

Wind Maps

1. Skimming Wind Analysis Map

(Marius)

Goal: to look for Grids with similar building heights >> High risk of experiencing skimming wind
>> Low wind flow >> High Anthropogenic Heat in these subzones

When area is not very dense, need to study building height. When area is dense, does not need to consider building height, but need to identify areas of skimming wind flow.

In dense areas, building heights does little to affect wind flow, it is the **variation in neighbouring building heights** that affects risk of experiencing skimming wind

Cross check with: (to identify relationships)

- Average surface temperature/ UHI (to cross check with average surface temperature)
- Carbon emissions/ Energy Consumption (Increased emissions due to higher energy usage to reduce temperature)

Method of Analysis:

In grids that fall under **high density** areas, do a stand dev of building heights. (high/ low **variance of building heights** in the area)

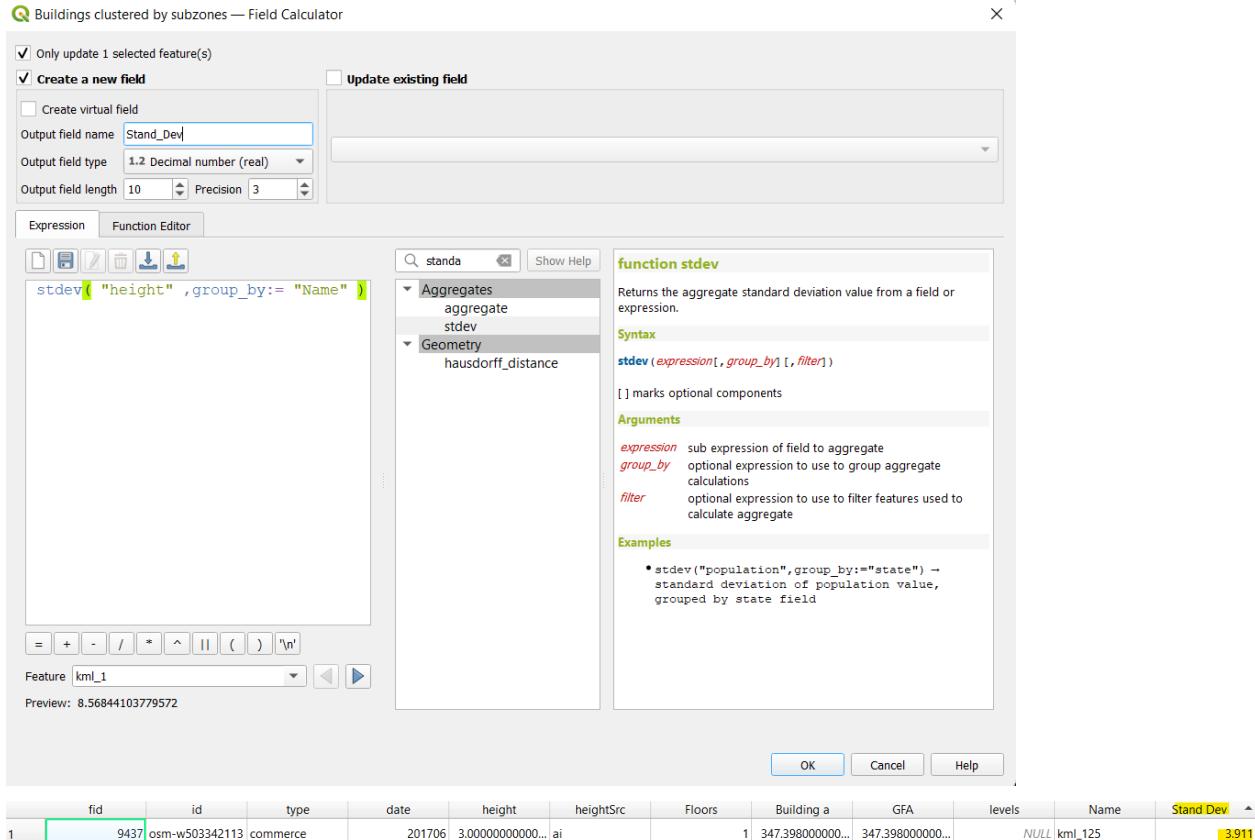
>> get: **areas with high risk of skimming wind**

Steps:

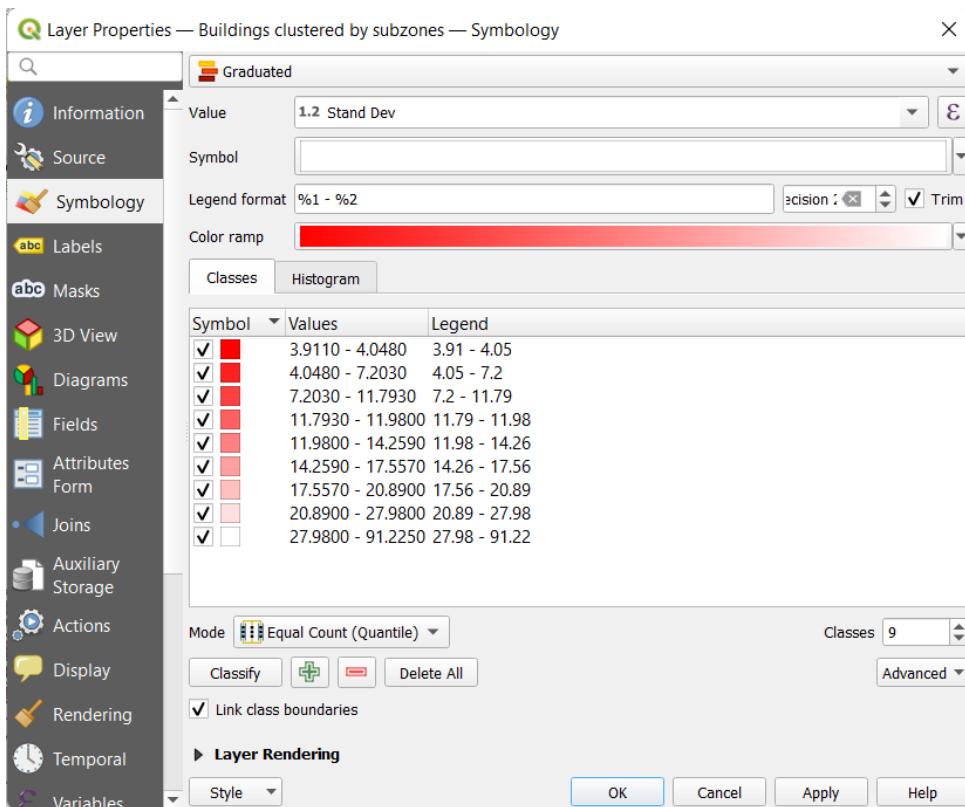
From the building density mapping, lay 90x90m grid

In areas of high density, calculate standard deviation

Attribute table >> Field Calculator >> create Standard deviation based on building heights, grouped by each grid.



Result: “Stand Dev” Attribute added to “Building Footprint + Height”



Presentation of data:

Properties >> Symbology >> Graduated classification of Data based on “Stand Dev” >> Equal Count

Results: the more red the subzone, the lower the standard deviation og building heights in the area. This means that there is a higher probability of skimming wind flow occurring. (Skimming wind flow happens when there is little to no variation in neighbouring building heights)

Assessment of accuracy:

2. Pedestrian Level Wind Velocity Map (Upedes)

(Karen)

Goal: to look for areas with Low Pedestrian Level Wind Speed >> Low Air Flow >> Low Thermal Comfort

Cross check with: (to identify relationships)

- Average surface temperature/ UHI (to cross check with average surface temperature)
- Skimming wind map (to cross check on accuracy, ie. some areas of high skimming wind flow should correspond to low wind speed)
- Actual absolute values from weather stations (for accuracy)

Method of Analysis:

Find GCR (%) of each grid, then use the regression line to find values of pedestrian level wind speed.

>> get: areas with low pedestrian level wind speed

Steps:

1. Getting GCR (building footprint area / Grid area)
- Overlay grid on top of SG Building footprint with landuse.

Building FP attribute table:

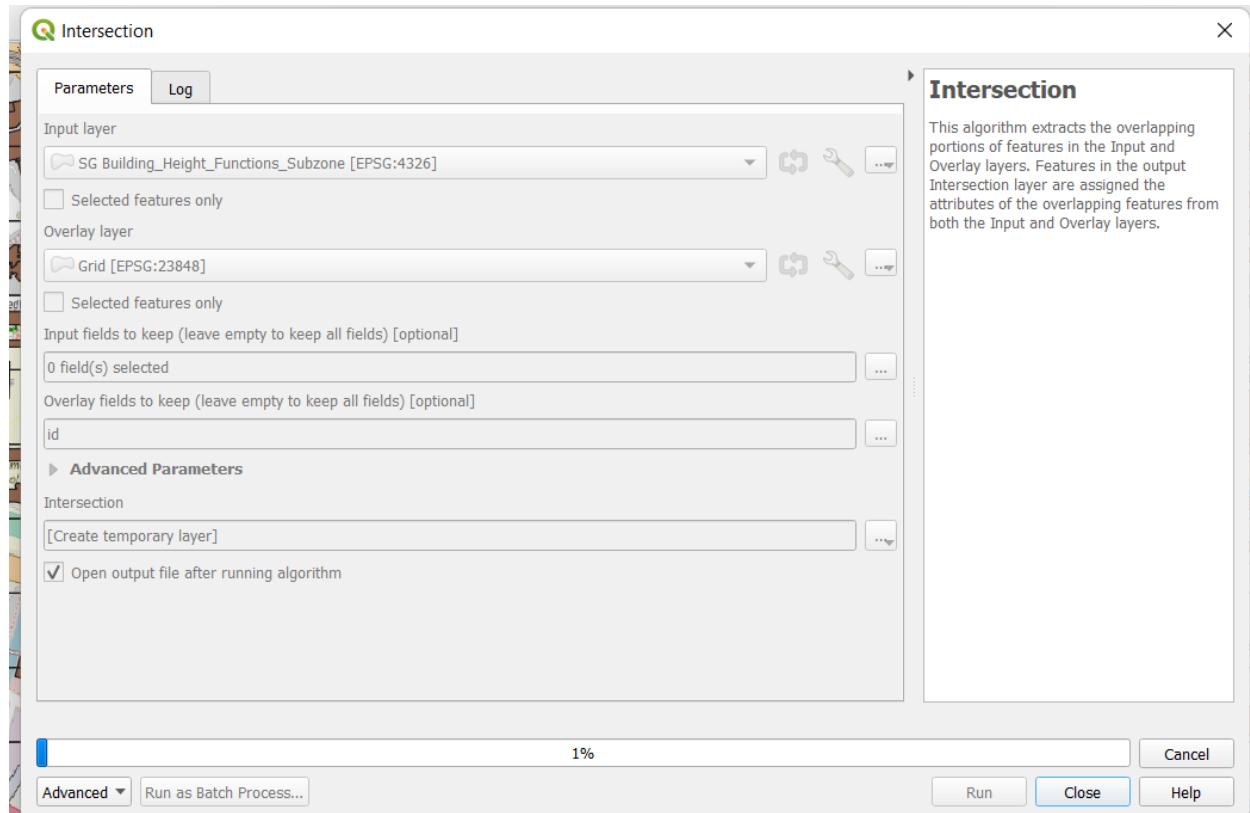
	fid	id	height	Floors	Building a	GFA	LU_DESC	SUBZONE_N	PLN_AREA_N
1	11598	osm-w174717963	17.0000000000...	6	1157.76299999...	6946.57800000...	RESERVE SITE	MARINA EAST	MARINA EAST
2	11600	osm-w174717967	5.0000000000...	2	175.69900000...	351.39800000...	RESERVE SITE	MARINA EAST	MARINA EAST
3	11601	osm-w174717980	3.0000000000...	1	872.24500000...	872.24500000...	RESERVE SITE	MARINA EAST	MARINA EAST
4	106873	osm-w547145123	5.0000000000...	2	553.69100000...	1107.38200000...	RESERVE SITE	MARINA EAST	MARINA EAST

Grid attribute table:

	id	left	top	right	bottom
1	1	344838.754459...	162611.113414...	344928.754459...	162521.113414...
2	2	344838.754459...	162521.113414...	344928.754459...	162431.113414...
3	3	344838.754459...	162431.113414...	344928.754459...	162341.113414...

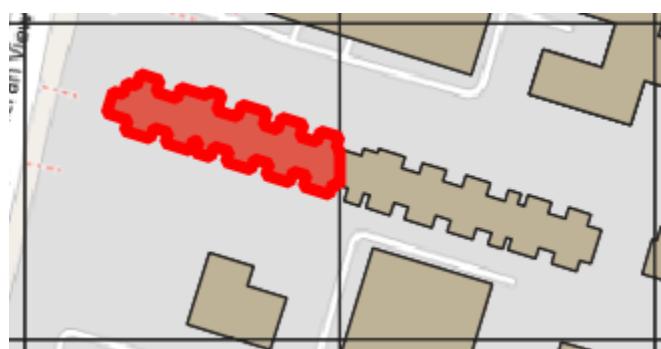
2. Intersect Building FP with Grid

- Vector >> Geoprocessing tools >> Intersection

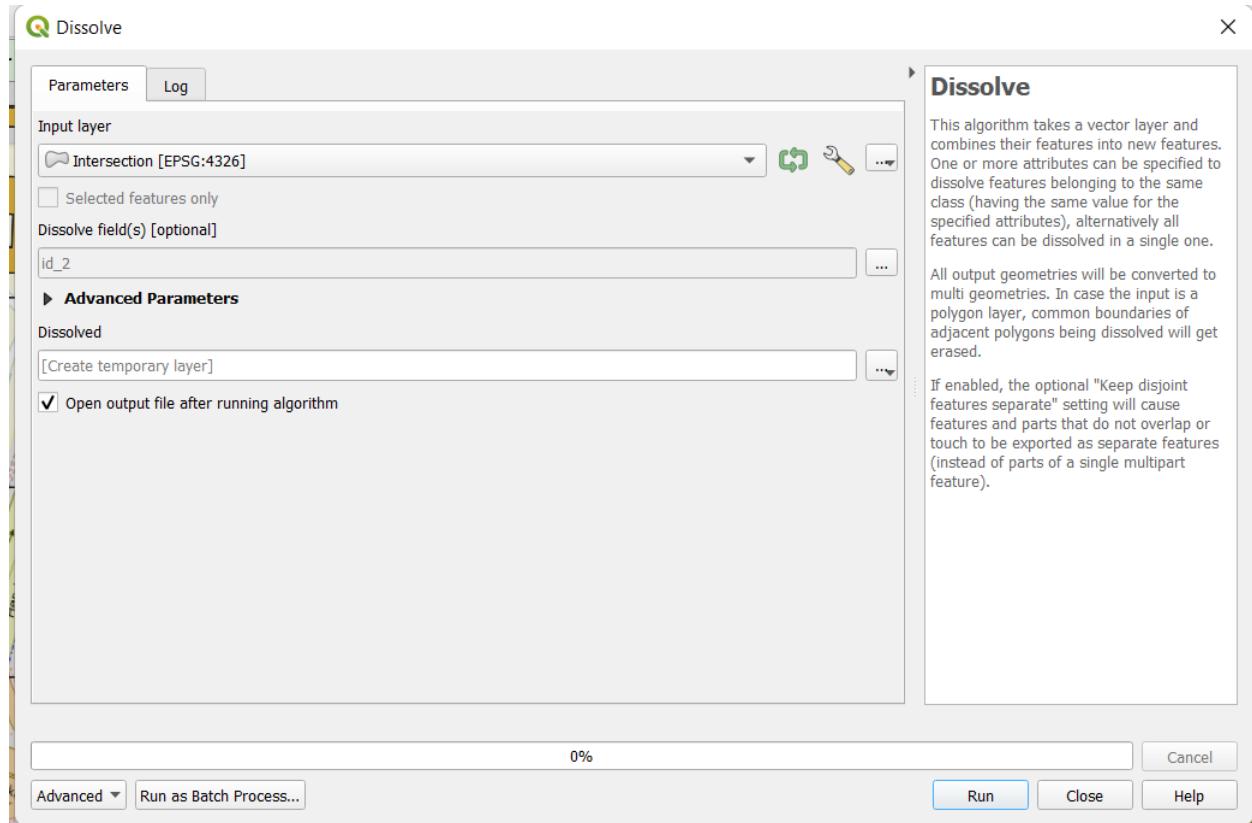


Result: grid ID added to Building FP attribute table, Building FP is cut by grid line

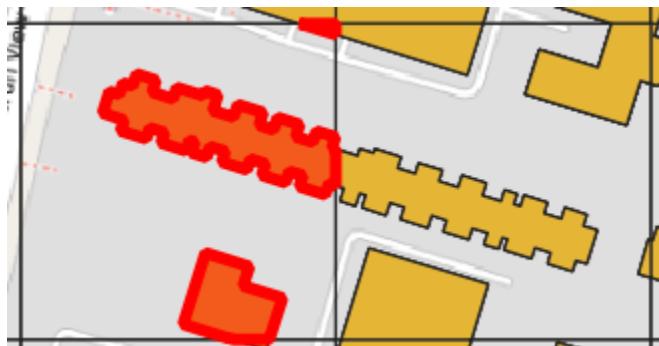
	fid	id	height	Floors	Building a	GFA	LU_DESC	SUBZONE_N	PLN_AREA_N	id_2
1	11598	osm-w174717963	17.0000000000...		6	1157.76299999...	6946.57800000...	RESERVE SITE	MARINA EAST	MARINA EAST
2	11598	osm-w174717963	17.0000000000...		6	1157.76299999...	6946.57800000...	RESERVE SITE	MARINA EAST	MARINA EAST
3	11600	osm-w174717967	5.0000000000...		2	175.69900000...	351.39800000...	RESERVE SITE	MARINA EAST	MARINA EAST
4	11600	osm-w174717967	5.0000000000...		2	175.69900000...	351.39800000...	RESERVE SITE	MARINA EAST	MARINA EAST



3. Dissolve based on grid
 - Vector >> Geoprocessing tools >> Dissolve

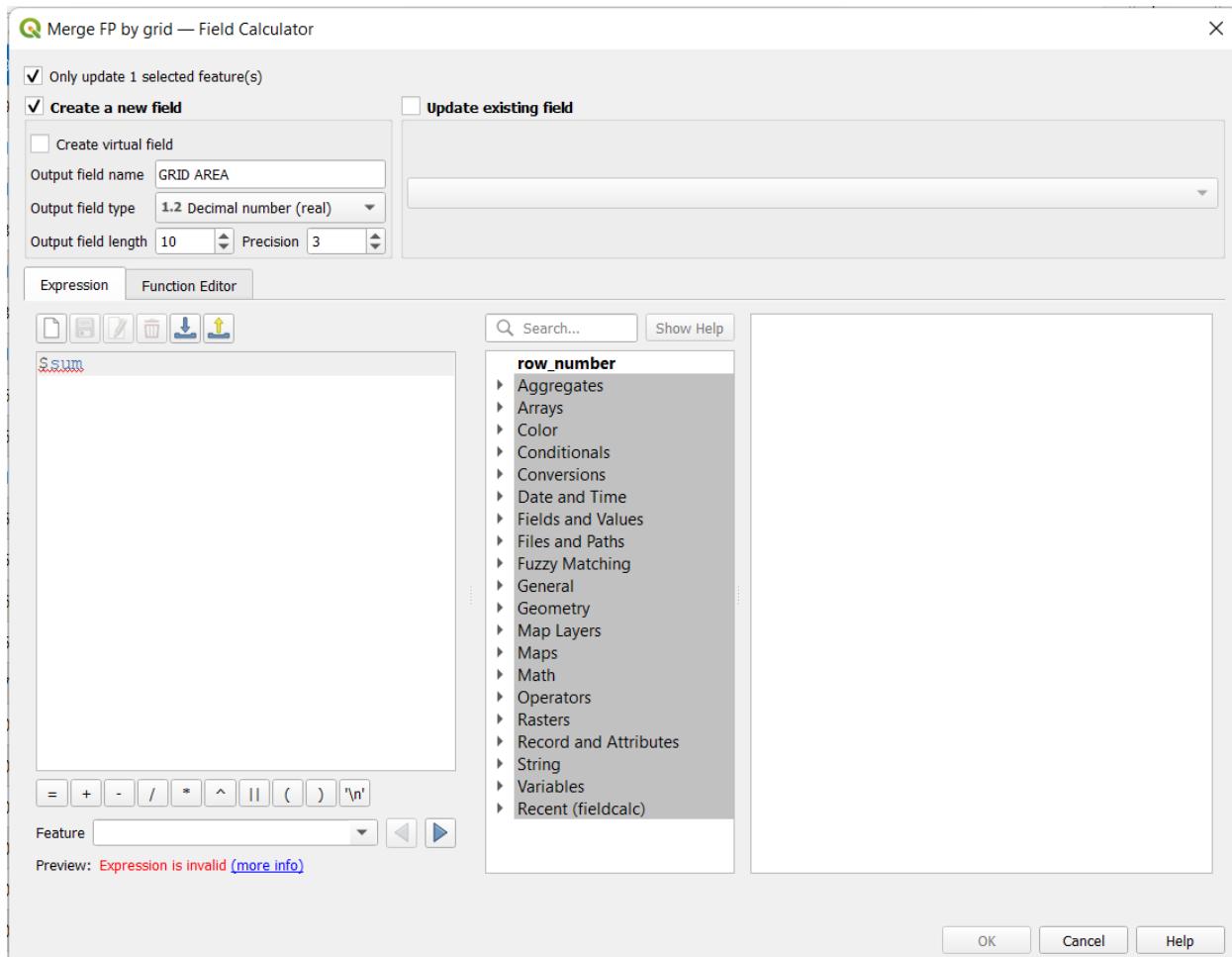


Result: building FP areas are merged together.



