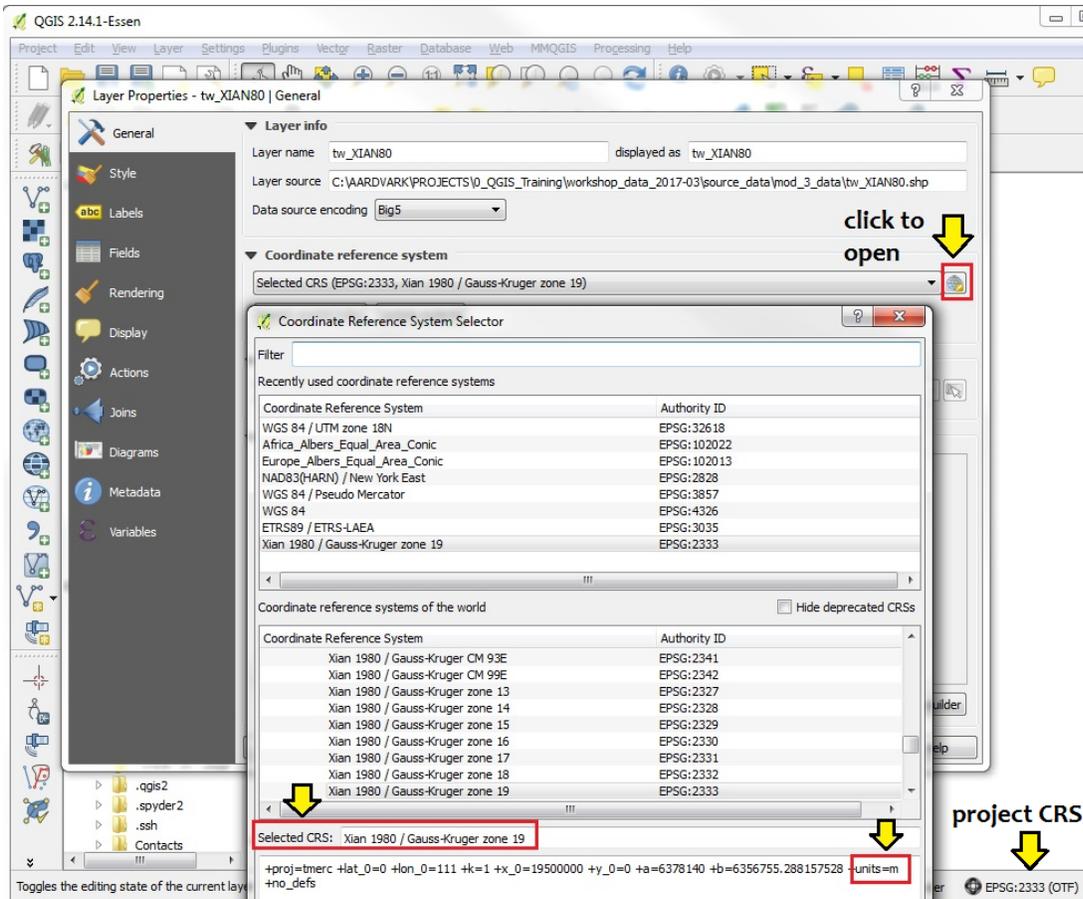
Conceptual Overview: The **Buffer** analysis takes a layer of spatial objects, for example a points layer, and creates a set of polygons with a specified distance radius from each point. The same Buffer tool can be used to create a buffer polygon for polylines, at a specified distance perpendicular to the line on both sides of the original polygon or polyline. Once the buffers are available, they can be used to make spatial selections of overlapping features, or they can be used for other geoprocessing tasks. The **Difference** process will take two layers of spatial features and trim any overlapping parts of those features so that only the “difference” remains. The **Clip** process will trim a polygon area to the outer perimeter of another polygon or set of polygons in a polygon layer.

Exercise: In this example we will create a buffer areas at a distance 10 km from power plants (points) in Taiwan, and then create buffer areas that are five km to either side of the railway lines in Taiwan. The two sets of buffers will then be compared using the “difference” analysis, which essentially will subtract all the areas that are overlapping between the two buffer layers. This difference layer will then be clipped to edge match the coastline of Taiwan, to remove the buffer areas that would otherwise extend outside of the land area. In short, we will be able to answer the question, which land areas in Taiwan are at least 10km away from a power plant, but still within 5km of a railway line.