4. Calculate GCR (%)
 - Create New Field: "Grid area" via Attribute table >> Field calculator

Input: \$area

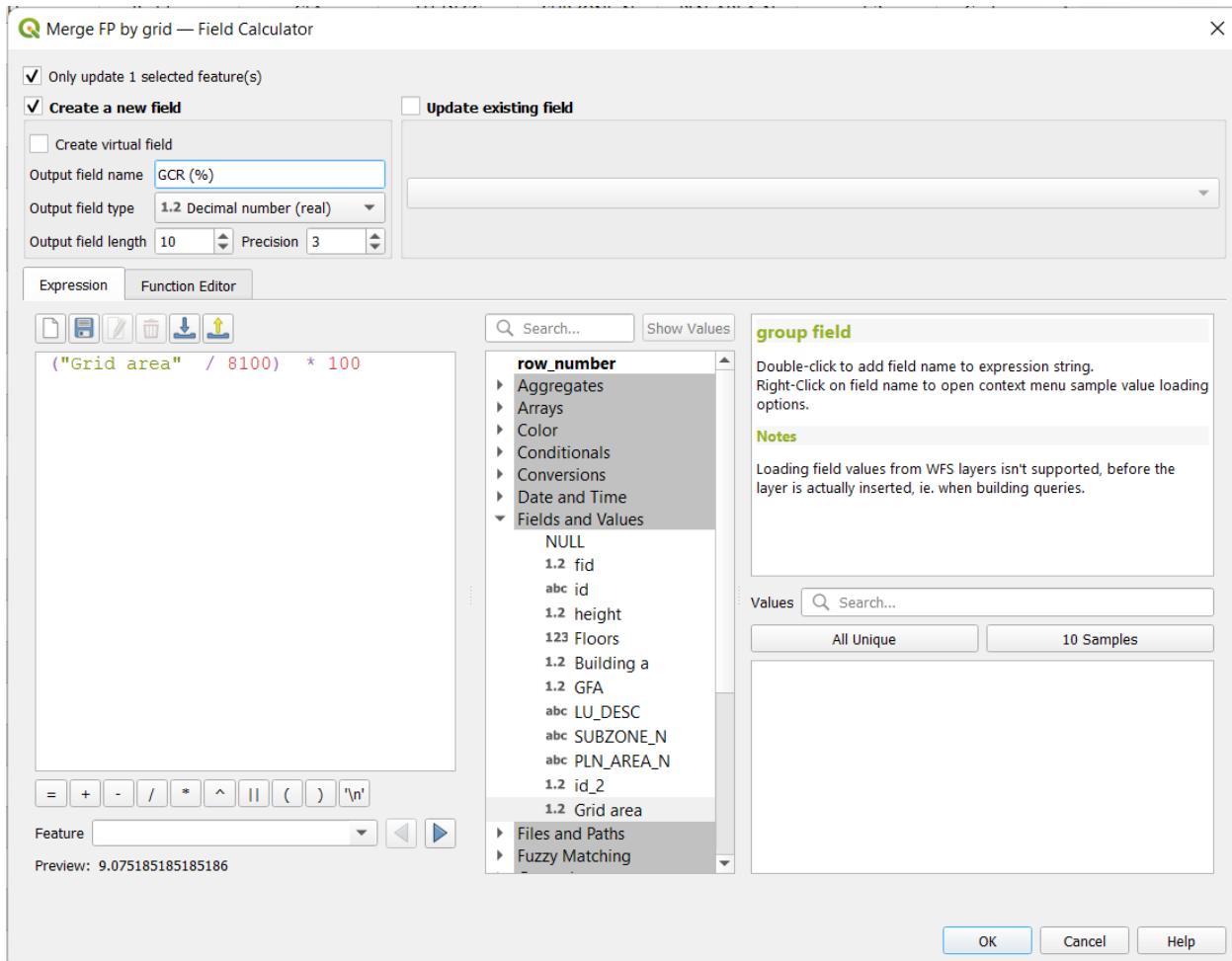


Result: grid area column is created in the attribute table

	fid	id	height	Floors	Building a	GFA	LU_DESC	SUBZONE_N	PLN_AREA_N	id_2	Grid area
34	35941	osm-w111700662	3.0000000000000000...		1	5004.72299999...	5004.72299999...	SPORTS & RECR...	LIM CHU KANG	58041	0.019
35	54354	SG-0003809	9.0000000000000000...		3	145.323000000...	435.96899999...	NULL	NULL	125400	0.022
36	7289	osm-w188187759	3.0000000000000000...		1	57.762000000...	57.762000000...	BUSINESS 2	PASIR RIS WAFE...	151007	0.022
37	71114	osm-w965301174	3.0000000000000000...		1	233.03899999...	233.03899999...	TRANSPORT FA...	MANDAI WEST	88765	0.023

- Create New Field: "GCR (%)" via Attribute table >> Field calculator

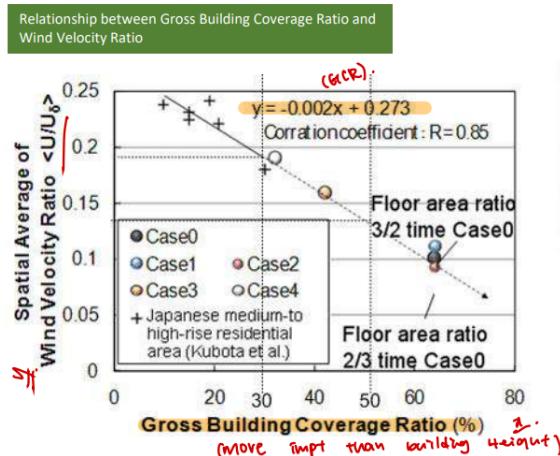
Input: ("Grid area" / 8100) * 100



Result: "GCR (%)" column is created in the attribute table

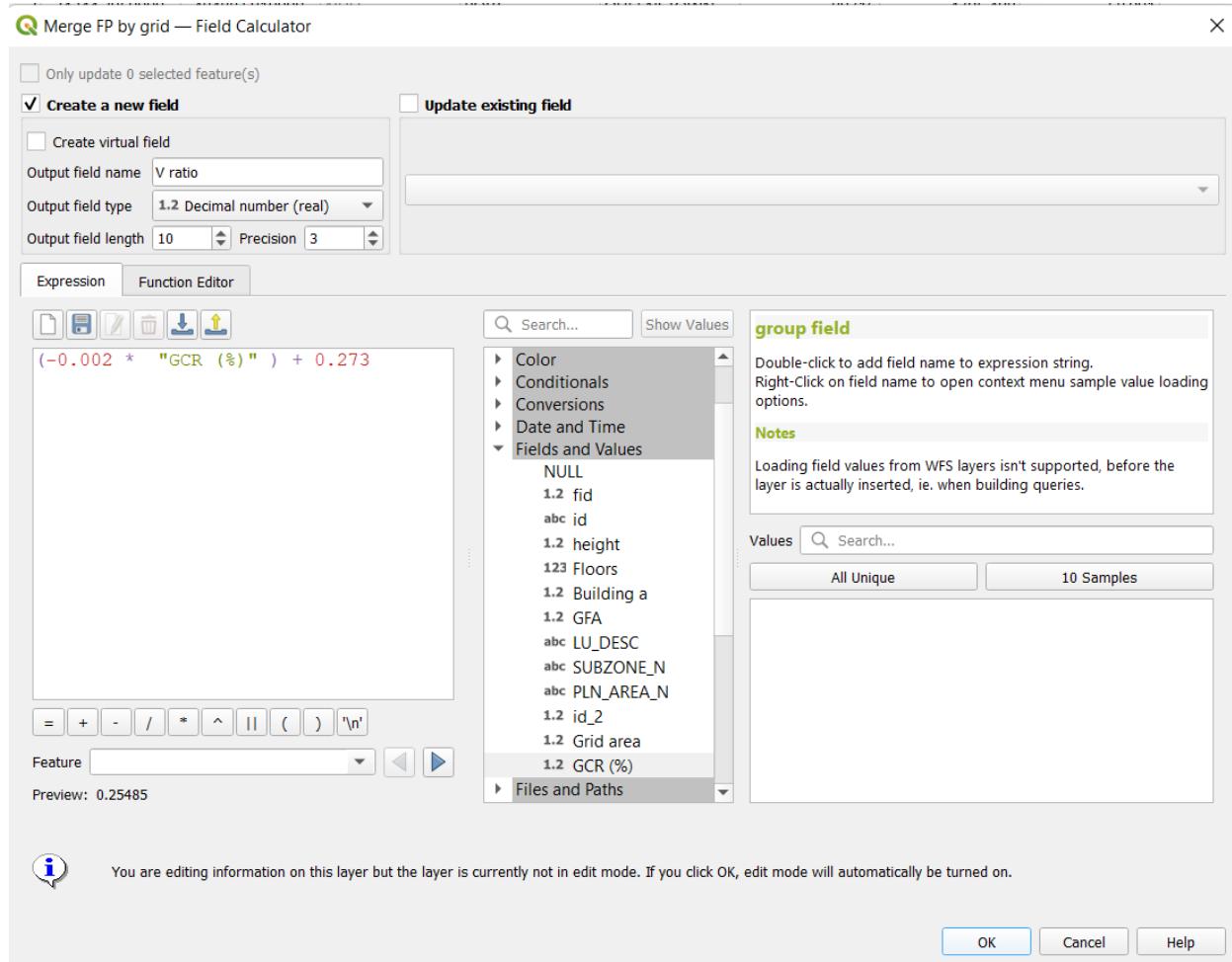
fid	id	height	Floors	Building a	GFA	LU_DESC	SUBZONE_N	PLN_AREA_N	id_2	Grid area	GCR (%)
1	osm-r2241095	5.0000000000...	2	24244.2959999...	48488.5919999...	NULL	PORT	QUEENSTOWN	89716	4705.408	58.091
1	osm-r2241095	5.0000000000...	2	24244.2959999...	48488.5919999...	NULL	PORT	QUEENSTOWN	90099	525.604	6.489
1	osm-r2241095	5.0000000000...	2	24244.2959999...	48488.5919999...	NULL	PORT	QUEENSTOWN	90486	0.878	0.011

5. Calculate Pedestrian level wind speed (Up)



- Since there is a strong correlation between Spatial Average Wind Velocity ratio $\langle U/Up \rangle(y)$ and Gross Building Coverage Ratio % (x), $R= 0.85$, we can use: $y = -0.002x + 0.273$ to approximate the Wind velocity ratio for each grid.

- Create New Field: "V ratio" via Attribute table >> Field calculator



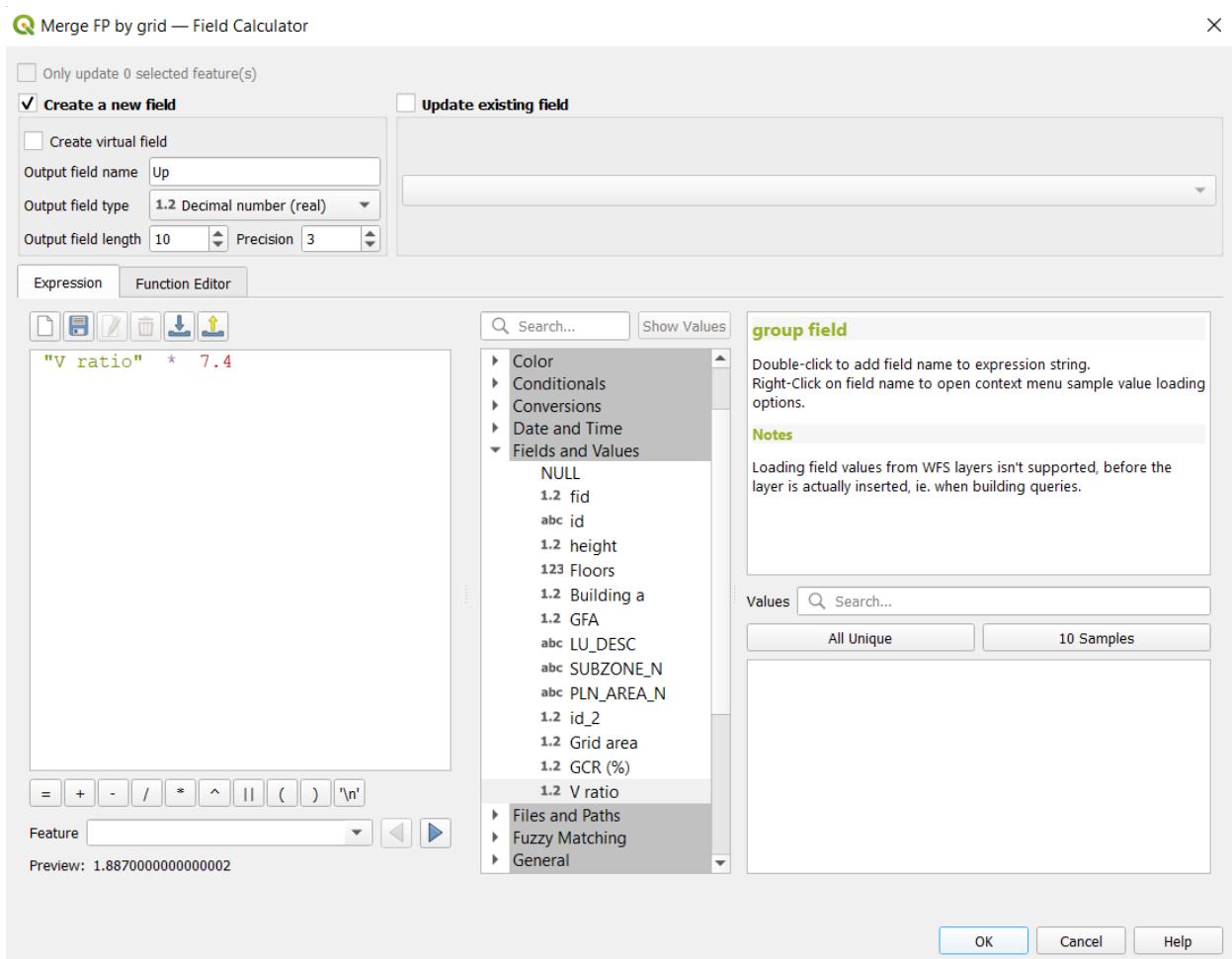
Result: "V ratio" column is created in the attribute table

fid	id	height	Floors	Building a	GFA	LU_DESC	SUBZONE_N	PLN_AREA_N	id_2	Grid area	GCR (%)	V ratio
1	osm-r2241095	5.0000000000...	2	24244.2959999...	48488.5919999...	NULL	PORT	QUEENSTOWN	89716	4705.408	58.091	0.157
1	osm-r2241095	5.0000000000...	2	24244.2959999...	48488.5919999...	NULL	PORT	QUEENSTOWN	90099	525.604	6.489	0.26
1	osm-r2241095	5.0000000000...	2	24244.2959999...	48488.5919999...	NULL	PORT	QUEENSTOWN	90486	0.878	0.011	0.273

- since $V \text{ ratio} = \text{Average wind speed at pedestrian level (Up)} / \text{Average wind speed at Reference level (7.4 m/s)}$

$$\text{Up (m/s)} = V \text{ ratio} * 7.4 \text{ m/s}$$

- Create New Field: "Up" via Attribute table >> Field calculator

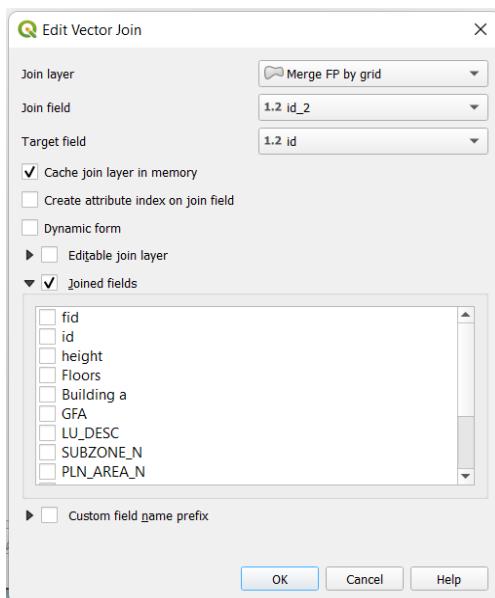


Result: “Up” column is created in the attribute table

	fid	id	height	Floors	Building a	GFA	LU_DESC	SUBZONE_N	PLN_AREA_N	id_2	Grid area	GCR (%)	V ratio	Up
1	osm-r2241095	5.0000000000...		2	24244.2959999...	48488.5919999...	NULL	PORT	QUEENSTOWN	89716	4705.408	58.091	0.157	1.162
1	osm-r2241095	5.0000000000...		2	24244.2959999...	48488.5919999...	NULL	PORT	QUEENSTOWN	90099	525.604	6.489	0.26	1.924
1	osm-r2241095	5.0000000000...		2	24244.2959999...	48488.5919999...	NULL	PORT	QUEENSTOWN	90486	0.878	0.011	0.273	2.020

6. Map Up back to the grid and reflect results

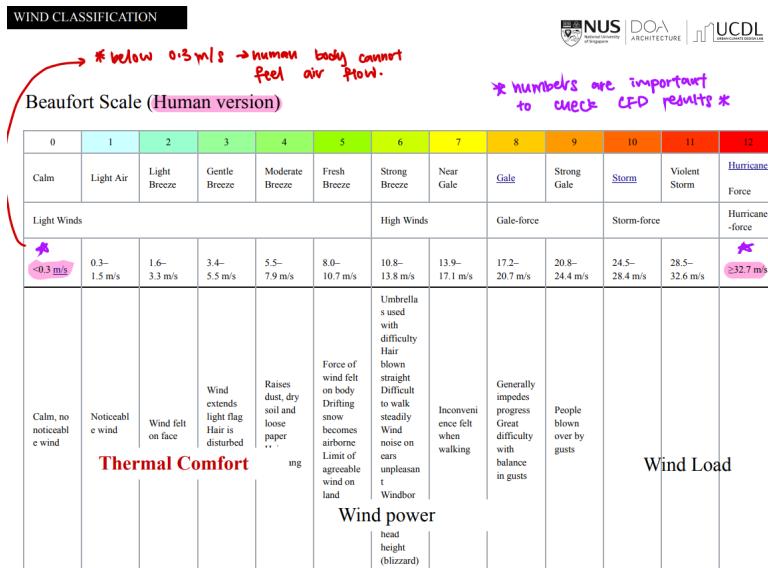
- Grid >> Properties >> Joins



Result: “Up” column is added to the attribute table of “Grid” layer

	id	left	top	right	bottom	Merge FP by grid_Up
1	307	344838.754459...	135071.113414...	344928.754459...	134981.113414...	2.020
2	1804	345198.754459...	138581.113414...	345288.754459...	138491.113414...	2.020
3	2190	345288.754459...	138401.113414...	345378.754459...	138311.113414...	2.020

- The final results of Up are then classified by the Beaufort Scale (Human Version) table:



Result:

Wind speeds are separated into 3 categories

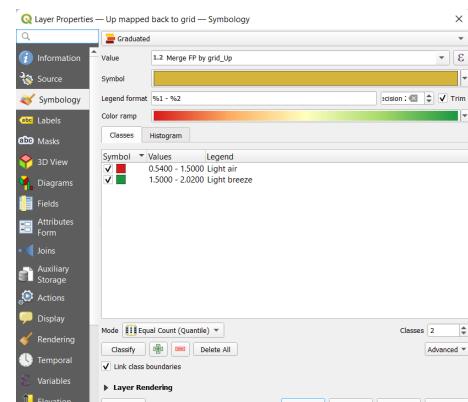
- White: Zero (no Building FP)

- Red: (0.54 - 1.5 m/s)

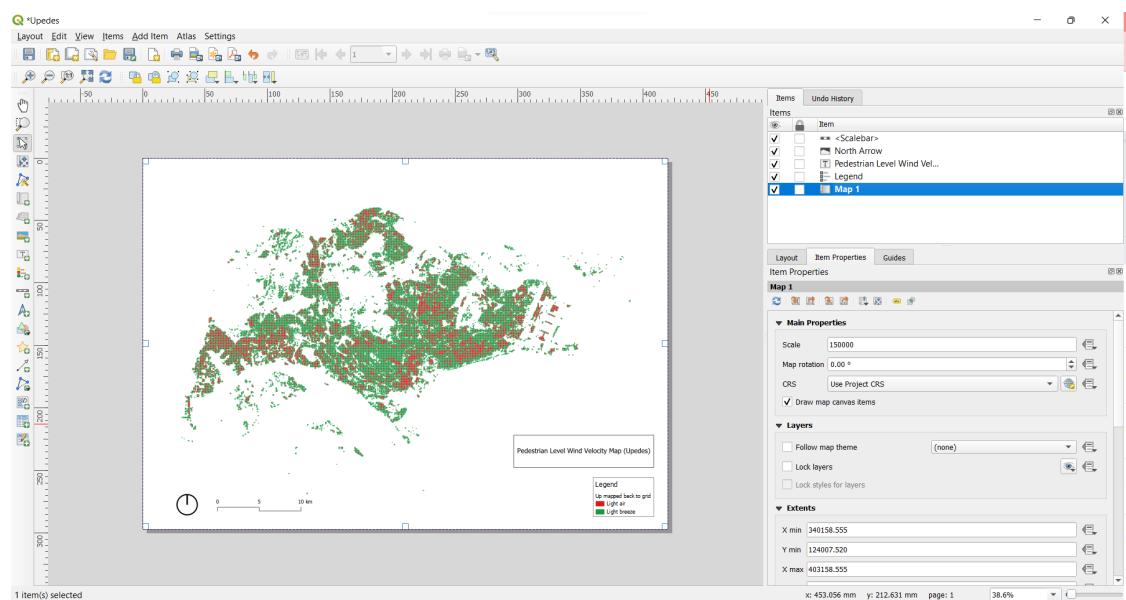
Light air (values starts from 0.54) - areas of low thermal comfort

- Green: (1.5 - 2.02 m/s)

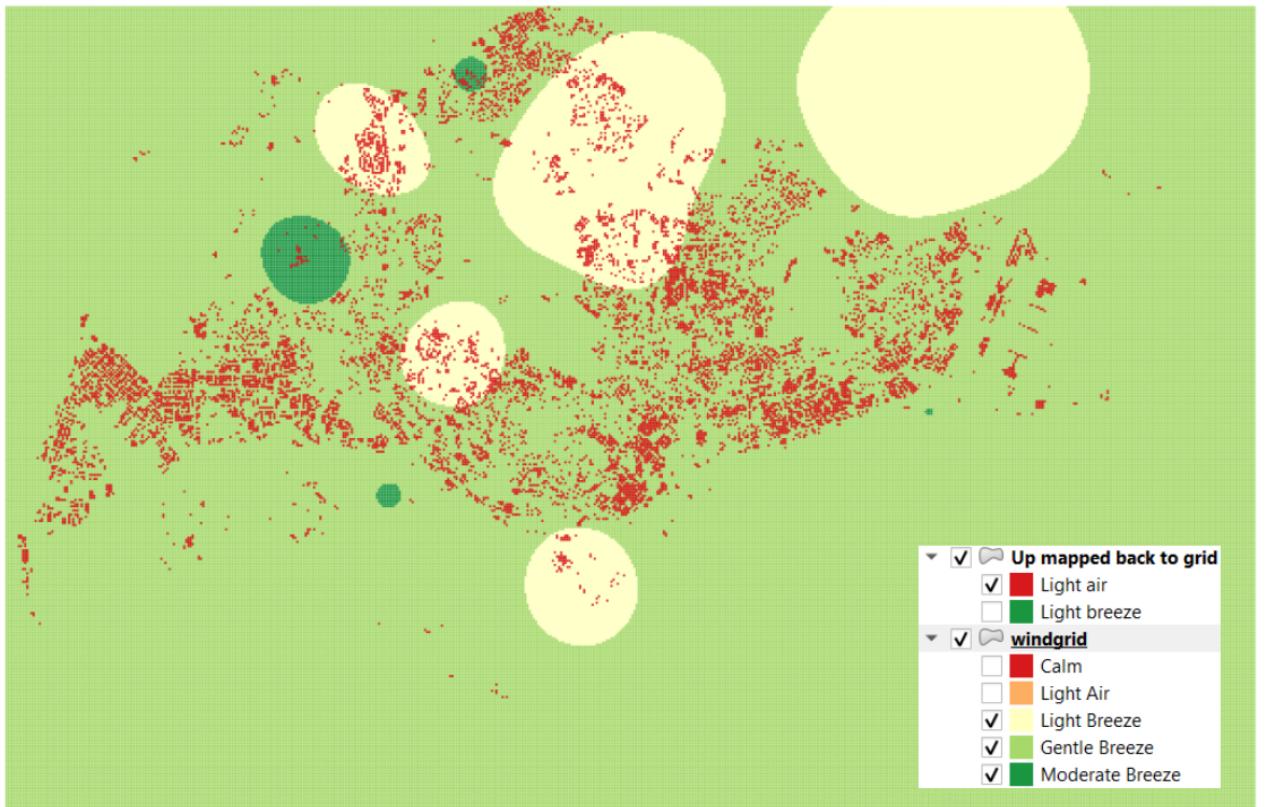
Light breeze (values end at 2.02) - areas of higher thermal comfort



7. Layout Settings



3. Skimming Wind Map Overlayed with U_{pedes} Map



Up with actual wind speed values overlaid on top.

4. Crosschecking with actual data

(Shaun & Junseok)

Step 1. Fetch weather API data to calculate annual average per weather station in R.

Obtain list of Dates in the necessary query format.

```
links <- as.data.frame(  
  seq.Date(as.Date("2021-09-04"),as.Date("2022-09-03"),"days"))  
  colnames(links) <- "link"
```

Add URL to obtain list of API URLs for each day.

```
l <- "https://api.data.gov.sg/v1/environment/air-temperature?date="  
links$link <- paste(l,links$link, sep="")
```

Initialise dataframe and loop through each API URL.

```
air_temp <- data.frame(station_id=character(),  
                        air_temp=double(),  
                        stringsAsFactors=FALSE)  
for (link in links$link){
```

Fetch API and string contents.

```
res <- GET(link)  
data <- fromJSON(rawToChar(res$content),flatten=TRUE)
```

Name	Type	Value
data	list [3]	List of length 3
metadata	list [3]	List of length 3
stations	list [15 x 5] (S3: data.frame)	A data.frame with 15 rows and 5 columns
id	character [15]	'S50' 'S107' 'S43' 'S108' 'S44' 'S121' ...
device_id	character [15]	'S50' 'S107' 'S43' 'S108' 'S44' 'S121' ...
name	character [15]	'Clementi Road' 'East Coast Parkway' 'Kim Chuan Road' 'Marina Gardens Drive' 'Na ...
location.latitude	double [15]	1.33 1.31 1.34 1.28 1.35 1.37 ...
location.longitude	double [15]	104 104 104 104 104 104 ...
reading_type	character [1]	'DBT 1M F'
reading_unit	character [1]	'deg C'
items	list [1436 x 2] (S3: data.frame)	A data.frame with 1436 rows and 2 columns
timestamp	character [1436]	'2022-09-03T00:01:00+08:00' '2022-09-03T00:02:00+08:00' '2022-09-03T00:03:00+08: ...
readings	list [1436]	List of length 1436
api_info	list [1]	List of length 1
status	character [1]	'healthy'

Create dataframe for Items.

```
df <- data$items
```

	timestamp	readings
1	2022-09-03T00:01:00+08:00	2 variables
2	2022-09-03T00:02:00+08:00	2 variables
3	2022-09-03T00:03:00+08:00	2 variables
4	2022-09-03T00:04:00+08:00	2 variables
5	2022-09-03T00:05:00+08:00	2 variables
6	2022-09-03T00:06:00+08:00	2 variables
7	2022-09-03T00:07:00+08:00	2 variables
8	2022-09-03T00:08:00+08:00	2 variables
9	2022-09-03T00:09:00+08:00	2 variables
10	2022-09-03T00:10:00+08:00	2 variables
11	2022-09-03T00:11:00+08:00	2 variables
12	2022-09-03T00:12:00+08:00	2 variables
13	2022-09-03T00:13:00+08:00	2 variables

The data frame is nested, with each reading containing the station id and its respective value.

	station_id	value
1	S50	26.5
2	S107	27.9
3	S43	27.2
4	S108	27.0
5	S44	26.6
6	S121	26.0
7	S106	25.0
8	S111	26.7
9	S60	27.6
10	S115	28.0
11	S24	26.4
12	S116	27.9
13	S104	26.3
14	S100	26.0

Therefore, we flatten the nested data frame, and calculate the average per station.

```
flat <- unnest(df,readings)
flat %>%
  group_by(station_id) %>%
  summarise(air_temp=mean(value)) -> flat
```

	station_id	air_temp
1	S100	28.49194
2	S104	28.23531
3	S106	27.57414
4	S107	28.83862
5	S108	28.99196
6	S109	28.57851
7	S111	27.75937
8	S115	28.69065
9	S116	28.46289
10	S121	28.44201
11	S24	28.42324
12	S43	28.75574
13	S44	28.18538
14	S50	28.05039
15	S60	28.20077

This gives us the average reading per day per station.

We then merge all these average readings into one data frame for data manipulation.

```
air_temp <- rbind(air_temp,flat)
}
```

This obtains a long list of average readings per day per weather station.

	station_id	air_temp
1	S100	27.96234
2	S104	27.89889
3	S106	27.75724
4	S107	28.45310
5	S108	29.07098
6	S109	28.31113
7	S111	27.81989
8	S115	28.29777
9	S116	28.08963
10	S121	27.86611
11	S122	27.63463
12	S24	28.55421
13	S43	28.91025
14	S44	27.72672
15	S50	27.61962
16	S100	28.05338
17	S104	28.14492
18	S106	28.11434
19	S107	28.57029
20	S108	29.50424
21	S109	28.70543
22	S111	28.13693
23	S115	28.36756
24	S116	28.48643
25	S121	27.72669
26	S122	28.08085
27	S24	28.67418
28	S43	29.24045
	...	

We can get the averages of each weather station, which gives us the averages across the year.

```
air_temp %>%
  group_by(station_id)%>%
  summarise(airtemp=mean(air_temp,na.rm=TRUE))-> airtemp
```

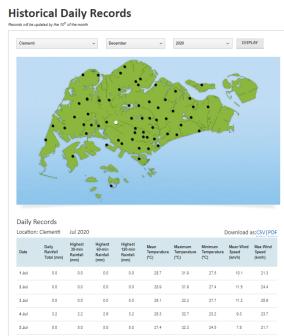
	station_id	airtemp
1	S100	27.99870
2	S104	27.66520
3	S106	27.32017
4	S107	28.51621
5	S108	28.58071
6	S109	28.07430
7	S111	27.62739
8	S115	28.19552
9	S116	28.22462
10	S121	27.83659
11	S122	28.05322
12	S24	28.08376
13	S43	28.34075
14	S44	27.48316
15	S50	27.68840
16	S60	27.80500

Write to CSV.

```
write.csv(airtemp, "~/School/AR5805 Advanced Architecture  
Studio/QGIS/Data/Climate/airtemp.csv", row.names=FALSE)
```

Step2. Map the Data

Step1. Download daily weather data for every month
<http://www.weather.gov.sg/climate-historical-daily/>



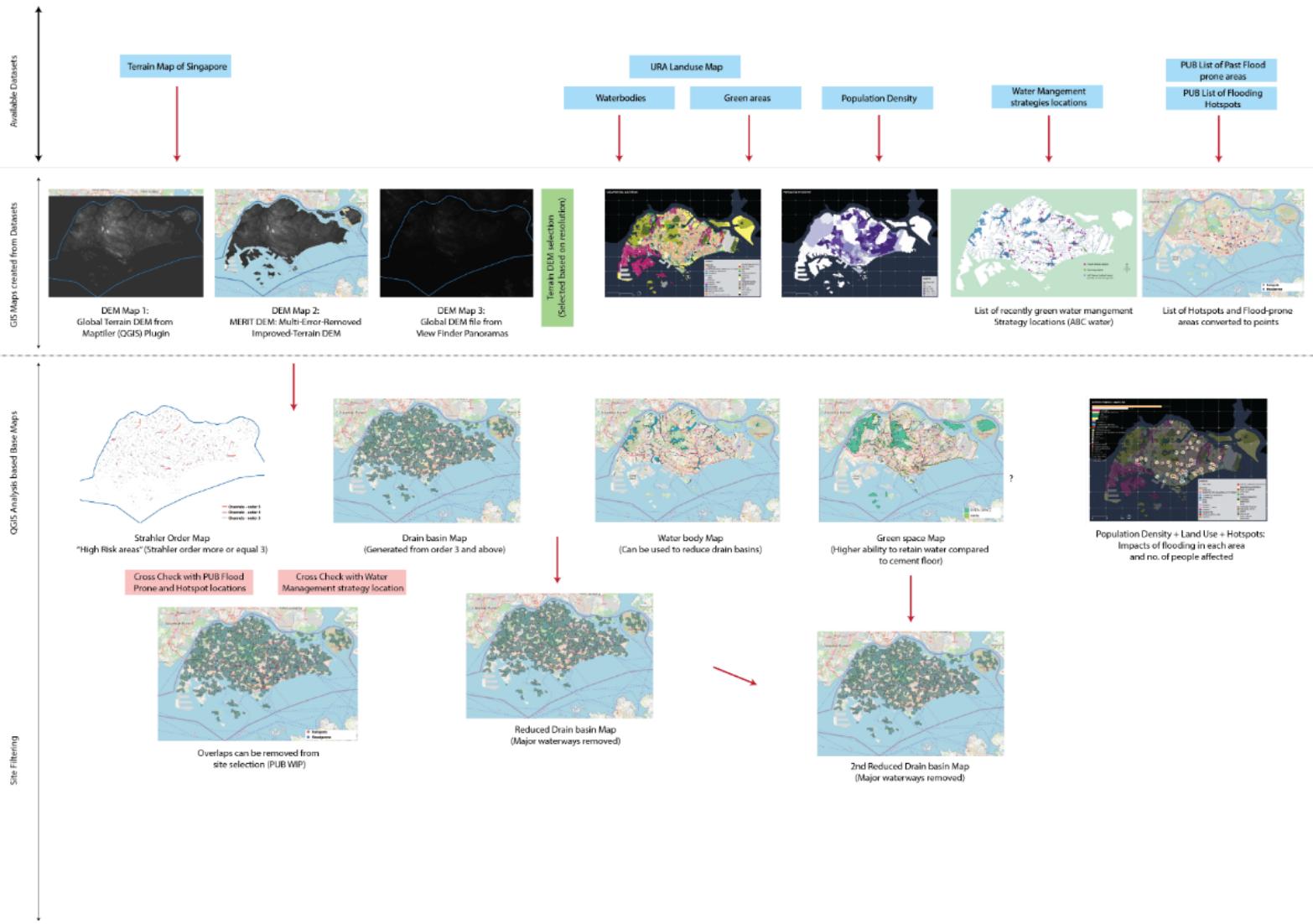
▣	DAILYDATA_S39_201301	2022-09-01 오후 5:14	Microsoft Excel 워크	2KB
▣	DAILYDATA_S39_201302	2022-09-01 오후 5:15	Microsoft Excel 워크	2KB
▣	DAILYDATA_S39_201303	2022-09-01 오후 5:15	Microsoft Excel 워크	2KB
▣	DAILYDATA_S39_201304	2022-09-01 오후 5:15	Microsoft Excel 워크	2KB
▣	DAILYDATA_S39_201305	2022-09-01 오후 5:15	Microsoft Excel 워크	2KB
▣	DAILYDATA_S39_201306	2022-09-01 오후 5:15	Microsoft Excel 워크	2KB
▣	DAILYDATA_S39_201307	2022-09-01 오후 5:15	Microsoft Excel 워크	2KB
▣	DAILYDATA_S39_201308	2022-09-01 오후 5:15	Microsoft Excel 워크	2KB
▣	DAILYDATA_S39_201311	2022-09-01 오후 5:15	Microsoft Excel 워크	2KB
▣	DAILYDATA_S39_201312	2022-09-01 오후 5:15	Microsoft Excel 워크	2KB

Step2. Merge the data to calculate annual average

Step3. Repeat this whole process for 63 stations

Water Map - Pluvial Flooding

Overall Method of Analysis - Flow Chart



1. Watershed analysis - Strahler Order Map and Drain Basins

(Karen - Week 4)

Goal: From Topography map, to look for areas with High intensity of flooding.

Higher Strahler Order >> Higher Speed and Intensity of Flooding (due to more streams of water)
 Drain Basins >> area of ponding according to the strahler order

Cross check with: (to identify relationships)

- Current flood prone areas and hotspots (for accuracy)

Method of Analysis:

Select sufficiently high resolution terrain DEM >> Watershed analysis >> Strahler Order Map and Drain Basins

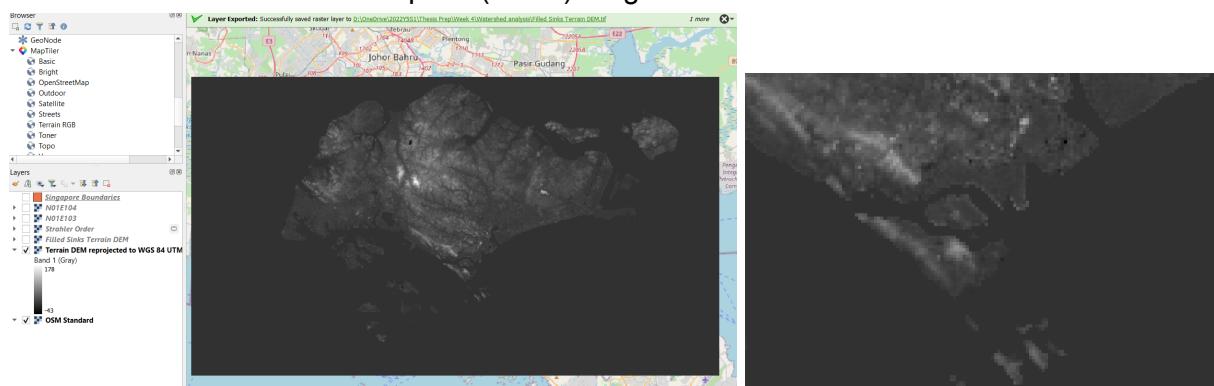
>> get: areas with Higher Speed and Intensity of Flooding based on topography and Grid system to evaluate flooding(flood basins).

Steps:

1. Choosing a High resolution DEM terrain map of Singapore

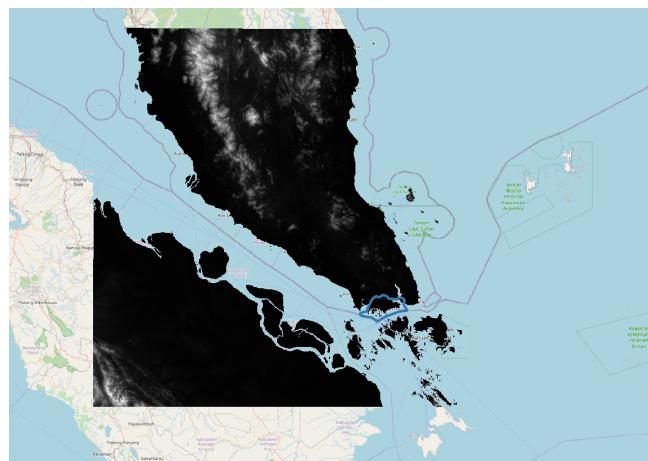
Choice of DEM maps:

1. Global Terrain DEM from Maptiler (QGIS) Plugin



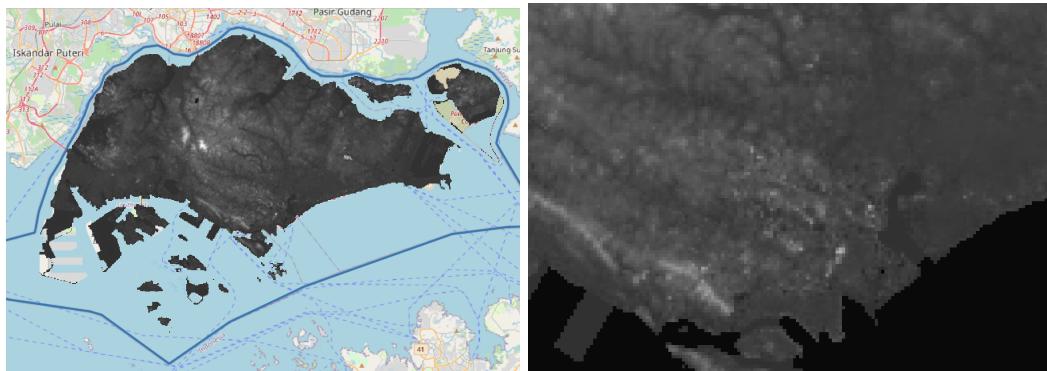
Verdict: Low resolution when zoomed in.

2. MERIT DEM: Multi-Error-Removed Improved-Terrain DEM¹



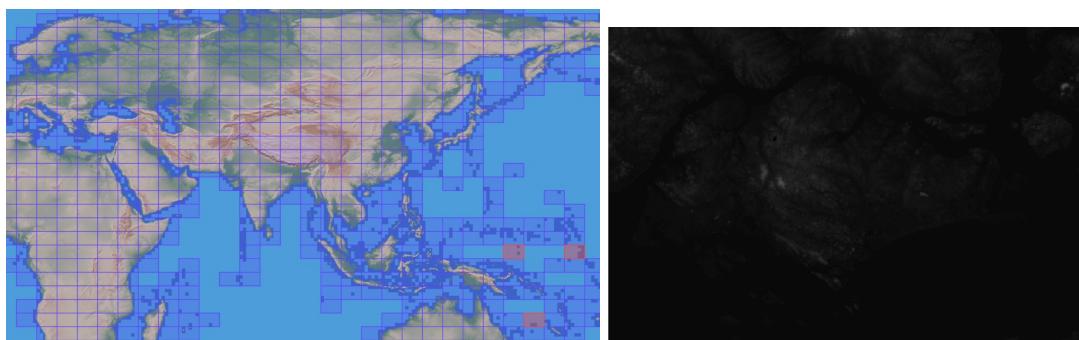
Singapore is located in the n00e100 tile.

¹ http://hydro.iis.u-tokyo.ac.jp/~yamadai/MERIT_DEM/index.html



While this DEM dataset lacks data for some of the reclaimed areas, It seemed to the most high resolution out of the 3, sufficient to do flooding analysis for mainland singapore.

3. DEM file from View Finder Panoramas ²



In this website, global DEM data is provided. Singapore's DEM can be found in the N01E103 and N01E103 Tile.

This DEM data resolution is similar to the Maptiler's DEM data, but much darker.