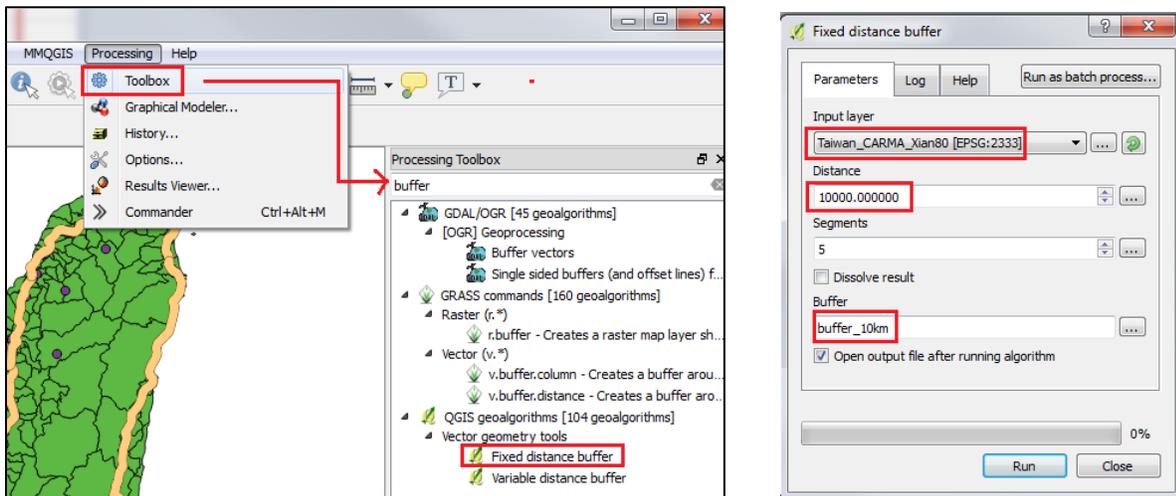
[Note: spatial operations depending on linear distances can only be run on layers that are first projected in CRS that have defined “real-world” distance units, such as m, km, mi]

1. We'll begin by adding the official basemap for Taiwan (more accurate for buffering)
 - 1.1 Open the *tw_adm1_xian80* layer with **Encoding = BIG5**, and **CRS = Xian1980 EPSG:2333**
 - 1.2 next open our points layer of Power Plants, called: *Taiwan_CARMA_Xian80*
 - 1.3 also add the railways, (set encoding to UTF8), *TW_Railways*

2. Check Projection before running any geoprocessing
 - 2.1 right click on each of the layers and check Properties | General
 - 2.2 we want all three layers to be in the same projection, in this case EPSG 2333, Xian 1980 Zone 19
 - 2.3 click on the SELECT CRS button (looks like a little Globe) to view the details of the current Projection
 - 2.4 There are three places we want to check:
 - Selected CRS: is the currently selected CRS for this layer.
 - Units of the selected CRS: in this case units=m (meters)
 - Project CRS: shown in the bottom right of status bar
 - 2.5 If our layers to be buffered are all in the same projection and match the Project CRS, close the CRS dialog and proceed to the buffering



3. Open the Processing Toolbox and search for "buffer." Double-click the FIXED DISTANCE BUFFER tool.

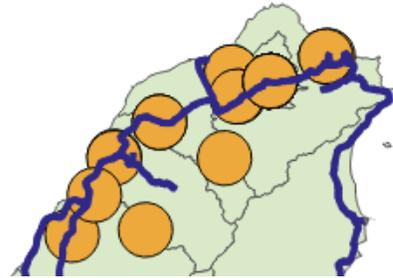
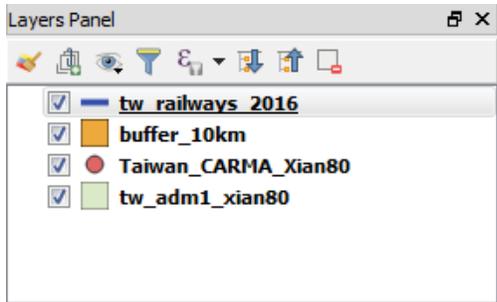