Conclusion:

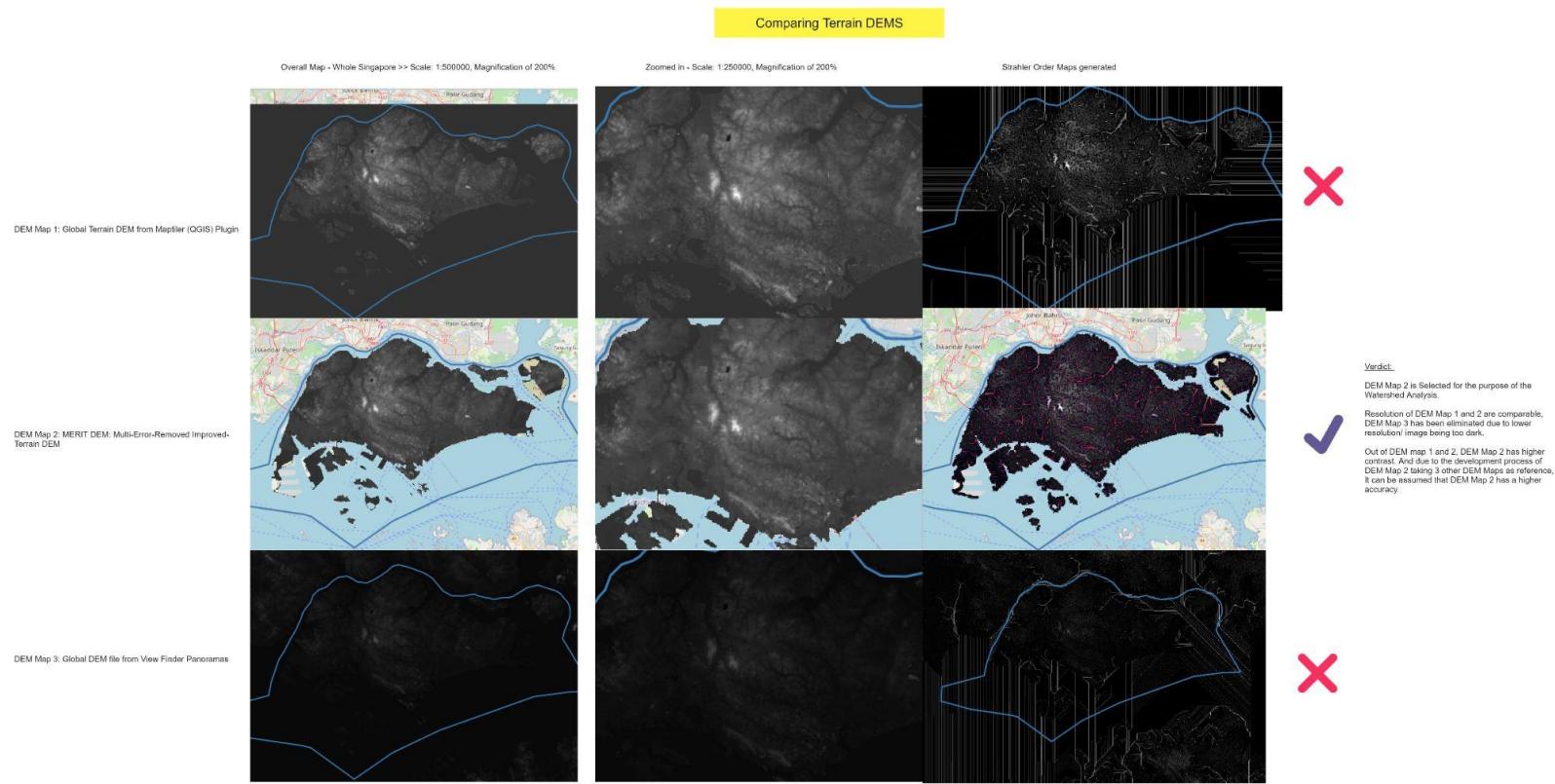
DEM Map 2 is Selected for the purpose of the Watershed Analysis.

Resolution of DEM Map 1 and 2 are comparable, DEM Map 3 has been eliminated due to lower resolution/ image being too dark.

Out of DEM map 1 and 2, DEM Map 2 has higher contrast. And due to the development process of DEM Map 2 taking 3 other DEM Maps as reference, It can be assumed that DEM Map 2 has a higher accuracy.

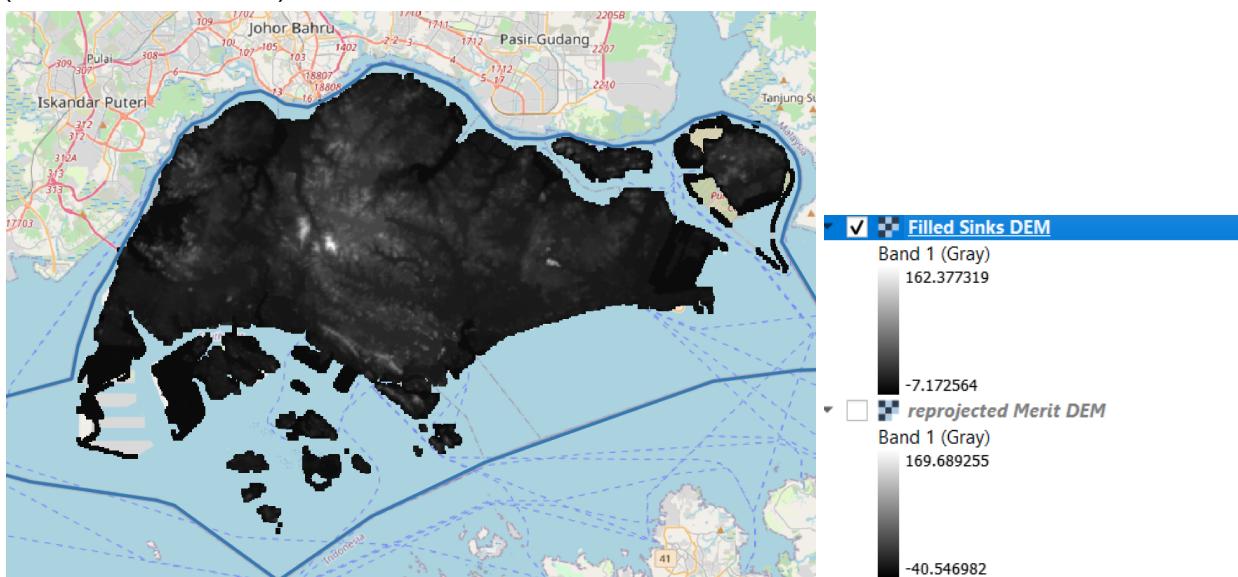
This is supported by the quality of the Strahler order maps generated too. With Map 2 generating the one with the highest quality.

² http://viewfinderpanoramas.org/Coverage%20map%20viewfinderpanoramas_org3.htm

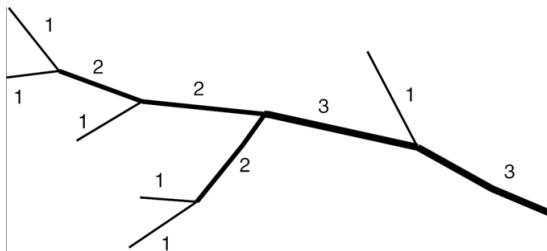


2. Use function “Fill Sinks by Wang and Liu” to remove kinks in the DEM map (while using the Fill Sinks tool seem to produce Fuzzy edges in the DEM map, using the Fill Sinks tool is essential to create a more accurate analysis that omits unwanted kinks from the DEM raster (that is not present in reality)

The “Filled Sinks” values are also closer approximates of actual elevation values in Singapore. (Max: 164m, Min: 0m)

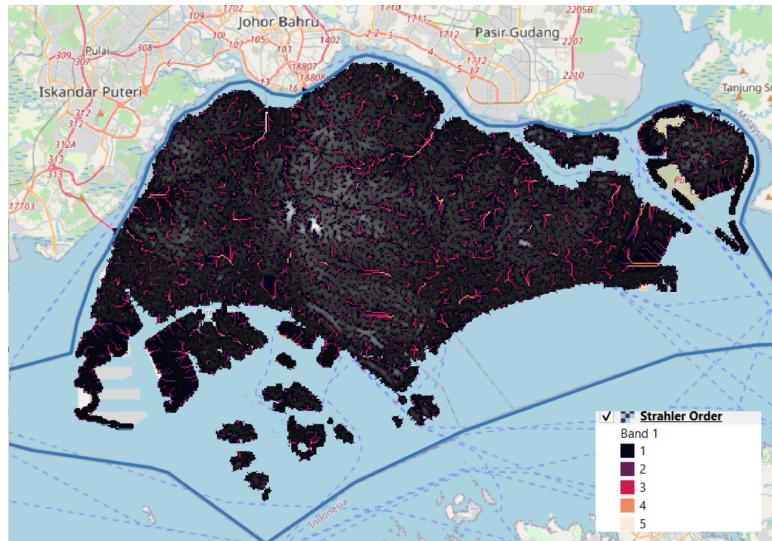


3. Use function “Strahler Order” to determine how streams of water would flow based on the difference in terrain.



According to the system made by Strahler, rivers of the first order are the outermost tributaries. If two streams of the same order meet, the resulting stream is given a number that is one higher. If two rivers of different stream orders meet, the resulting stream gets the higher of the two numbers.³

This can be used to determine the intensity of flooding as higher Strahler Order would mean more streams of water (from different directions) meet, thus resulting in quicker and more intense flooding. In this Strahler Order mapping of Singapore, 5 orders have been identified. The lighter the colour, the higher intensity and speed flooding would occur in the area.



³

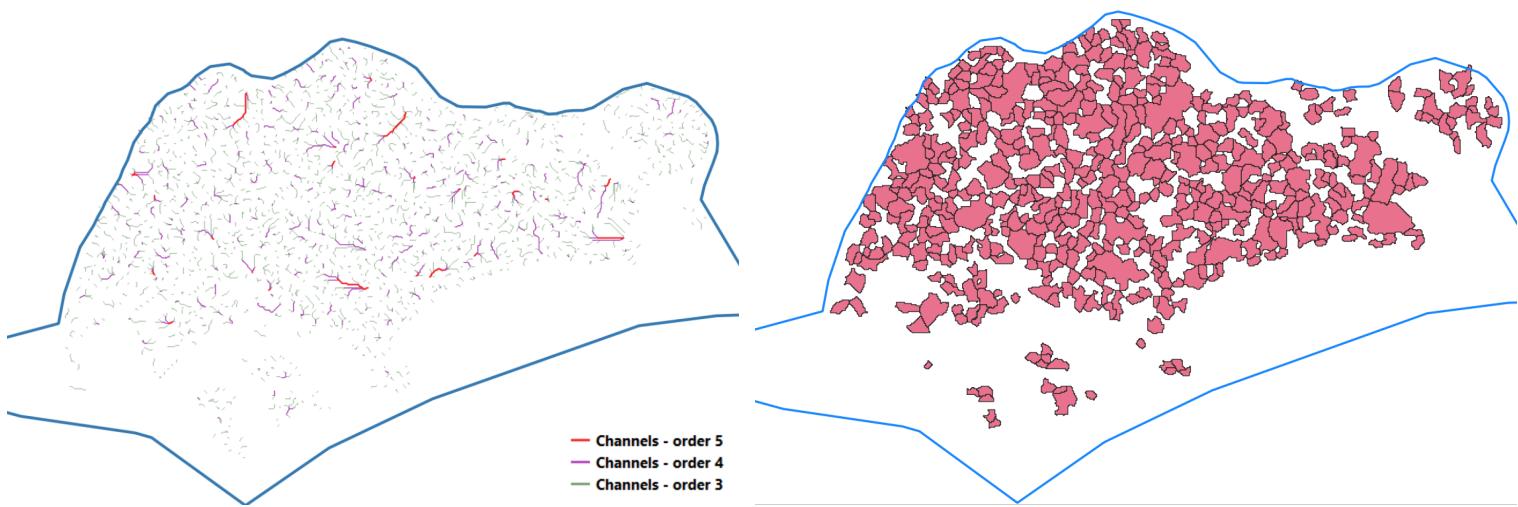
https://dges.carleton.ca/CUOSGwiki/index.php/Using_QGIS_to_conduct_watershed_analysis_and_3D_modelling



"High Risk areas" shown in Dark blue (Strahler order more or equal 3)

"Low Risk areas" shown in Light blue (Strahler order 1 and 2)

4. Use function "Channel Network and Drainage Basins" on Filled Sinks DEM to identify water channels. (Vectors) and generate drainage basin vectors.



2. Match base dataset information in the Drainage Basin Polygon Grid

Goal: Map (land use, population density, green map, water management location, hotspot) to the flood basin polygons so that each polygon can be compared.

Method of Analysis:

1. Land use

>> get: Type of Landuse in each DB polygon

>> Waterbodies = area of above a certain % can be eliminated

>> Greens (Parks and Open Spaces) = area of above a certain % can be eliminated

>> Land use Type (Residential/ Industrial etc) = access extent of economic and

humanitarian damaged in each DB polygon area.

2. Population Density

>> get: The no. of people affected in each DB polygon.

3. PUB list of Floodprone areas and Hotspots

>> get: Existing risk of flooding in each polygon

4. ABC water management locations and methods

>> get: Areas that have been adequately dealt with by updated and sustainable measures.

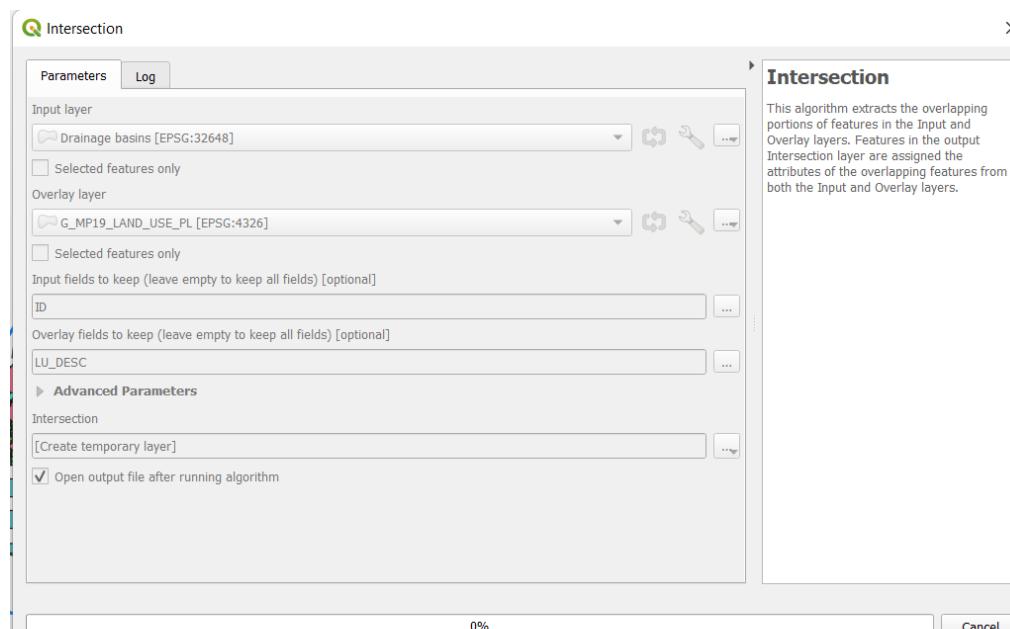
2.1 Land use mapped to DB grid

(Karen)

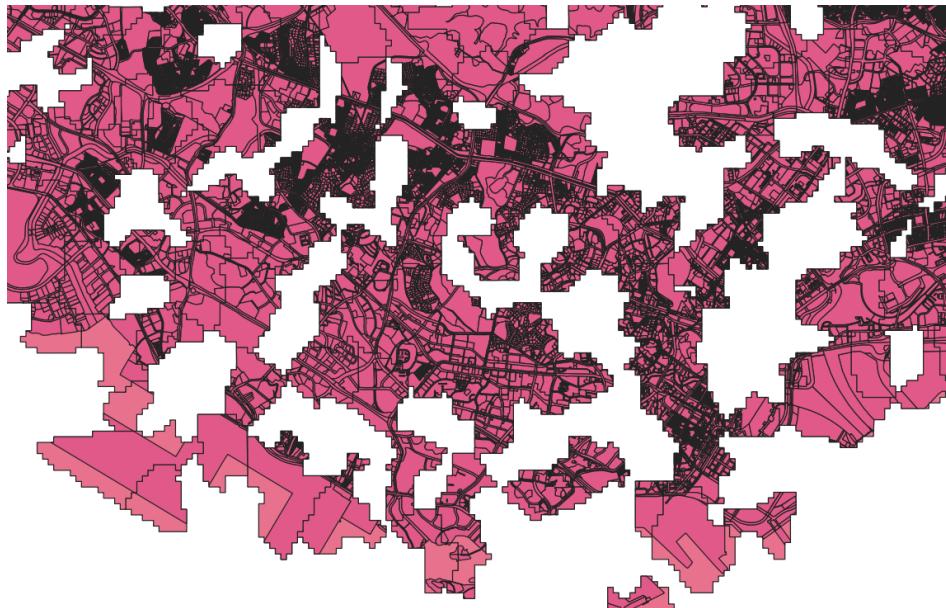
Steps:

1. Finding percentage of area of each type of Land use in a DB polygon.

Intersect landuse (fixed geometries) and DB, keeping DB ID and Landuse.



Result: Isolating landuse data (LU_DESC) to each DB polygon (ID)



ID	LU_DESC
1	0 OPEN SPACE
2	1 OPEN SPACE
3	1 OPEN SPACE
4	2 OPEN SPACE
5	3 UTILITY
6	4 BUSINESS 2
7	5 OPEN SPACE

- Dissolve “intersection” by “ID” and “LU_DESC”

Dissolve

Parameters

Input layer: Intersection [EPSG:32648]

Selected features only

Dissolve field(s) [optional]: ID,LU_DESC

Advanced Parameters

Dissolved: [Create temporary layer]

Open output file after running algorithm

Dissolve

This algorithm takes a vector layer and combines their features into new features. One or more attributes can be specified to dissolve features belonging to the same class (having the same value for the specified attributes), alternatively all features can be dissolved in a single one.

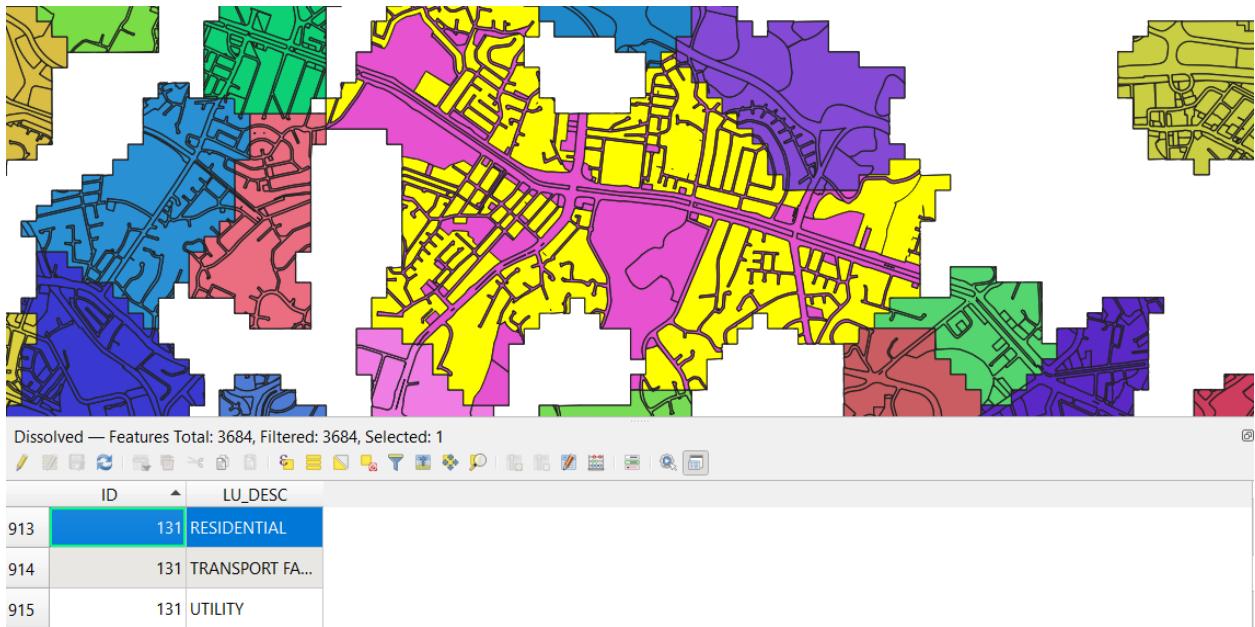
All output geometries will be converted to multi geometries. In case the input is a polygon layer, common boundaries of adjacent polygons being dissolved will get erased.

If enabled, the optional "Keep disjoint features separate" setting will cause features and parts that do not overlap or touch to be exported as separate features (instead of parts of a single multipart feature).