3.1 for the Input Vector Layer, select *Taiwan_CARMA_Xian80* (the Power Plants as points)

3.2 for the Buffer Distance enter the distance (in the layer units !), in our case: **10000** (= 10km)

3.3 browse to your working folder where the new buffer layer will be created, and provide a name for the buffer file, for example: *buffer_10km*

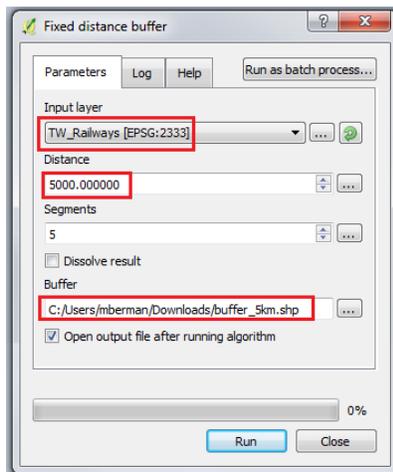
3.4 click RUN to run the Buffer process and view the resulting layer



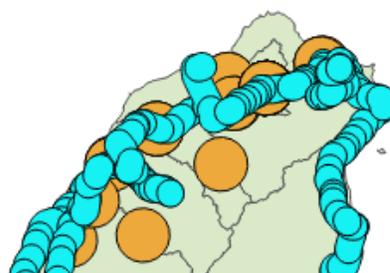
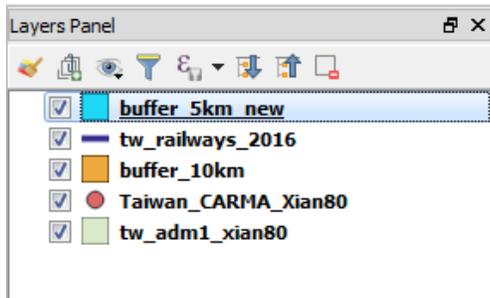
3.5 Now we will repeat the process to buffer the Railways layer

3.6 Go to the Processing Toolbox and double-click the FIXED DISTANCE BUFFER tool

3.7 In the Buffers form, we'll select the *tw_railways_2016* layer and enter Buffer distance of 5000 m, the layer name can be *buffer_5km*



3.8 Click RUN and view the resulting layer, *buffer_5km_new*



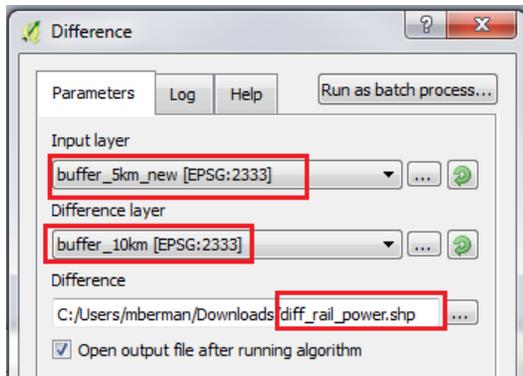
3.9 we now have two polygon layers that can be used for our next analysis, Difference

4. Go to the Processing Toolbox and search for “difference” the double-click the Difference tool

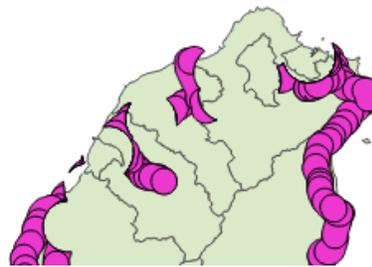
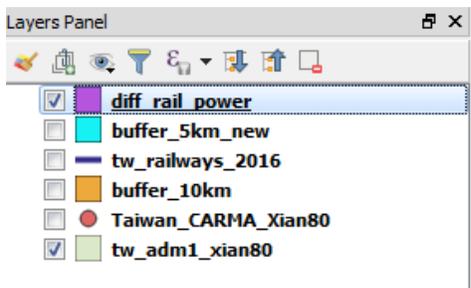
4.1 for the Input Vector Layer select *Buffer_5km_new* (the buffer along the railway lines)

4.2 now for the Difference Layer, select *Buffer_10km* (in order to erase the overlapping power plant areas from the Railway buffer areas)