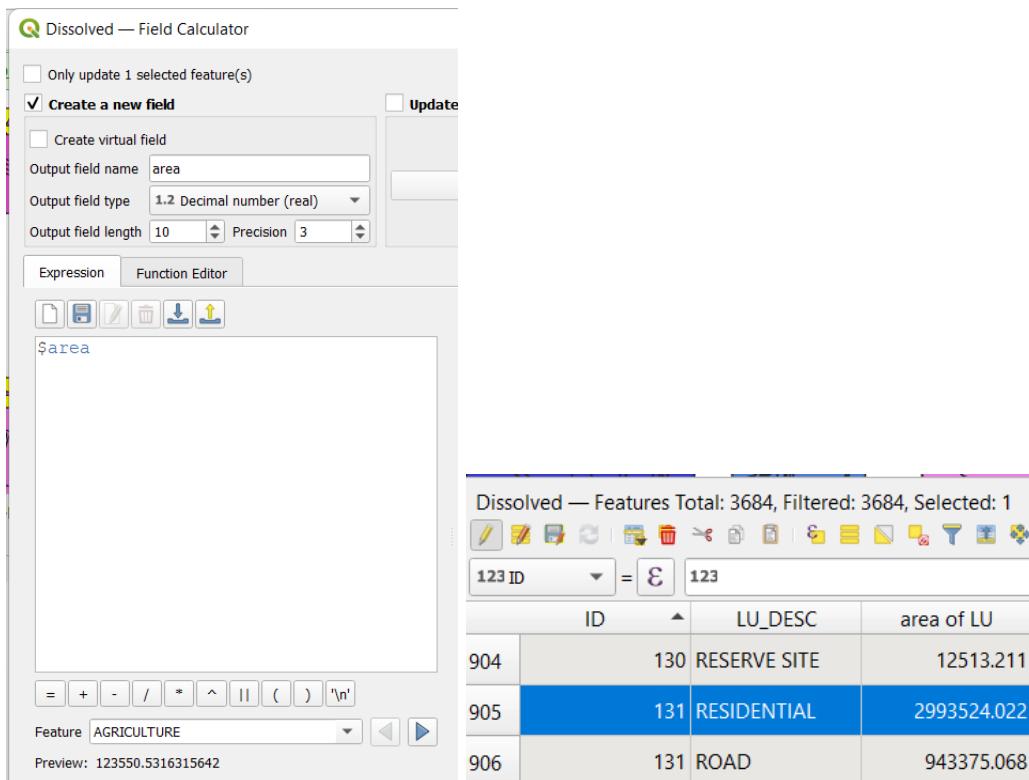
0%

Advanced Run as Batch Process... Run Close Help

Result: all landuse polygons within a single grid are grouped tgt



- find area of each LU_DESC



Result: "area of LU" column created

- Join DB areas as a new column

Add Vector Join

Join layer: Drainage basins

Join field: 123 ID

Target field: 123 ID

Cache join layer in memory

Create attribute index on join field

Dynamic form

Editable join layer

Joined fields

- ID
- VALUE
- NAME
- DB area

Custom field name prefix

OK Cancel Help

ID	LU_DESC	area of LU	Drainage basins_DB area
724	113 WATERBODY	26820.023	1380270.473
725	113 TRANSPORT FA...	6066.174	1380270.473
726	113 BUSINESS 2	1090147.337	1380270.473
727	113 UTILITY	15809.394	1380270.473
728	114 ROAD	239975.882	1946168.767
729	114 WATERBODY	15079.659	1946168.767
730	114 COMMERCIAL	3013.200	1046168.767

Result: "DB area" column added

- create "% land use" as a column, Query:
 $(\text{"area of LU"} / \text{"Drainage basins_DB area"}) * 100$

Q (D) by Landuse and Grid — Field Calculator

Only update 0 selected feature(s)

Create a new field

Create virtual field

Output field name: % land use

Output field type: 1.2 Decimal number (real)

Output field length: 10 Precision: 3

Expression Function Editor

("area of LU" / "Drainage basins_DB area") * 100

ID	LU_DESC	area of LU	Drainage basins_DB area	% land use
1	0 OPEN SPACE	319852.057	454407.911	70.389
2	1 OPEN SPACE	249227.622	583012.583	42.748
3	2 OPEN SPACE	79840.118	505847.983	15.783
4	3 UTILITY	2266926.035	2580793.542	87.838
5	4 BUSINESS 2	131366.155	445857.636	29.464
6	5 OPEN SPACE	752683.197	771631.723	97.544
7	6 UTILITY	343725.066	445850.215	77.094
8	7 OPEN SPACE	197370.295	454402.365	43.435
9	8 OPEN SPACE	370587.568	865972.534	42.794
10	8 UTILITY	67611.070	865972.534	7.808
11	9 BEACH AREA	13895.848	420155.564	7.808
12	9 SPORTS & RECREATION	60396.691	420155.564	14.375
13	9 PLACE OF WORSHIP	474.293	420155.564	0.113
14	9 UTILITY	1761.300	420155.564	0.419
15	10 BUSINESS 2	115185.549	231481.969	49.760
16	11 BUSINESS 2	449237.894	1080328.358	41.583

2. Grouping area according to class

Facilities Categories:⁴

(Class 1) Highest Risk - Residential buildings

Residential with commercial 1st storey (Shophouseish) + Residential + Residential/ Institution

(Class 2) High Risk - Humanitarian + Other Essential Facilities

Civic & Community Institution + Health & Medical Care + Utility + Educational institutes

(Class 3) Medium Risk - Transport Facilities

Road + Transport Facilities + Rapid Transit + Port/Airport

(Class 4) Low risk to human lifes, High economic damages - Economic Facilities

Commercial & Residential (shopping mall + condo) + Commercial

Business Park + Business Park - White

Business 1 (B1) + Business 1 - White + Business 2 (B2) + Business 2 - White

+ Agriculture + Hotel

⁴ URA Land Use Categories - THE PLANNING ACT MASTER PLAN WRITTEN STATEMENT 2019

(Class 5) Lowest Risk - Social Facilities

Cultural and heritage, Religious (cemetery, Place of worship), Leisure and Entertainment, Sports and Recreation, Beach area

(Reserve Sites, Special Uses and White Sites not included)

(Parks, Open Spaces (Class 6) and Waterbodies mapped as separate categories)

- Assign class for each via Filter selected features >> Field Calculator

ID	LU_DESC	area of LU	Drainage basins_DB area	% land use	Class
1	0 OPEN SPACE	319852.057	454407.911	70.389	6
2	1 OPEN SPACE	249227.622	583012.583	42.748	6
3	2 OPEN SPACE	79840.118	505847.983	15.783	6
4	3 UTILITY	2266926.035	2580793.542	87.838	2
5	4 BUSINESS 2	131366.155	445857.636	29.464	4
6	5 OPEN SPACE	752683.197	771631.723	97.544	6
7	6 UTILITY	343725.066	445850.215	77.094	2

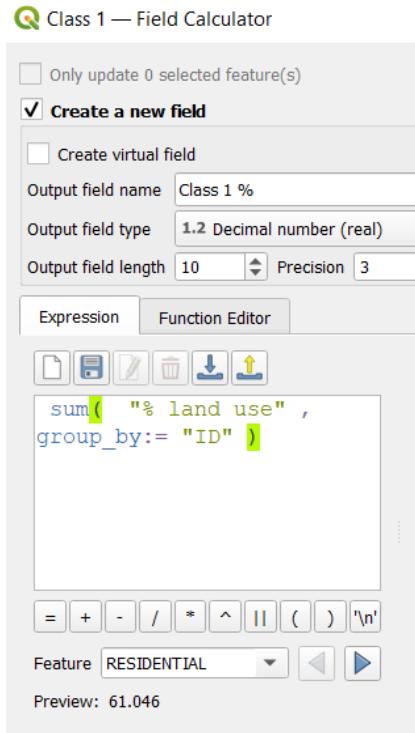
- However, landuse % are not by grid yet, take DB grid no.131 for example, while “Residential with commercial on 1st storey” and “Residential” are both Class 1, they need to be added to produce the overall landuse% for Class 1 in DB grid no.131.

Q (D) by Landuse and Grid — Features Total: 3684, Filtered: 3684, Selected: 0

ID	LU_DESC	area of LU	Drainage basins_DB area	% land use	Class
907	131 WATERBODY	91490.264	5127444.115	1.784	NULL
908	131 RESIDENTIAL WITH COM...	9614.392	5127444.115	0.188	1
909	131 RESIDENTIAL	2993524.022	5127444.115	58.382	1
910	131 EDUCATIONAL INSTITUTION	582469.793	5127444.115	11.360	2
911	131 CIVIC & COMMUNITY INST...	11865.315	5127444.115	0.231	2
912	131 UTILITY	11445.845	5127444.115	0.223	2
913	131 HEALTH & MEDICAL CARE	1818.167	5127444.115	0.035	2
914	131 TRANSPORT FACILITIES	6624.033	5127444.115	0.129	3
915	131 ROAD	943375.068	5127444.115	18.399	3
916	131 COMMERCIAL & RESIDEN...	21025.894	5127444.115	0.41	4
917	131 COMMERCIAL	8657.788	5127444.115	0.169	4
918	131 SPORTS & RECREATION	12311.481	5127444.115	0.24	5
919	131 PLACE OF WORSHIP	14010.803	5127444.115	0.273	5
920	131 PARK	372623.899	5127444.115	7.267	6

- To do this, we can first export each layer separately for each class, then create a new field "Class %" to get the overall landuse % of each class.

Use field calculator, Query >> sum("% land use" , group_by:= "ID") in each class layers.

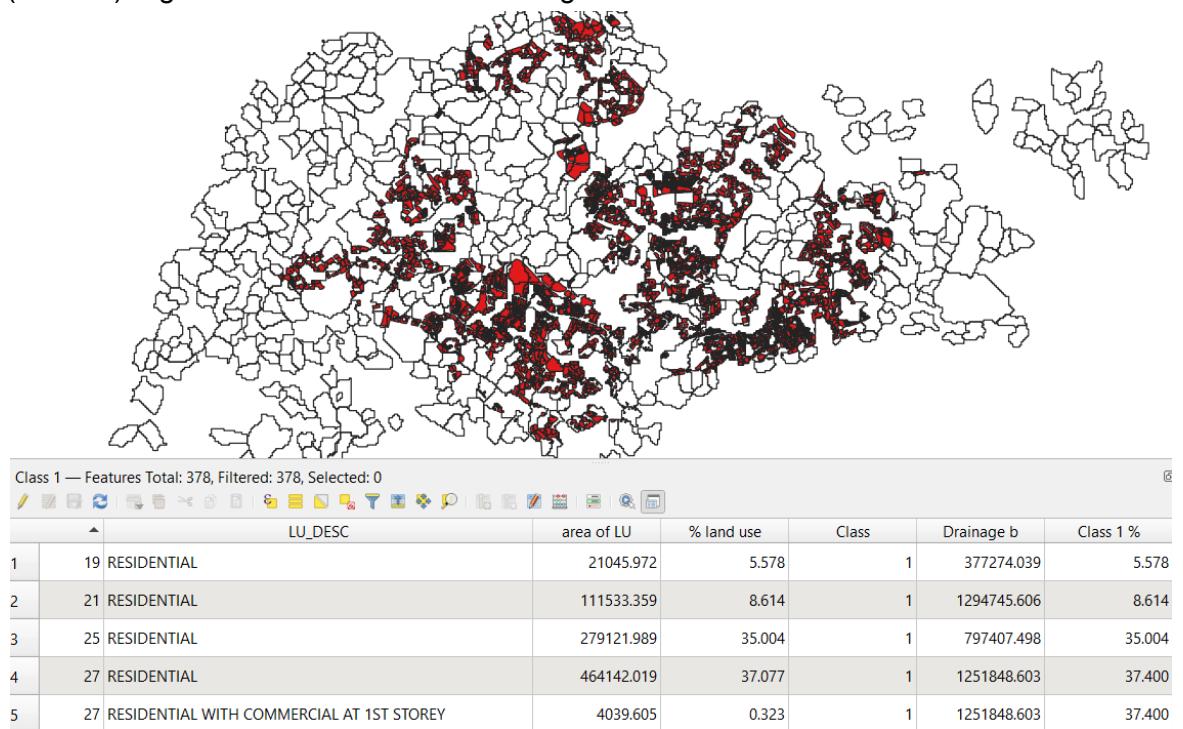


Class 1 — Features Total: 378, Filtered: 378, Selected: 0						
		LU_DESC	area of LU	% land use	Class	Drainage b
92	131	RESIDENTIAL WITH COMMERCIAL AT 1ST STOREY	9614.392	0.188	1	5127444.115 58.570
93	131	RESIDENTIAL	2993524.022	58.382	1	5127444.115 58.570

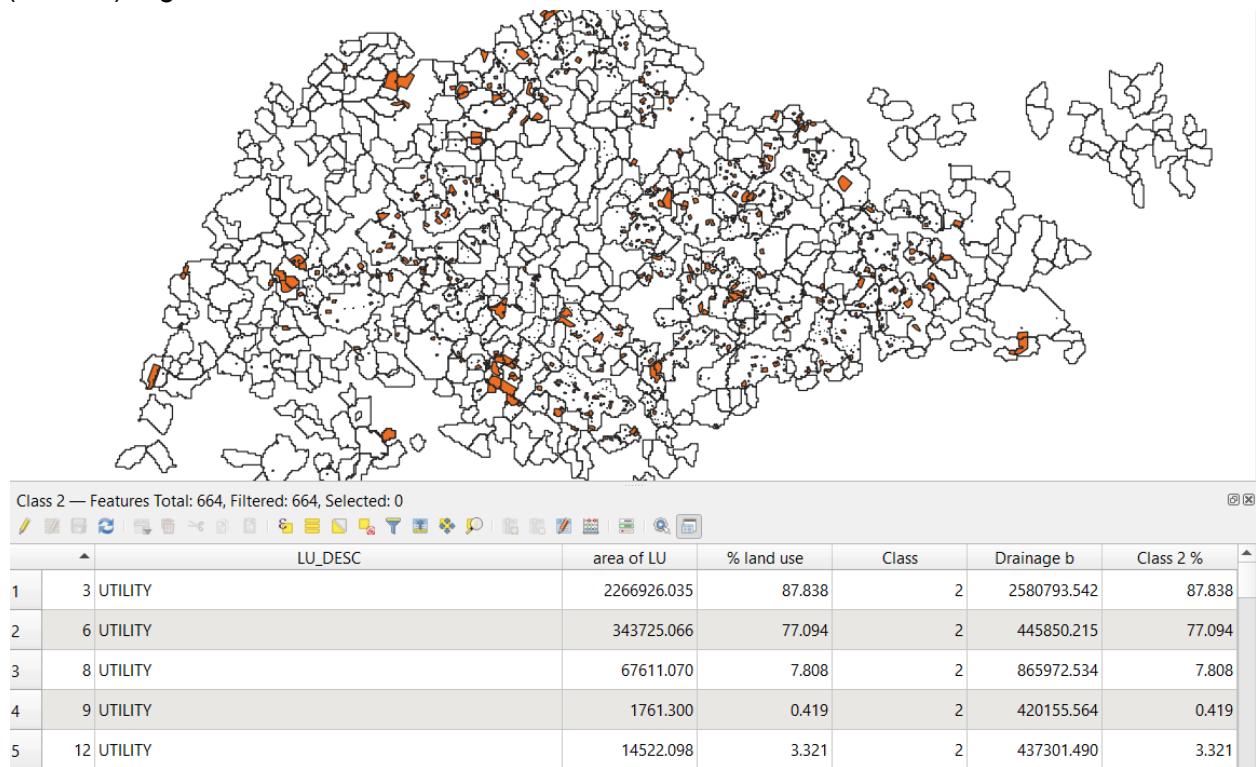
Result: We now have a column "Class 1 %" that we can use to visualise the datas.

- This process is then repeated for all the classes, and also for greenareas and waterbodies.

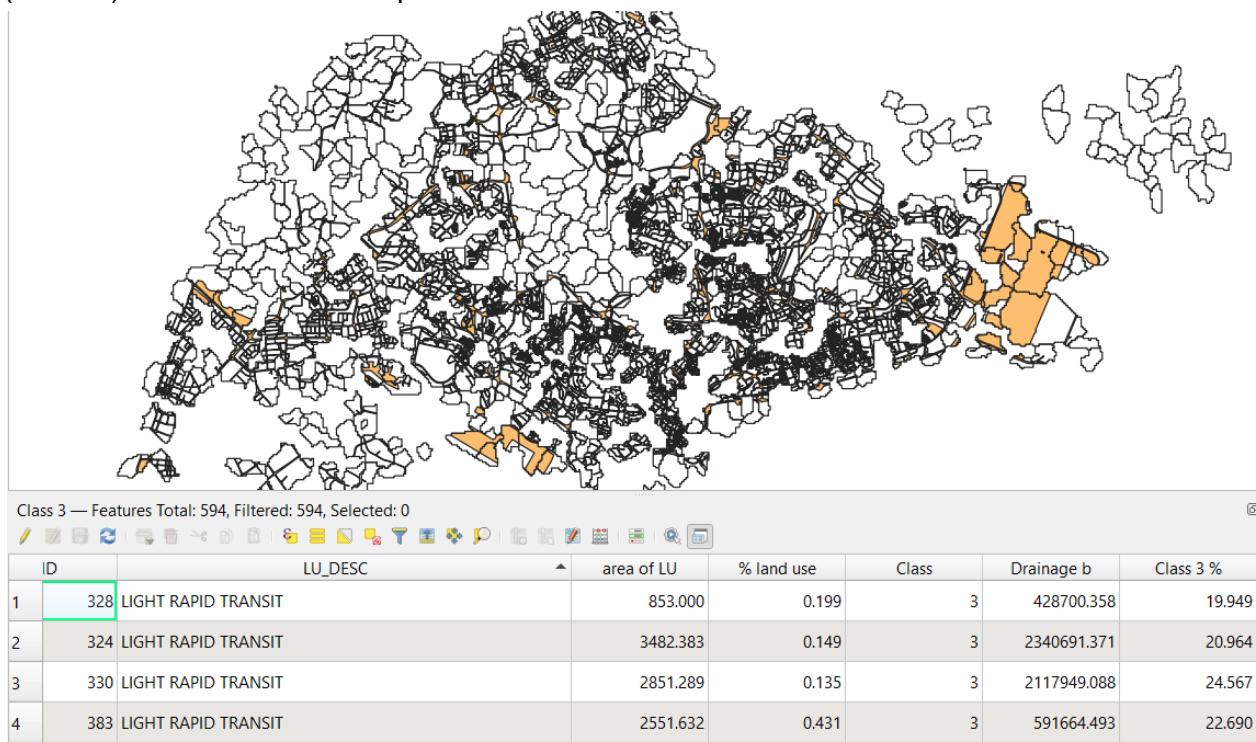
(Class 1) Highest Risk - Residential buildings



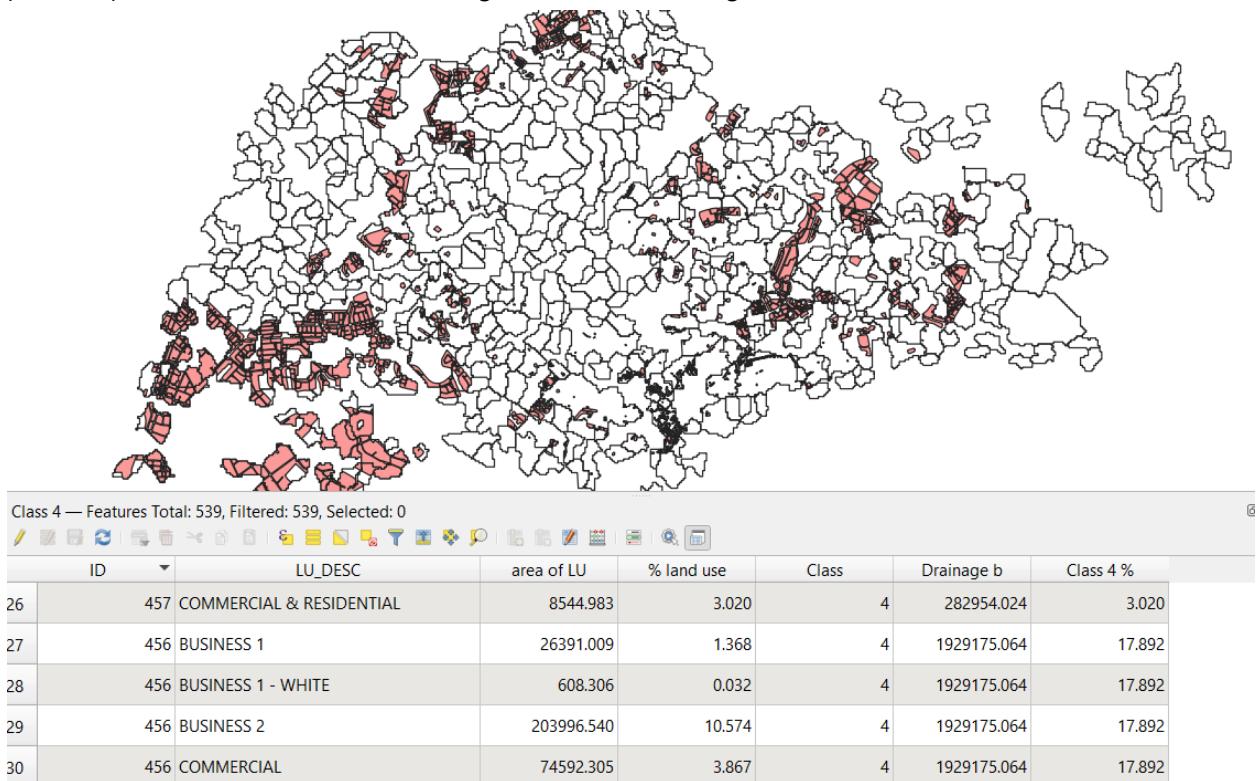
(Class 2) High Risk - Humanitarian + Other Essential Facilities