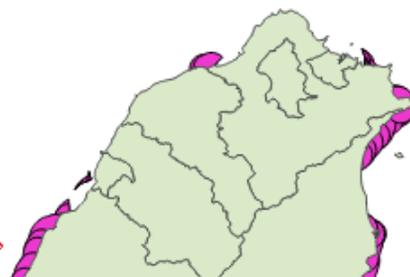
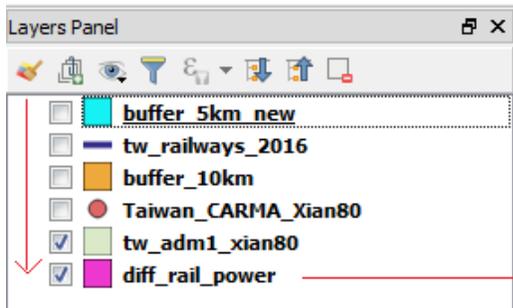
4.3 Browse to the folder to create your shapefile and name it, for example: *Diff_rail_power*



4.4 view the resulting “difference” or the areas that are within the 5km buffer zone, but NOT within the overlapping 10km radius from each power plant.



4.5 Drag the *diff_rail_power* layer to the BOTTOM of the drawing order in the Layer List. Notice that the 5km buffer extended beyond the actual coastline in a few places



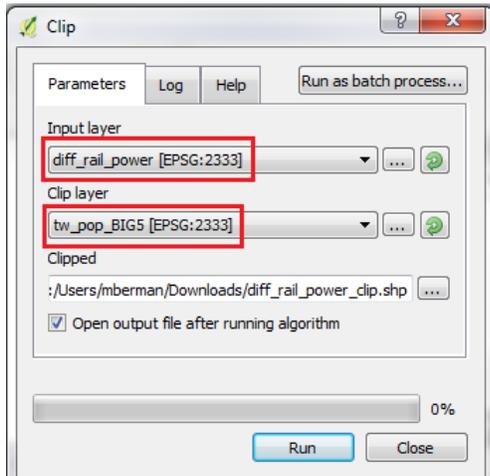
4.6 we can fix these overextended buffer areas using the CLIP process to trim those areas off the *diff_rail_power* layer.

5. Go to the Processing Toolbox and search for “clip” then double-click on the CLIP tool

5.1 Set the Input Vector Layer to *diff_rail_power* (the layer that we want to trim)

5.2 set the Clip Layer to *tw_adm1_xian80* (the layer that we want to use as the template to clip the edge)

5.3 select an output folder and output name, such as *diff_rail_power_clip* then click RUN



5.4 view the resulting *diff_rail_power_clip* layer, notice that the edge of the layer now matches the coastline in the *tw_pop_BIG5* layer.



6. Now let's add all the Railway Stations in Taiwan, and use them to find all the areas in the *diff_rail_power_clip* layer that are WITHIN 500 Meters of a railway station.

6.1 First we add the Vector layer *tw_stations* (note Encoding = UTF8)

6.2 Go to Processing Toolbox and double-click the FIXED DISTANCE BUFFER tool (under Recently Used)

6.3 In the Buffers form, select the *tw_stations* layer and enter Buffer distance of 500, the layer name can be *stations_500m*

6.4 click RUN and check the results

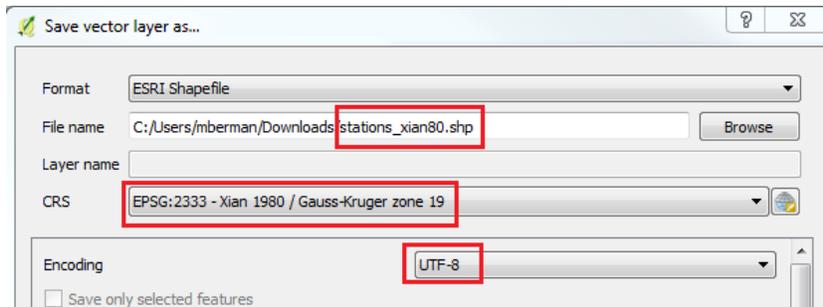
6.5 What happened? The buffers are larger than planet earth... Go back to your *tw_stations* layer and right-click to check the PROPERTIES | GENERAL | SELECT CRS

6.6 Aha! we were using a buffer distance of 500 but the units were decimal degrees, so we tried to create buffers that were 1000 degrees in diameter (while a globe is only 360 degrees in circumference).