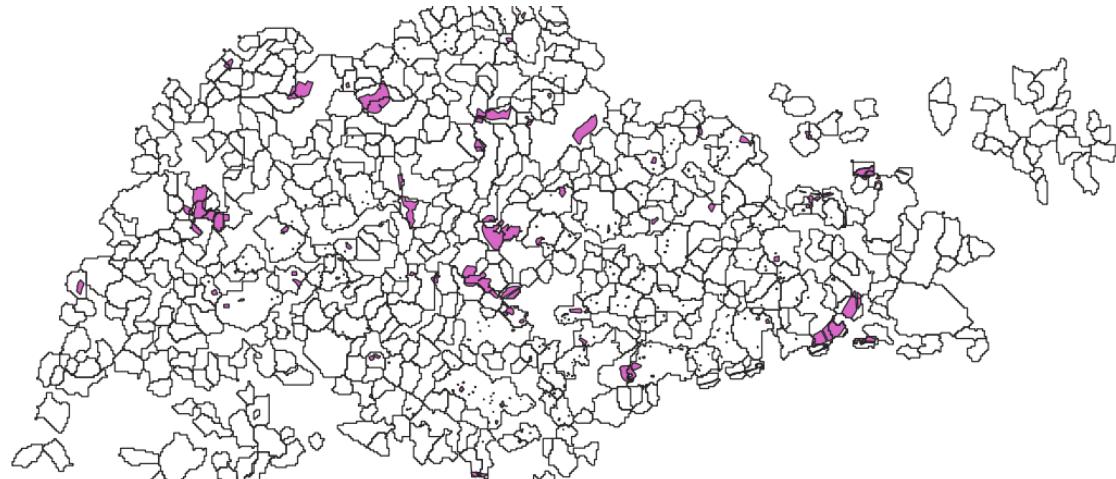
(Class 3) Medium Risk - Transport Facilities



(Class 4) Low risk to human lives, High economic damages - Economic Facilities



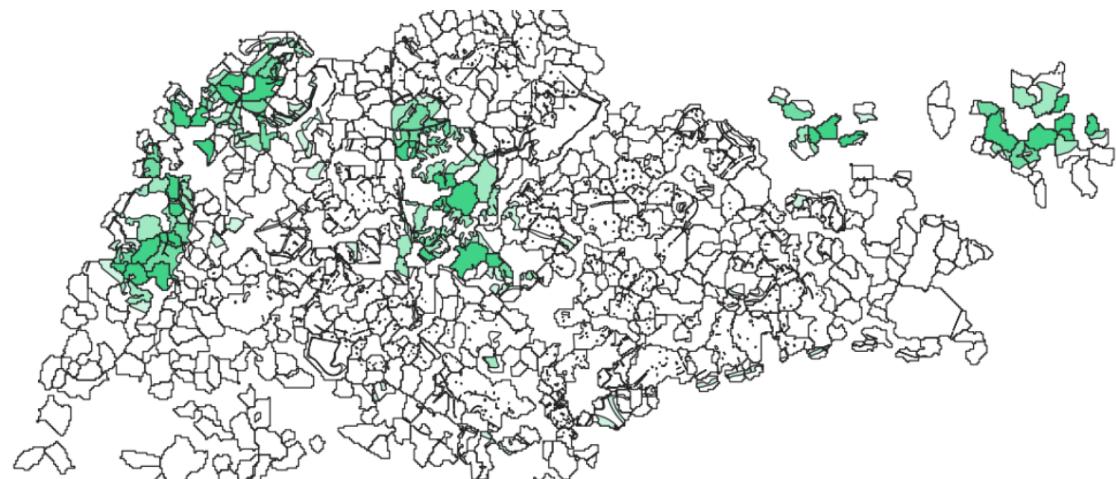
(Class 5) Lowest Risk - Social Facilities



Class 5 — Features Total: 287, Filtered: 287, Selected: 0

ID	LU_DESC	area of LU	% land use	Class	Drainage b	Class 5 %
1	9 BEACH AREA	13895.848	3.307	5	420155.564	17.795
2	9 PLACE OF WORSHIP	474.293	0.113	5	420155.564	17.795
3	9 SPORTS & RECREATION	60396.691	14.375	5	420155.564	17.795
4	12 BEACH AREA	9785.069	2.238	5	437301.490	9.311
5	12 SPORTS & RECREATION	30930.248	7.073	5	437301.490	9.311

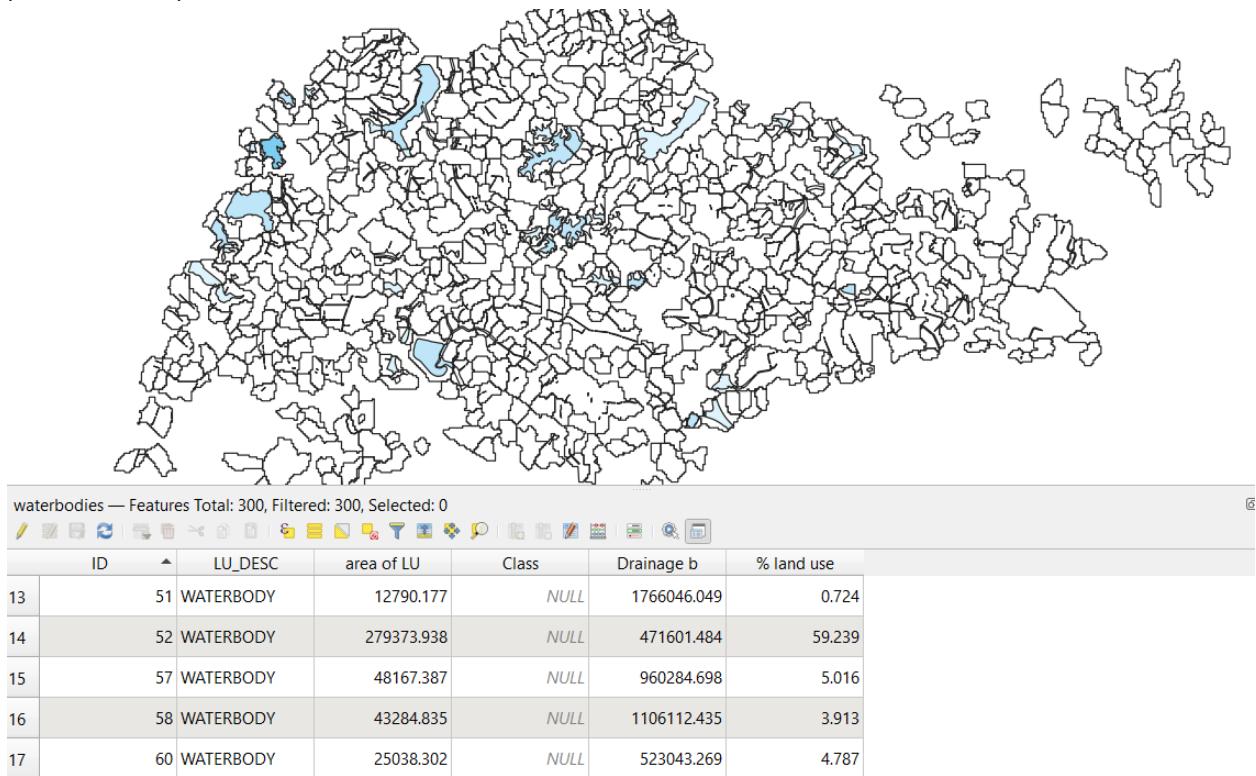
(Green spaces) Parks and Open Space



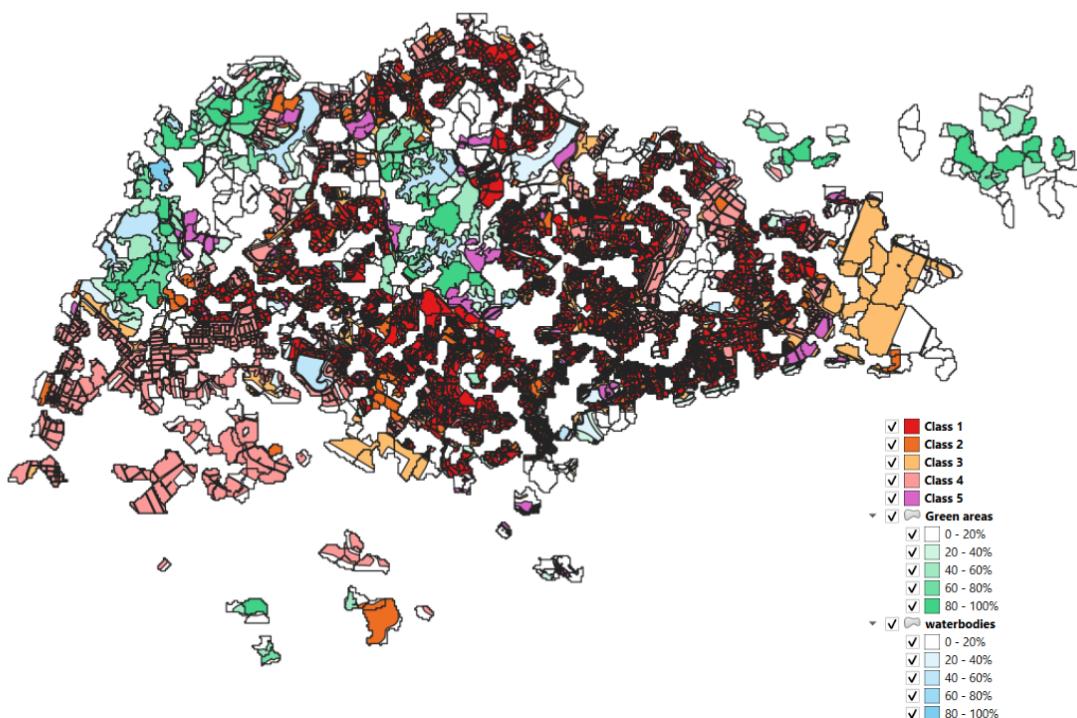
Green areas — Features Total: 523, Filtered: 523, Selected: 0

ID	LU_DESC	area of LU	% land use	Class	Drainage b	% Green
1	0 OPEN SPACE	319852.057	70.389	6	454407.911	70.389
2	1 OPEN SPACE	249227.622	42.748	6	583012.583	42.748
3	2 OPEN SPACE	79840.118	15.783	6	505847.983	15.783
4	5 OPEN SPACE	752683.197	97.544	6	771631.723	97.544

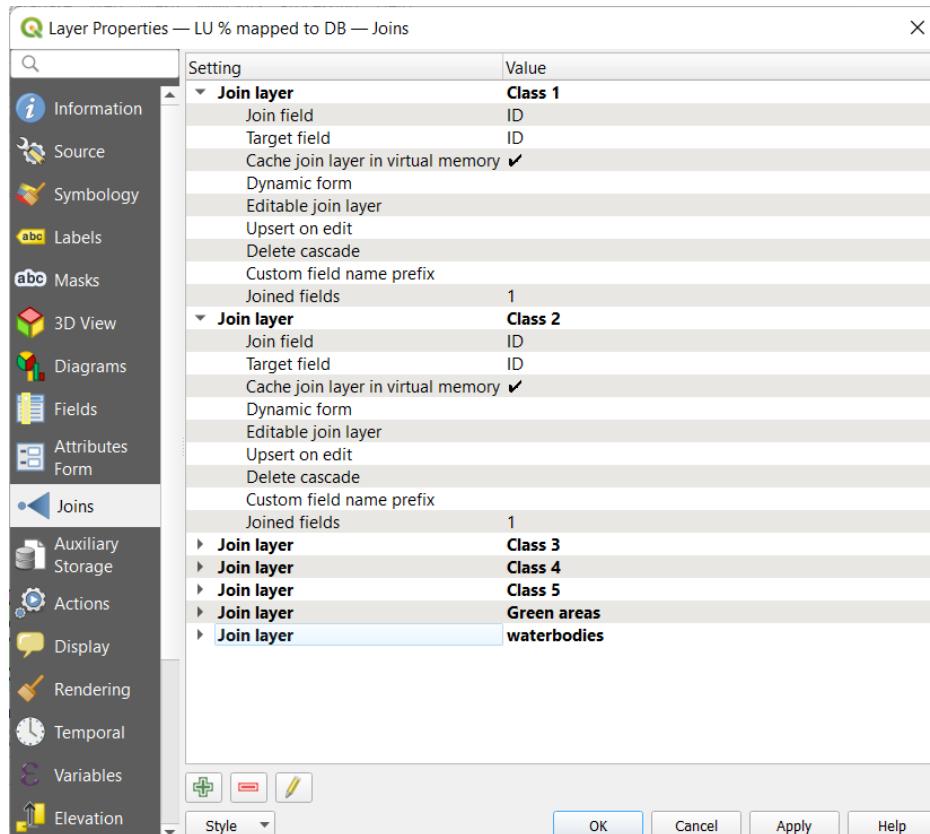
(Waterbodies)



Overview of all landuse mapped to drain basins



3. Consolidate Class data for each DB grid and Map back to the “Drain Basin Grid” Layer



LU % mapped to DB — Features Total: 478, Filtered: 478, Selected: 0										
ID	VALUE	NAME	DB area	Class 1_Class 1 %	Class 2_Class 2 %	Class 3_Class 3 %	Class 4_Class 4 %	Class 5_Class 5 %	een areas_% Gre	waterbodies_% land use
1	0	1 1	454407.911	NULL	NULL	NULL	NULL	NULL	70.389	NULL
2	1	2 2	583012.583	NULL	NULL	NULL	NULL	NULL	42.748	NULL
3	2	3 3	505847.983	NULL	NULL	NULL	NULL	NULL	15.783	NULL

Result: Columns are added in the attribute table

- Find the Class that has the highest %landuse in each DB grid

In field calculator, create a new column called “MAX”, Query:

```
max ( "Class 1_Class 1 %", "Class 2_Class 2 %", "Class 3_Class 3 %", "Class 4_Class 4 %", "Class 5_Class 5 %", "een areas_% Gre", "waterbodies_% land use" )
```

LU % mapped to DB — Features Total: 478, Filtered: 478, Selected: 0										
ID	VALUE	NAME	DB area	Class 1_Class 1 %	Class 2_Class 2 %	Class 3_Class 3 %	Class 4_Class 4 %	Class 5_Class 5 %	een areas_% Gre	waterbodies_% land use
1	0	1 1	454407.911	NULL	NULL	NULL	NULL	NULL	70.389	NULL
2	1	2 2	583012.583	NULL	NULL	NULL	NULL	NULL	42.748	NULL
3	2	3 3	505847.983	NULL	NULL	NULL	NULL	NULL	15.783	NULL

Result: “MAX” column is added in the attribute table, showing the maximum landuse% in each DB grid (ID).

- Map maximum value %landuse in each grid to the column, so that we can understand and visualise which class is of the highest % in each DB grid.

In Field calculator, create a new field “ MAX class” , Query:

Case

```
when "Class 1_Class 1 %" = max ( "Class 1_Class 1 %" , "Class 2_Class 2 %" , "Class 3_Class 3 %" , "Class 4_Class 4 %" , "Class 5_Class 5 %" , "Green areas_% Green" , "waterbodies_% land use" ) THEN 'Class 1'
```

```
when "Class 2_Class 2 %" = max ( "Class 1_Class 1 %" , "Class 2_Class 2 %" , "Class 3_Class 3 %" , "Class 4_Class 4 %" , "Class 5_Class 5 %" , "Green areas_% Green" , "waterbodies_% land use" ) THEN 'Class 2'
```

```
when "Class 3_Class 3 %" = max ( "Class 1_Class 1 %" , "Class 2_Class 2 %" , "Class 3_Class 3 %" , "Class 4_Class 4 %" , "Class 5_Class 5 %" , "Green areas_% Green" , "waterbodies_% land use" ) THEN 'Class 3'
```

```
when "Class 4_Class 4 %" = max ( "Class 1_Class 1 %" , "Class 2_Class 2 %" , "Class 3_Class 3 %" , "Class 4_Class 4 %" , "Class 5_Class 5 %" , "Green areas_% Green" , "waterbodies_% land use" ) THEN 'Class 4'
```

```
when "Class 5_Class 5 %" = max ( "Class 1_Class 1 %" , "Class 2_Class 2 %" , "Class 3_Class 3 %" , "Class 4_Class 4 %" , "Class 5_Class 5 %" , "Green areas_% Green" , "waterbodies_% land use" ) THEN 'Class 5'
```

```
when "Green areas_% Green" = max ( "Class 1_Class 1 %" , "Class 2_Class 2 %" , "Class 3_Class 3 %" , "Class 4_Class 4 %" , "Class 5_Class 5 %" , "Green areas_% Green" , "waterbodies_% land use" ) THEN 'Green Areas'
```

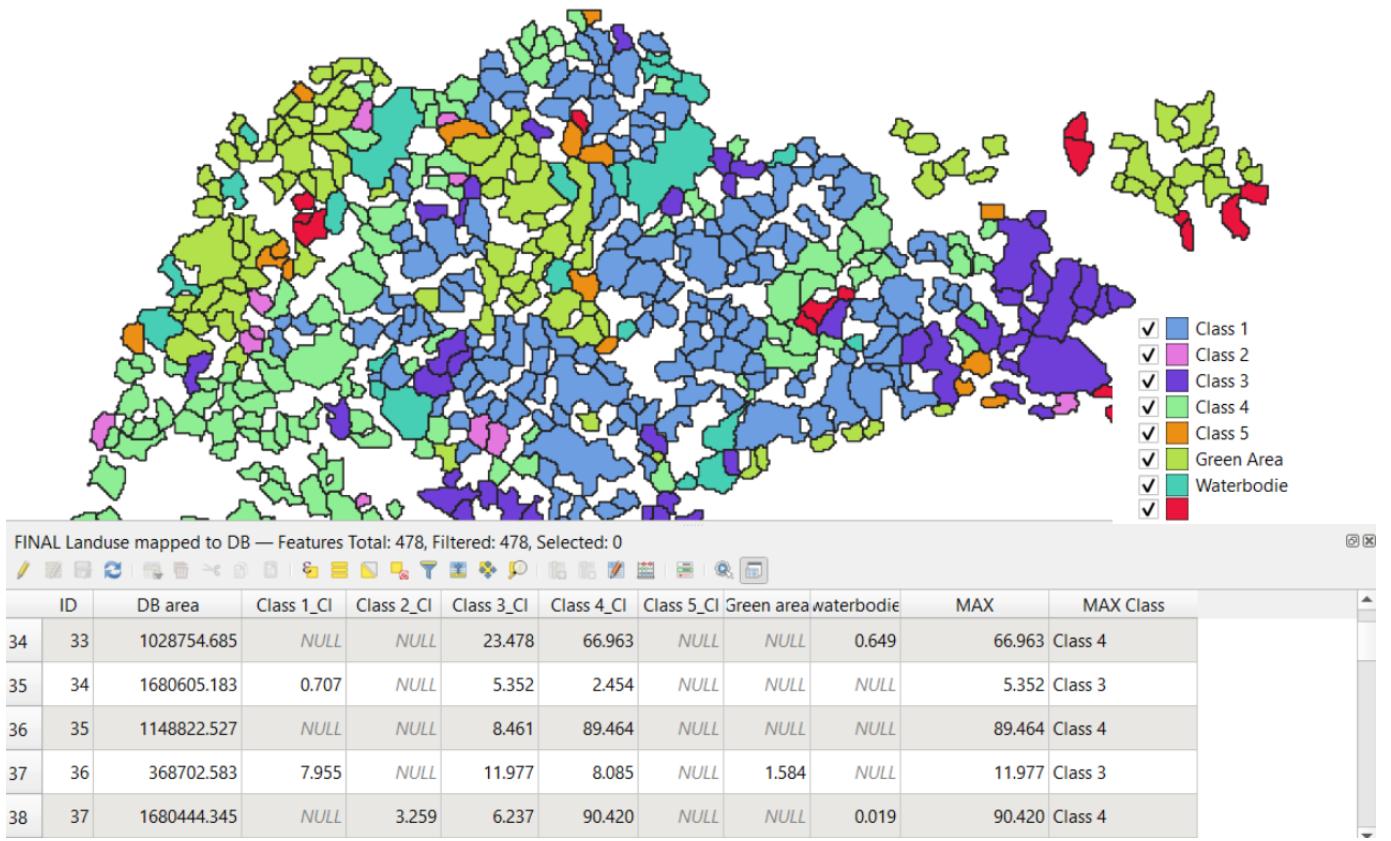
```
when "waterbodies_% land use" = max ( "Class 1_Class 1 %" , "Class 2_Class 2 %" , "Class 3_Class 3 %" , "Class 4_Class 4 %" , "Class 5_Class 5 %" , "Green areas_% Green" , "waterbodies_% land use" ) THEN 'Waterbodies'
```

end

ID	VALUE	NAME	DB area	Class 1_Class 1 %	Class 2_Class 2 %	Class 3_Class 3 %	Class 4_Class 4 %	Class 5_Class 5 %	een areas_% Gre	waterbodies_% land use	MAX	MAX Class
1	0	1 1	454407.911	NULL	NULL	NULL	NULL	NULL	70.389	NULL	70.389	Green Area
2	1	2 2	583012.583	NULL	NULL	NULL	NULL	NULL	42.748	NULL	42.748	Green Area
3	2	3 3	505847.983	NULL	NULL	NULL	NULL	NULL	15.783	NULL	15.783	Green Area
4	3	4 4	2580793.542	NULL	87.838	NULL	NULL	NULL	NULL	NULL	87.838	Class 2
5	4	5 5	445857.636	NULL	NULL	NULL	29.464	NULL	NULL	NULL	29.464	Class 4

Result: “MAX class” column is added in the attribute table, showing the maximum landuse% in terms of the name of class in each DB grid (ID).

- Create map based on the “MAX Class” column, categorised.



Result: This mapping shows the Class with the largest %landuse area in each DB Grid.

2.2 Population Density mapped to DB grid

(Shaun)

Calculate area of each Subzone with sum of population data.

Intersect Subzone with Flood Basin.

Import Basin shp file and Intersected Subzone shp file into R

```
basin_pop <- read_sf('~/School/AR5805 Advanced Architecture  
Studio/QGIS/Data/Flood/Watershed/basin_pop.gpkg')
```

```
basin <- read_sf('~/School/AR5805 Advanced Architecture  
Studio/QGIS/Data/Flood/Watershed/Drainage basins.shp')  
basin %>%  
  select(ID)->basin
```

Get area of each intersected subzone

```
basin_pop$subarea <- st_area(basin_pop)
```

	SUBZONE_N	sum	area	ID	geom	subarea
1	MARINA EAST	0	1844040.69	50	list(list(c(103.873912957697, 103.873750424758, 103.873699...))	9.571887e+05 [m^2]
2	MARINA EAST	0	1844040.69	59	list(list(c(103.878070472222, 103.878300198217, 103.878641...))	6.614617e+04 [m^2]
3	MARINA EAST	0	1844040.69	65	list(list(c(103.870579028478, 103.870927785974, 103.871615...))	5.274576e+05 [m^2]
4	INSTITUTION HILL	3170	392563.33	60	list(list(c(103.841970896854, 103.841956303955, 103.841826...))	1.452546e+05 [m^2]
5	INSTITUTION HILL	3170	392563.33	67	list(list(c(103.841457446543, 103.841511019433, 103.841578...))	6.630966e+03 [m^2]
6	INSTITUTION HILL	3170	392563.33	73	list(list(c(103.838129170118, 103.838250858742, 103.838396...))	2.852973e+04 [m^2]
7	ROBERTSON QUAY	3160	506588.95	60	list(list(c(103.837270064538, 103.837303947539, 103.837314...))	1.720146e+05 [m^2]
8	ROBERTSON QUAY	3160	506588.95	63	list(list(c(103.834803670973, 103.834776572417, 103.834642...))	1.215720e+04 [m^2]
9	ROBERTSON QUAY	3160	506588.95	67	list(list(c(103.841970896854, 103.84214056639, 103.8421507...))	1.257905e+04 [m^2]
10	JURONG ISLAND AND BUKOM	0	36639175.34	10	list(list(c(103.678031266486, 103.677447253519, 103.675744...))	1.157021e+05 [m^2]
11	JURONG ISLAND AND BUKOM	0	36639175.34	11	list(list(c(103.767437879141, 103.76820462439, 103.7681775...))	4.512526e+05 [m^2]
12	JURONG ISLAND AND BUKOM	0	36639175.34	13	list(list(c(103.762447952813, 103.762206919628, 103.761726...))	1.253092e+05 [m^2]
13	JURONG ISLAND AND BUKOM	0	36639175.34	16	list(list(c(103.755790908279, 103.755774340546, 103.755773...))	5.146078e+05 [m^2]
14	JURONG ISLAND AND BUKOM	0	36639175.34	17	list(list(c(103.758909117943, 103.758912564473, 103.758940...))	3.712757e+05 [m^2]
15	JURONG ISLAND AND BUKOM	0	36639175.34	18	list(list(c(103.758154543649, 103.75824267235, 103.758864...))	4.038492e+05 [m^2]
16	JURONG ISLAND AND BUKOM	0	36639175.34	20	list(list(c(103.664679279671, 103.664263296462, 103.664262...))	1.377889e+06 [m^2]
17	JURONG ISLAND AND BUKOM	0	36639175.34	22	list(list(c(103.698787252791, 103.698371262918, 103.698370...))	6.372893e+05 [m^2]
18	JURONG ISLAND AND BUKOM	0	36639175.34	23	list(list(c(103.717502641007, 103.717445122146, 103.717415...))	4.987310e+05 [m^2]

Calculate population of each intersected subzone by its proportion of the subzone * pop, and sum each row with the same ID together to get the population of each flood basin.

```
basin_pop%>%
  mutate(pop=as.integer(sum*subarea/area))%>%
  group_by(ID)%>%
  summarise(pop=sum(pop))->basinpop
```

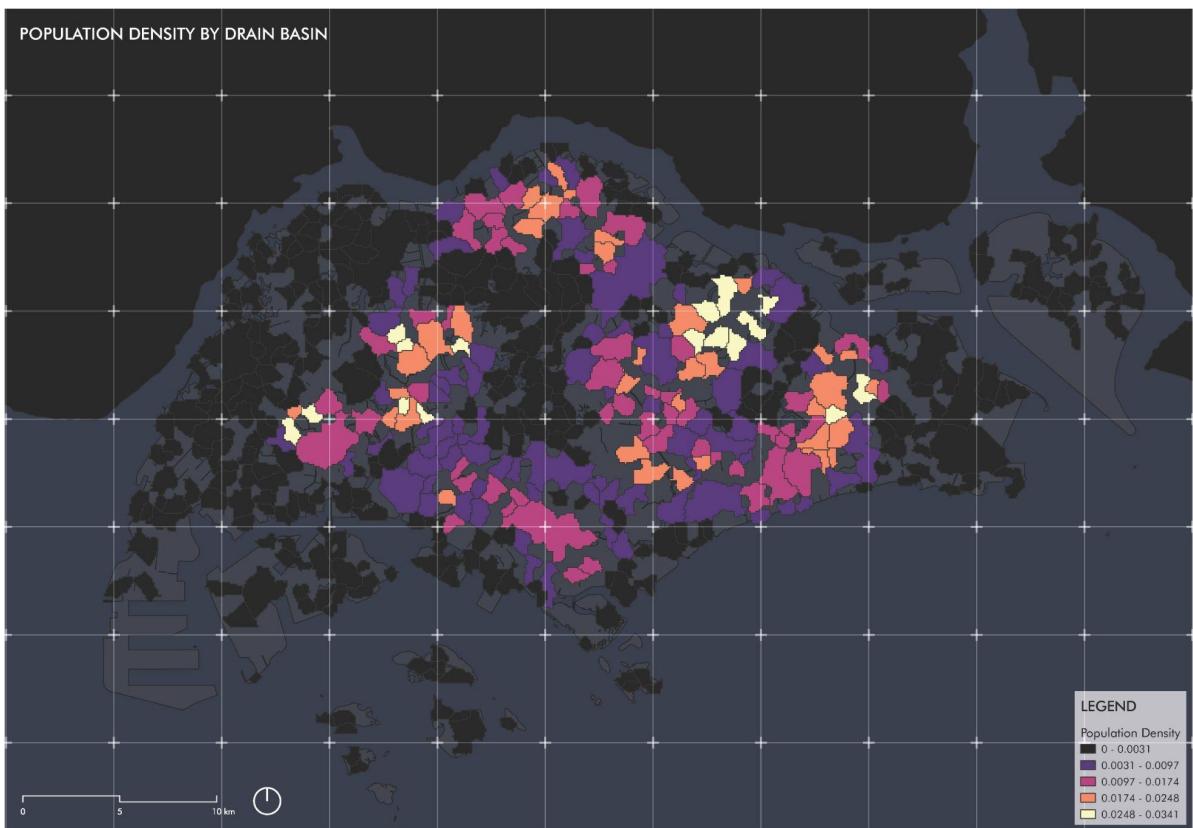
	ID	geometry	pop	area	popdensity
1	0	list(list(c(357682.936614631, 357682.936614631, 357590.356...)	0	454271.1 [m^2]	0.000000e+00 [1/m^2]
2	1	list(list(c(357636.646355638, 357590.356096644, 357590.356...)	0	582838.4 [m^2]	0.000000e+00 [1/m^2]
3	2	list(list(c(356803.421693758, 356849.711952752, 356849.711...)	0	505698.0 [m^2]	0.000000e+00 [1/m^2]
4	3	list(list(c(363052.606657852, 363052.606657852, 362960.026...)	0	2579916.8 [m^2]	0.000000e+00 [1/m^2]
5	4	list(list(c(366015.183233423, 366015.183233423, 365922.602...)	0	445699.9 [m^2]	0.000000e+00 [1/m^2]
6	5	list(list(c(356896.002211745, 356849.711952752, 356849.711...)	0	771403.7 [m^2]	0.000000e+00 [1/m^2]
7	6	list(list(c(362728.574844899, 362682.284585906, 362682.284...)	0	445699.9 [m^2]	0.000000e+00 [1/m^2]
8	7	list(list(c(356618.260657785, 356571.970398792, 356571.970...)	0	454271.1 [m^2]	0.000000e+00 [1/m^2]
9	8	list(list(c(361895.35018302, 361849.059924027, 361849.0599...)	0	865686.4 [m^2]	0.000000e+00 [1/m^2]
10	9	list(list(c(373097.592859396, 373051.302600403, 373051.302...)	0	419986.5 [m^2]	0.000000e+00 [1/m^2]
11	10	list(list(c(352544.717866376, 352498.427607383, 352498.427...)	0	231421.1 [m^2]	0.000000e+00 [1/m^2]
12	11	list(list(c(363885.831319732, 363885.831319732, 363793.250...)	0	1079965.2 [m^2]	0.000000e+00 [1/m^2]
13	12	list(list(c(371894.046125571, 371847.755866577, 371847.755...)	0	437128.8 [m^2]	0.000000e+00 [1/m^2]
14	13	list(list(c(362219.381995973, 362219.381995973, 362126.801...)	0	411415.3 [m^2]	0.000000e+00 [1/m^2]

Calculate density of each flood basin by dividing pop with area of flood basin.

```
as.data.frame(basinpop)%>%
  select(ID,pop)->basinpop
```

```
left_join(basin, basinpop, by="ID") -> basinpop
```

```
basinpop$area <- st_area(basinpop)
basinpop%>%
  mutate(popdensity=pop/area)->basinpop
```

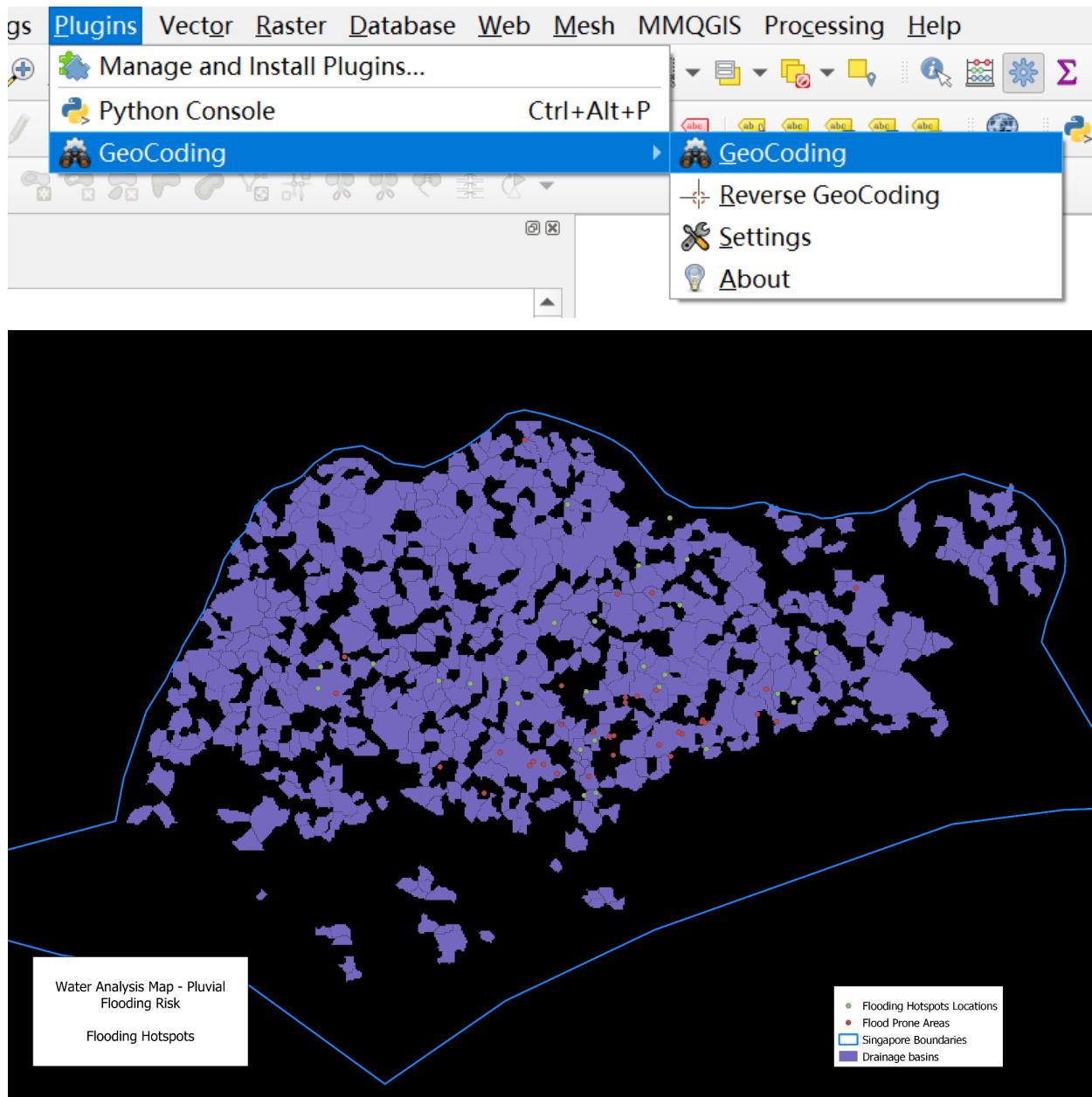


2.3 PUB list of Flood Prone areas and Hotspots mapped to DB grid

(Yi Ying)

1. Use Geocoding plug-in in QGIS to locate the locations of Flood Prone Areas and Hotspots on the drainage basins map

<https://guides.library.ucsc.edu/DS/Resources/QGIS#:~:text=To%20use%20it%C2%9C%20select%20the,where%20the%20address%20is%20located>



2. Project Flood Prone Areas and Hotspots to Drainage Basins

Vector > Data Management Tools > Join Attributes by Location

Join Attributes by Location

Join to features in: prep for weighing — Drainage basins [EPSG:32648]

Selected features only

Features they (geometric predicate):

- intersect overlap
- contain are within
- equal cross
- touch

By comparing to: prep for weighing — floodprone [EPSG:4326]

Selected features only

Fields to add (leave empty to use all fields) [optional]: 0 field(s) selected

Join attributes by location

This algorithm takes an input vector layer and creates a new vector layer that is an extended version of the input one, with additional attributes in its attribute table.

The additional attributes and their values are taken from a second vector layer. A spatial criteria is applied to select the values from the second layer that are added to each feature from the first layer in the resulting one.

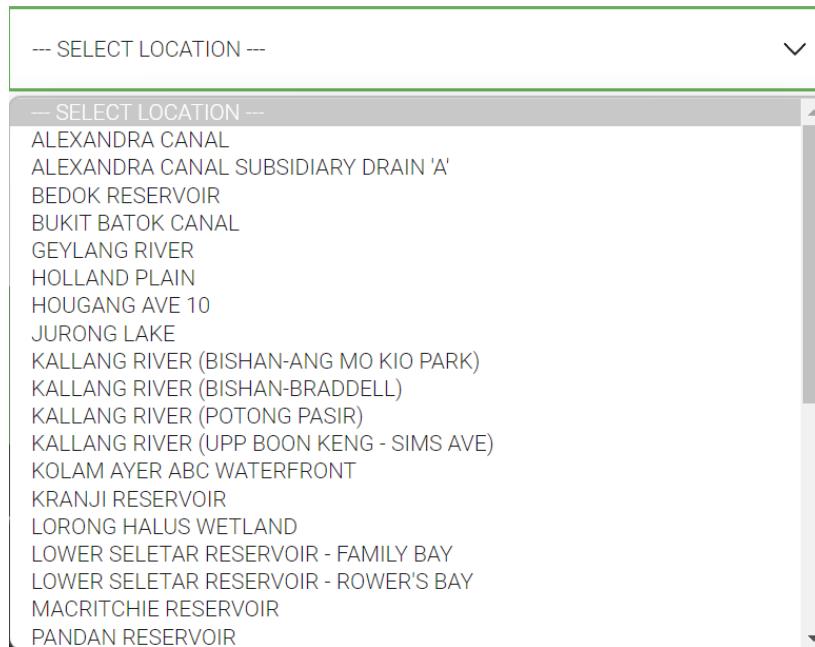
0% Cancel Run Close Help

Water Analysis Map - Pluvial Flooding Risk

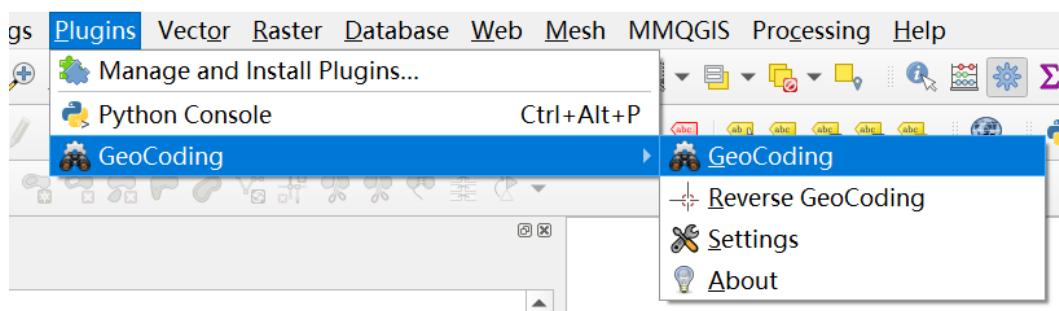
Water Analysis Map - Pluvial Flooding Risk

2.4 ABC water management locations and methods mapped to DB grid

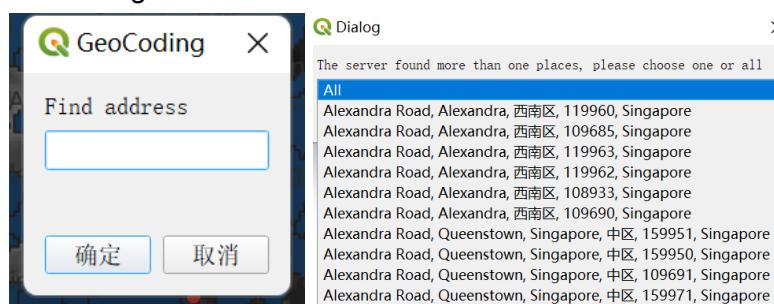
1. Find ABC water locations from PUB website: [ABC Waters Virtual Tour \(pub.gov.sg\)](http://ABC Waters Virtual Tour (pub.gov.sg))



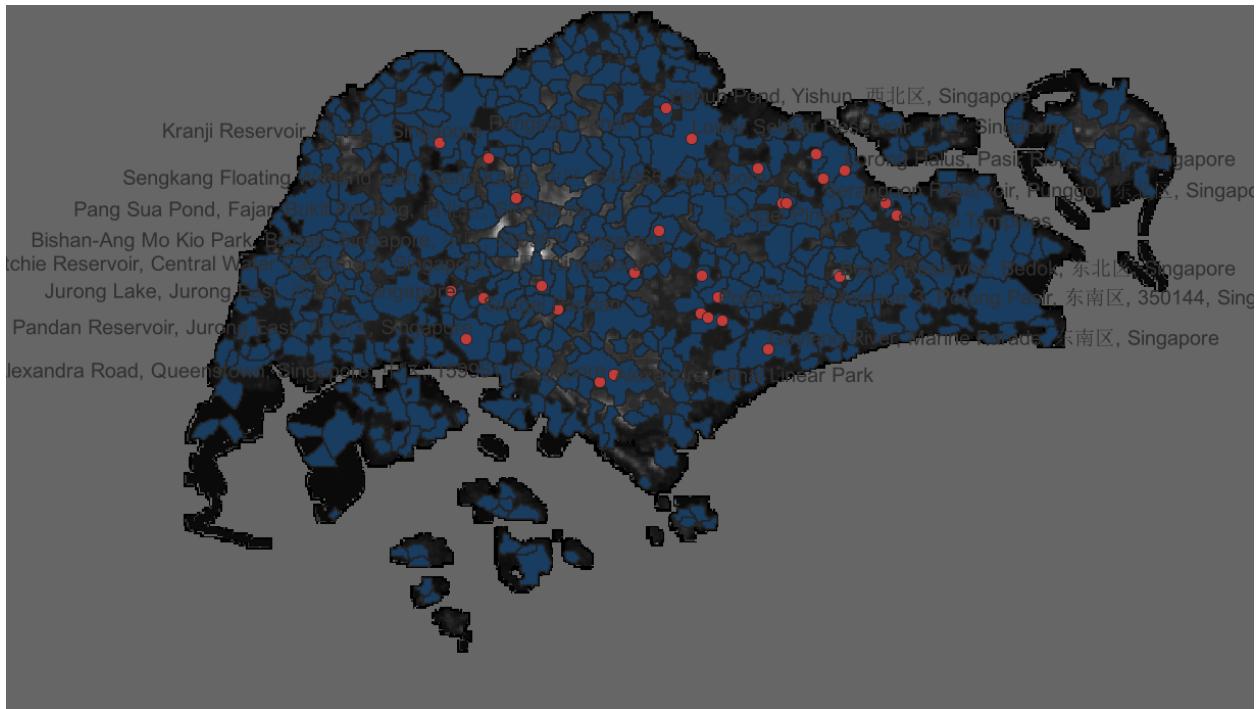
2. Use Geocoding plug-in in QGIS to locate the locations on the drainage basins map.