6.7 Let's reproject, by right-clicking on the *tw_stations* layer, then SAVE AS a new Shapefile.

6.8 Save to your work folder as: *stations_xian80*

6.9 in the CRS drop down menu, set to the recently used EPSG 2333 Xian 1980 item

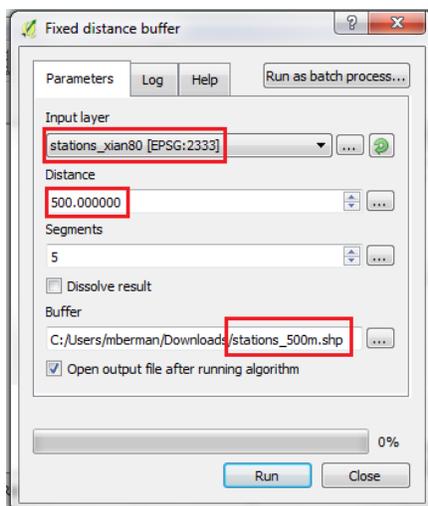


6.10 Click OK and the new layer *stations_xian80* should be added to the project

7 We will now run the Buffer process again

7.1 Go to Processing Toolbox and double-click the FIXED DISTANCE BUFFER tool

7.2 Input Vector Layer is the newly reprojected *stations_xian80* layer, buffer distance = 500, output shapefile = *stations_500m*



7.3 You will be prompted to OVERWRITE the existing *stations_500m* layer, click YES

7.4 now click RUN to run the buffer process

7.5 View the results, this time the *stations_500km* look like tiny dots on the *tw_stations* symbols

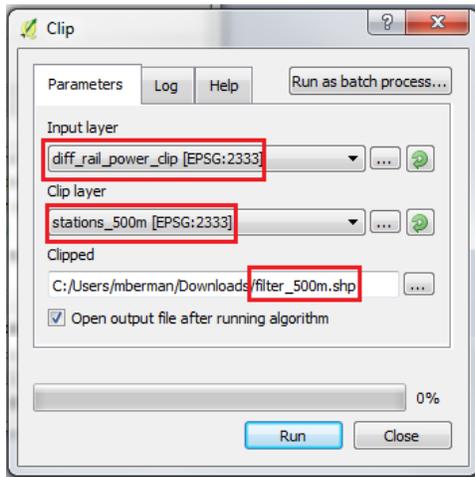
8 Finally, we can run another CLIP process to find all the areas of the *diff_rail_power_clip* layer, that are contained within the 500m radius of any Railway Station

8.1 Go to the Processing Toolbox and double-click on the CLIP tool (under Recently Used)

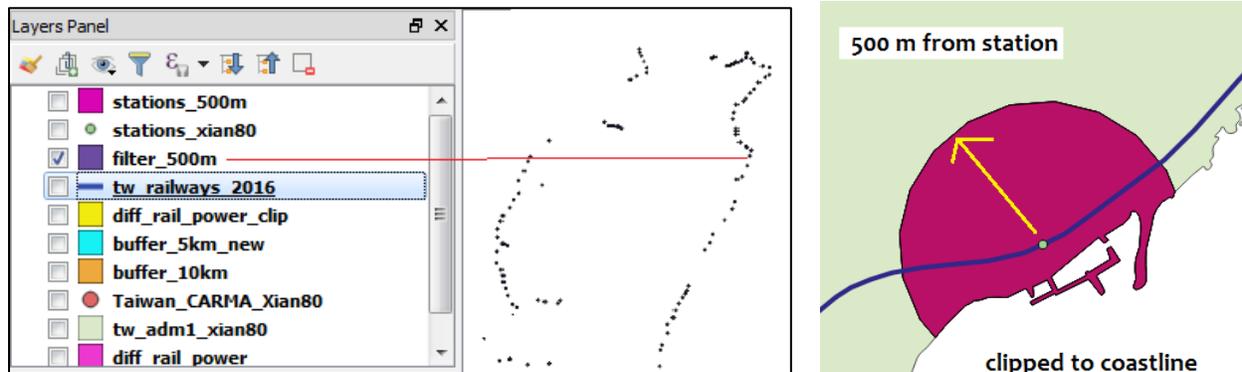
8.2 the Input Vector Layer will be *diff_rail_power_clip*

8.3 the Clip Layer will be *stations_500m*

8.4 the output Shapefile can be: *filter_500m*



8.5 Click OK to run the buffer process and then view the results by turning off ALL other layers besides the *filter_500m* layer. You should see just some tiny dots and slivers.

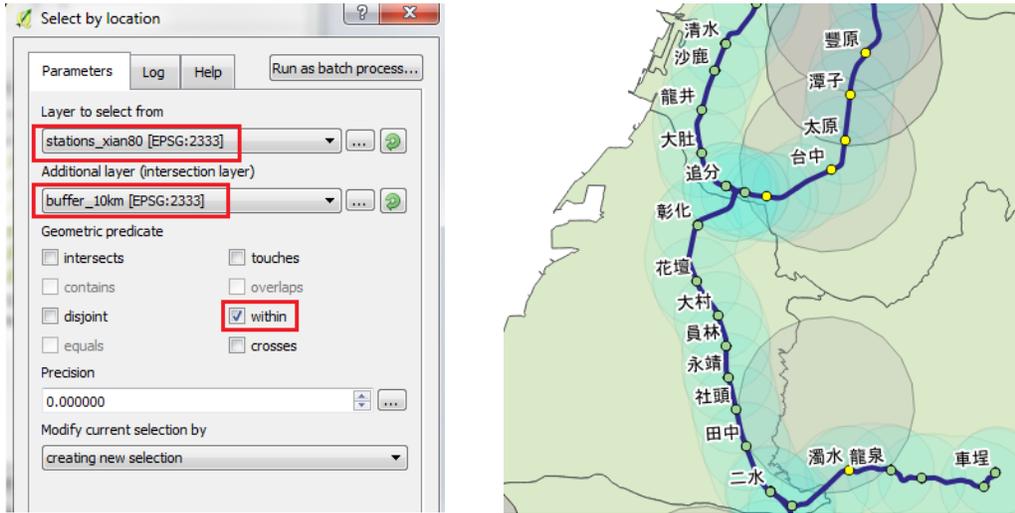


8.6 Turn on the *tw_adm1_xian80* *stations_xian80* and *tw_railways_2016* as basemaps. Drag the stations and railways ABOVE the *filter_500m* layer in the drawing order for some context

8.7 zoom in to a few of the *filter_500m* objects to take a closer look along the coastline

8.8 now right click on the *stations_xian80* layer and go to PROPERTIES | LABELS set the first drop-down to "Show Labels for this layer" and set label field = name_utf

8.9 we now have an interesting set of analytical results. We can select ALL the station points that fall within the 10 km buffer of Power Plants using Processing Toolbox SELECT BY LOCATION tool

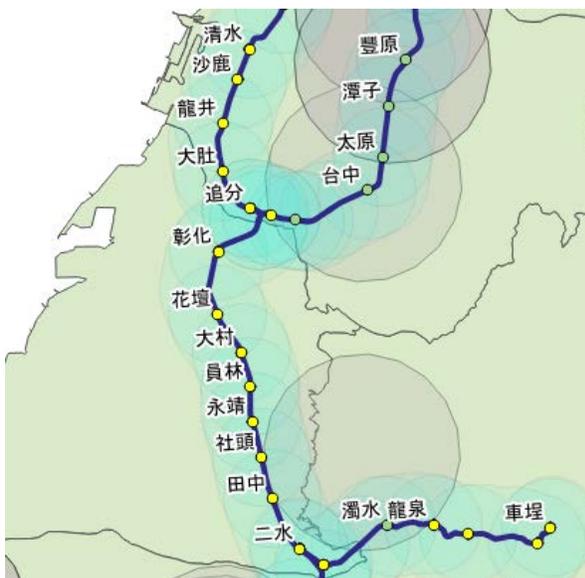


Looking around the resulting map, we see an area with both overlaps and gaps in the selected stations, in other words stations that ARE within 10km of a power plant or farther away. Now we can INVERT the selection, by right-clicking on the *stations_xian80* and open the ATTRIBUTE TABLE where we will see the BLUE selected rows, and we can click on the INVERT SELECTION button

stations_xian80 :: Features total: 219, filtered: 219, selected: 84

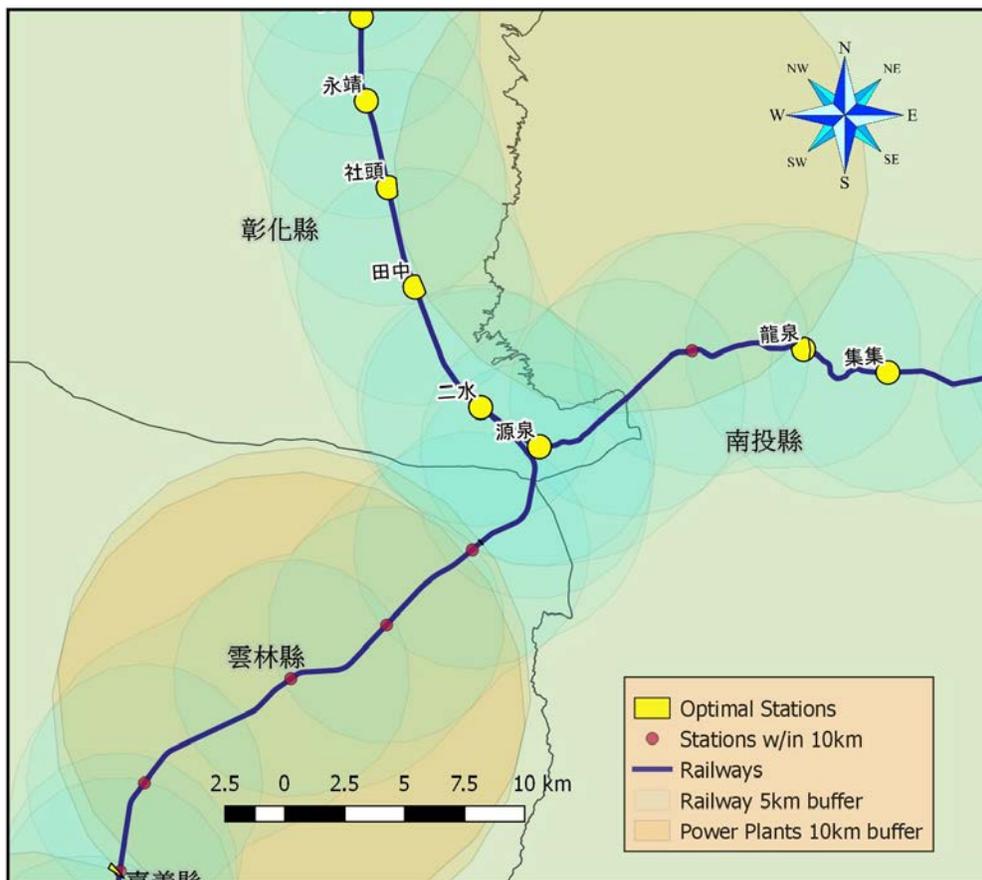
	stat_id	long	Invert selection (Ctrl+R)	name_utf	bureau	grade_hz
1	TW_ST_ID_0001	121.4998483269...	25.03336668389...	萬華	Taiwan	一等站
2	TW_ST_ID_0002	121.5781129319...	25.04925741739...	松山	Taiwan	一等站

Now the map would show the stations that are all OUTSIDE the 10km buffers around power plants.



8.10 Now we can see which areas of Taiwan are MORE than 10km from a Power Plant, which could be set up into a nice map using the QGIS PRINT COMPOSER. First, we could SAVE the current selection of stations as a new layer, by checking the box "save only selected features" and naming it *optimal_stations* then use that layer to label the *filter_500m* buffers (which show the detailed zones around the stations, clipped where they overlap the power plant buffers, or would extend into the sea).

Railways stations > 10km from power plants



Data Sources

Taiwan Ministry of Education, Taiwan Ministry of Transportation

<https://gist-map.motc.gov.tw/Complex/MapTopic>

CARMA Power Plants

<http://www.carma.org/plant>