Geocoding Panel:



The outcome of all the locations on map:



3. Multi-criteria analysis (Weighting System)

Goal: To assess which flood-prone areas pose a higher risk (in terms of damages)

Highest risk >> BLACK

Risk Causative Criterion	Unit	Class	Risk Class Ranges and Ratings	Risk Class Ratings	Weight (%)
Population Density	People/ m ²	0	Very Low	1	
		280 - 5000	Low	2	
		5000 - 13000	Moderate	3	
		13000 - 25000	High	4	
		25000 - 45000	Very High	5	
Land Use (excluding parks and waterbodies)	Classification	Class 1 ⁵ (Residential)	Very High	5	
		Class 2 ⁶ (Humanitarian and other Essential Facilities)	High	4	
		Class 3 ⁷ (Transport facilities)	Moderate	3	
		Class 4 ⁸ (Economic facilities)	Low	2	
		Class 5 ⁹ (Social)	Very Low	1	

⁵ Residential, Residential with commercial 1st storey, Residential/ Institution

⁶ Civic & Community Institution, Health & Medical Care, Utility

⁷ Road, Transport Facilities, Rapid Transit, Port/Airport

⁸ Commercial & Residential, Commercial, Business Park, Business Park - White, Business 1 (B1), Business 2 (B2), Business 2 - White, Agriculture

⁹ Cultural and heritage, Religious (cemetery), Leisure and Entertainment, Hotel

Green areas	% land	0 - 20%	Very High	5	
		20 - 40%	High	4	
		40 - 60%	Moderate	3	
		60 - 80%	Low	2	
		80 - 100%	Very Low	1	
Waterbodies	% land	0 - 20%	Very High	5	
		20 - 40%	High	4	
		40 - 60%	Moderate	3	
		60 - 80%	Low	2	
		80 - 100%	Very Low	1	
PUB ABC Strategies	Relative effectiveness	0 - 20%	Highest	5	
		20 - 40%	Higher	4	
		40 - 60%	Moderate	3	
		60 - 80%	Lower	2	
		80 - 100%	Lowest	1	

3.1 Assessing Percentage Effectiveness of PUB ABC Strategies (Weighting System)

- Locations of ABC
- Types of ABC in each location

Goal: To assess the relative effectiveness of **each** ABC site

Type of strategy	Strategy Effectiveness	Strategy Effectiveness Class Ratings
Parks and reservoir	Very High	5
Canals	High	4
Rain Gardens	Moderate	3
Gravel Swales	Low	2
Vegetated Swales	Very Low	1

*ABC sites that include 'Parks and reservoir' strategy are removed from the assessment as any successive strategies included will have minimal contribution to ABC strategy effectiveness

10% - 5
30% - 4
40% - 3
50% - 2
70% - 7
90% - 1

("Canal" * 4 + "Rain garde" * 3 + "Bioretenti" * 2 + "Gravel Swa") / 2

3.2 Relative Effectiveness of PUB ABC Strategies Map based on Drainage Basin

1. Geotag locations & effectiveness of systems through geocoding plugin, which automatically assigned location
 - Research ABC waters projects location <https://www.pub.gov.sg/abcwaters/explore>
 - Research efficiency of different types of ABC strategy

Before starting the design of a development, it is essential to understand the constraints and potential of the site and factors that would affect stormwater flow:

- Topography (natural slopes/depressions)
- Geology (soil type and quality – porosity, infiltration and conveyance properties)
- Internal drainage, sub-catchments and the connection points to public drains.

The design of a development is also bound by the basic urban planning parameters such as site coverage, plot ratio, height restrictions and land use.

Next, the calibration of the three ABCs was carried out by adjusting some of the model parameters as described in Section 2.4.1 with the final values indicated as follows.

1. Vegetative cover [FB21:0.4; FB9:0.2; FB1 and 2: 0.4].
2. Porosity in soil layer [FB21:0.45; FB9:0.4; FB1 and 2: 0.45].
3. Infiltration capacities of soil layer (mm/hr) [FB21:50; FB9:55; FB1 and 2: 50].
4. Leaking capacities in soil layer (mm/hr) [FB21:35; FB9:42; FB1 and 2: 40].
5. Infiltration capacity to surrounding soil in storage layer (mm/hr) [FB21:0; FB9:0; FB1 and 2: 0].
6. Clogging factor in storage layer [FB21:0; FB9:0; FB1 and 2: 0].

Table 3. Peak flow reduction performance of the various feature types for the 10-year design storm.

Design Feature Type	Average Peak Flow Reduction (%)	Average Normalised Peak Flow Reduction (%)
Rain gardens *	39%	47%
Gravel swales	9%	25%
Vegetated swales	0%	0%

Note: * Excluding rain gardens without orifice outlets (i.e., rain gardens FB6, FB10, FB15 and FB17).

Table A11. Required treated catchment areas and rain garden sizes to achieve $C = 0.55$ for the various land use types (percentages in brackets represents the upper limits beyond which the C-value would exceed 0.55 due to deteriorating performance of the rain garden).

Land Use Type	Rain Garden Area (% of Total Site Area)						
	4%	5%	6%	7%	8%	9%	10%
Residential ($C = 0.88$)	N.A.	N.A.	45.2% (56.4%)	42.4% (74.4%)	41.6% (87.8%)	41.5% (87.8%)	41.3% (87.8%)
Mixed residential-commercial ($C = 0.925$)	N.A.	N.A.	45.8% (55.0%)	43.3% (72.2%)	41.9% (87.4%)	41.8% (87.4%)	41.4% (87.4%)
Commercial ($C = 0.97$)	N.A.	N.A.	47.2% (55.0%)	43.9% (72.1%)	43.3% (85.5%)	42.8% (85.5%)	41.8% (85.5%)

Table 2. Outflow and effective C-value results of the precinct and alternative scenarios for the 10-year design storm.

S/N	Label	Scenario	Qmax (m ³ /s)	Reduction * in Qmax	Effective C-Value
1	No treatment/detention	Precinct without any treatment or detention	2.13	0%	0.89
2	Orifice only	Precinct with orifice outlets only	2.13	0%	0.89
3	Typical ABC	Precinct with typical design of ABC Waters features implemented in Singapore	1.85	13.0%	0.77
4	ABC + Orifice	Precinct with ABC Waters features and orifice outlets but without gravel storage	1.86	12.6%	0.77
5	ABC + Storage	Precinct with ABC Waters features and gravel storage but without orifice outlets	1.75	17.7%	0.73
6	ABC + Storage + Orifice	Precinct with ABC Waters features coupled with gravel storage and orifice outlet	1.44	32.6%	0.60

Note: * Relative to Scenario 1 of the precinct without any treatment or detention.

- Ranking was assigned over assigning real values, multiple variables needed to fully access effectiveness. Ranking also considers the number of strategies used in a single ABC water zone. Derived relative effectiveness is logical but requires the removal of jarring anomaly - reservoirs/ park which have extremely high efficiency for drainage (does not support our ranking too)

		Parks and Reservoirs (5)	Canal (4)	Rain Gardens (3)	Gravel Swales (2)	Bioretention/ vegetated swales (1)		Cumulative Ratings	Relative Effectiveness
Alexandra Road	Wetlands/ Canal		Y			Y		5	50.00%
Alexandra Canal Subsik	Rain Gardens/ Canal Reservoir	Y	Y	Y				7	70.00%
Bedok Reservoir	Reservoir							-	
Bukit Timah Canal	Rain Gardens/ Canal		Y	Y				7	70.00%
Geylang River	Rain Gardens		Y	Y				7	70.00%
Holland Plain/Bukit Timah First Diversion Canal	Rain Garden/ Wetland			Y		Y		4	40.00%
Hougang Avenue 10	Rain Gardens/ Canal		Y	Y				7	70.00%
Jurong Lake	Wetlands	Y				Y		-	
Bishan AMK Park	soil bio-engineering/ cleansing biotope/ vegetated swales	Y			Y	Y		-	

- Utilize geocoding plugin to tag locations on the map

<https://guides.library.ucsc.edu/DS/Resources/QGIS#:~:text=To%20use%20it%2C%20select%20the,where%20the%20address%20is%20located>

2. Assign Relative Effectiveness of each ABC site as an attribute

ABC Location — ABC Location.shp — Field Calculator

Only update 0 selected feature(s)

Create virtual field

Output field name: RelativeEf

Output field type: Integer (32 bit)

Output field length: 10 Precision: 3

Update existing field

Expression: $(("Canal" *4) + ("Rain garde" *3) + ("Gravel Swa" *2) + ("Bioretentni" *1)) *10$

Function Editor

Search... Show Values

Date and Time

Fields and Values

- NULL
- 1.2 fid
- abc address
- 123 Rain garde
- 123 Gravel Swa
- 123 Bioretentni
- 123 Reservoir
- 123 Canal
- 123 RelativeEf

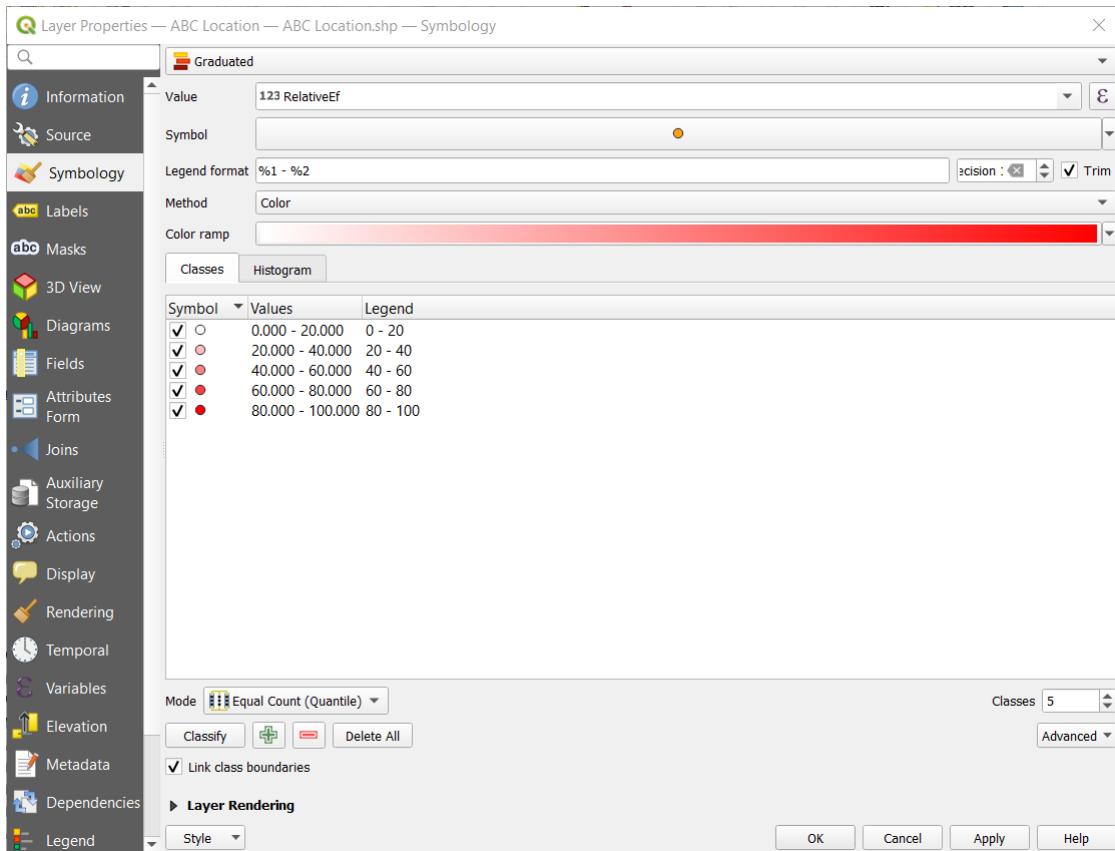
Feature: 10 Linear Park

Preview: 70

This layer does not support adding new provider fields. You can only add virtual fields.

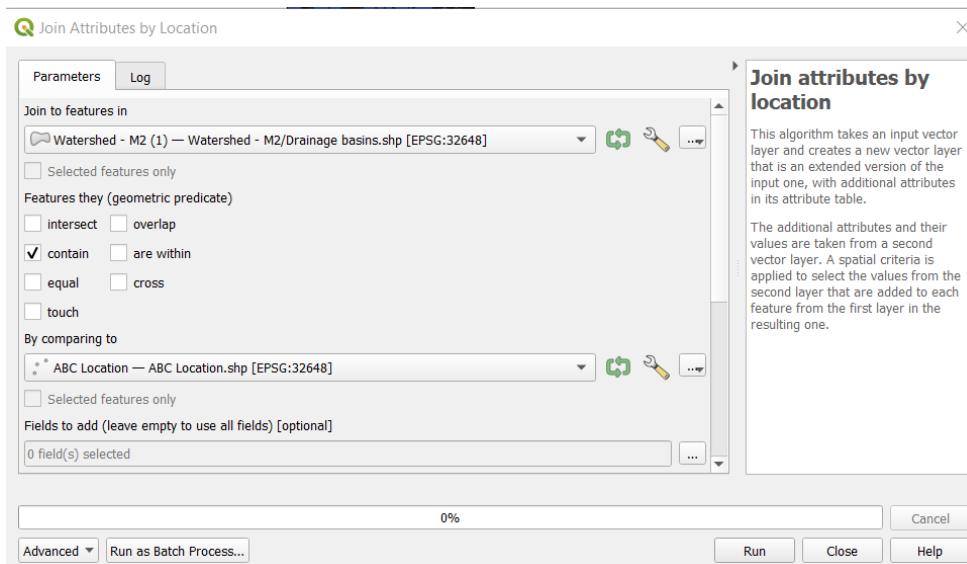
fid	address	Rain garde	Gravel Swa	Bioretentni	Reservoir	Canal	RelativeEf
1	Alexandra Roa...	0	0	1	0	1	50
2	Bedok Reservo...	0	0	0	1	0	0
3	Bukit Timah C...	1	0	0	0	1	70
4	Geylang River...	1	0	0	0	1	70
5	Holland Plain, ...	1	0	1	0	0	40
6	Hougang Ave...	1	0	0	0	1	70
7	Jurong Lake, J...	0	0	1	1	0	10
8	Bishan-Ang M...	0	1	1	1	0	30
9	Braddell Road...	1	0	0	0	1	70
10	Potong Pasir A...	1	0	1	0	0	40
11	Upp Boon Ken...	1	0	0	0	1	70
12	Kranji Reservoi...	0	0	0	1	0	0
13	Lorong Halus, ...	0	0	1	0	0	10
14	Lower Seletar ...	0	0	0	1	0	0
15	MacRitchie Re...	0	0	0	1	0	0
16	Pandan Reservoi...	0	0	0	1	0	0
17	Pungua Canal	0	0	0	0	1	40
18	Pang Sua Pon...	0	0	1	0	0	10
19	Rocher Canal	1	0	0	0	1	70
20	Sengkang Flora...	0	0	1	0	0	10
21	Serangoon Re...	0	0	0	1	0	0
22	Sungei Api Api	1	1	0	0	0	50
23	Sungei Pandan	1	0	0	0	0	30
24	Sungei Pinang	1	1	0	0	1	90
25	Sungei Tampl...	1	0	0	0	0	30
26	Whampoa Kim...	1	0	0	0	0	30
27	Sungei Wham...	1	0	0	0	0	30
28	Yishun Pond, Y...	0	0	1	0	0	10
29	Alexandra Can...	1	0	0	0	1	70

3. Assign classes based on Relative Effectiveness value



4. Project classes to Drainage Basin grid

Vector > Data Management Tools > Join Attributes by Location



4. Weighing overlay in raster calculator

1. Reclassify values in (3) Multi-criteria analysis to each DB (ID) for “Landuse by class”

In “Landuse by class” >> Field calculator, create a new field “ Risk ” , Query:

case

```
WHEN "MAX Class" = 'Class 1' THEN 5
WHEN "MAX Class" = 'Class 2' THEN 4
WHEN "MAX Class" = 'Class 3' THEN 3
WHEN "MAX Class" = 'Class 4' THEN 2
WHEN "MAX Class" = 'Class 5' THEN 1
END
```



The screenshot shows the QGIS attribute table for the "Landuse by Class" layer. The table includes columns for ID, DB area, Class 1_CI, Class 2_CI, Class 3_CI, Class 4_CI, Class 5_CI, Green area, waterbodie, MAX, MAX Class, and Risk. The Risk column contains values 5, 4, 3, 2, and 1 respectively for the first five rows, corresponding to the reclassification logic defined in the code.

ID	DB area	Class 1_CI	Class 2_CI	Class 3_CI	Class 4_CI	Class 5_CI	Green area	waterbodie	MAX	MAX Class	Risk
124	442	2435164.626	31.677	4.281	10.347	8.399	0.298	1.735	3.017	31.677 Class 1	5
125	208	925999.482	31.515	1.013	10.892	1.574	0.269	52.753	NULL	52.753 Green Area	NULL
126	308	548761.547	31.432	0.669	21.828	3.03	NULL	23.309	NULL	31.432 Class 1	5
127	119	1483395.51	31.372	15.963	26.629	17.039	1.744	2.945	NULL	31.372 Class 1	5

Result: “Risk” column is added in the attribute table, showing the allocated risk score (1-5) in each DB grid (ID).

- Rasterize (Vector to Raster)





Result: raster map generated for landuse by class

2. Reclassify values in (3) Multi-criteria analysis to each DB (ID) for “Green areas”

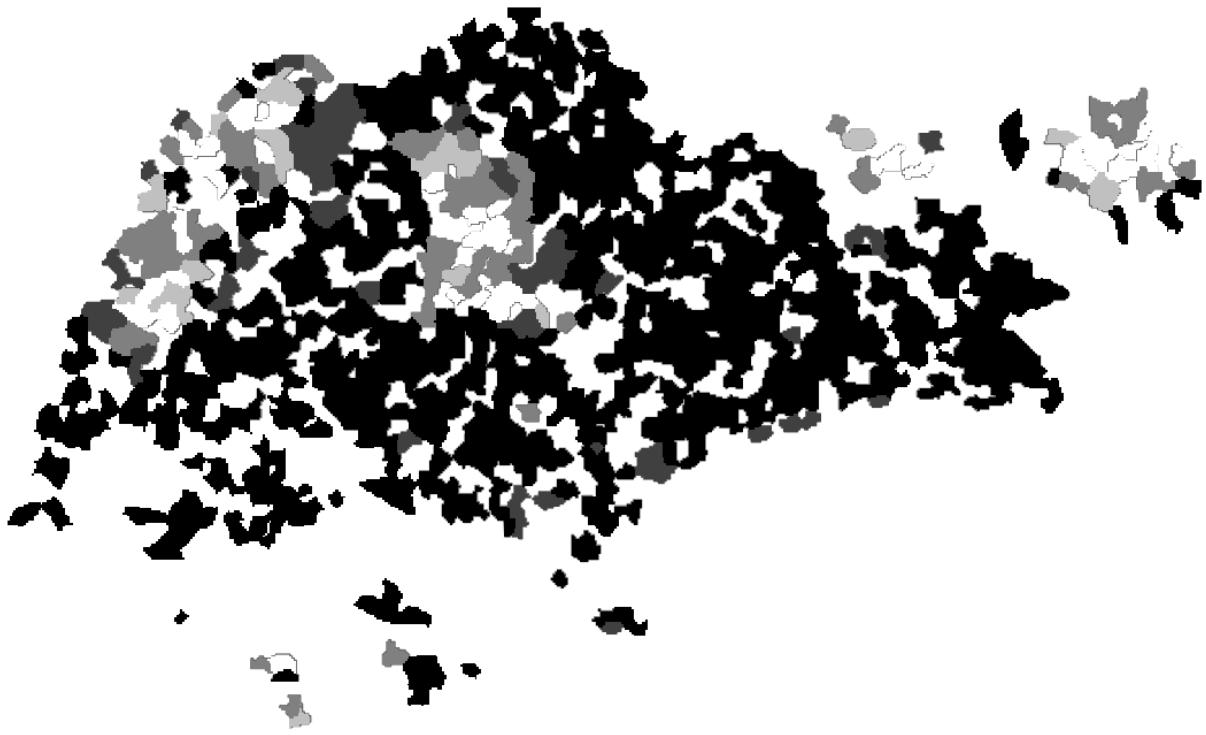
In “Green areas” >> Field calculator, create a new field “ Risk ” , Query:

```

case
WHEN "Green area" < 20 THEN 5
WHEN "Green area" >= 20 AND "Green area" < 40 THEN 4
WHEN "Green area" >= 40 AND "Green area" < 60 THEN 3
WHEN "Green area" >= 60 AND "Green area" < 80 THEN 2
WHEN "Green area" >= 80 AND "Green area" <= 100 THEN 1
ELSE 5
END
  
```

ID	DB area	Class 1_Cl	Class 2_Cl	Class 3_Cl	Class 4_Cl	Class 5_Cl	Green area	waterbodie	MAX	MAX Class	risk
1	0	454407.911	NULL	NULL	NULL	NULL	70.389	NULL	70.389	Green Area	2
2	1	583012.583	NULL	NULL	NULL	NULL	42.748	NULL	42.748	Green Area	3
3	2	505847.983	NULL	NULL	NULL	NULL	15.783	NULL	15.783	Green Area	5
4	3	2580793.542	NULL	87.838	NULL	NULL	NULL	NULL	87.838	Class 2	5
5	4	445857.636	NULL	NULL	NULL	29.464	NULL	NULL	29.464	Class 4	5

Result: “Risk” column is added in the attribute table, showing the allocated risk score (1-5) in each DB grid (ID), with “Green area” NULL (0%) returning a score of 5.



Result: raster map generated for green areas

3. Reclassify values in (3) Multi-criteria analysis to each DB (ID) for “Waterbodies”

In “Waterbodies” >> Field calculator, create a new field “ Risk ” , Query:

```

case
WHEN "waterbodie" < 20 THEN 5
WHEN "waterbodie" >= 20 AND "waterbodie" < 40 THEN 4
WHEN "waterbodie" >= 40 AND "waterbodie" < 60 THEN 3
WHEN "waterbodie" >= 60 AND "waterbodie" < 80 THEN 2
WHEN "waterbodie" >= 80 AND "waterbodie" <= 100 THEN 1
ELSE 5
END

```

	ID	DB area	Class 1_Cl	Class 2_Cl	Class 3_Cl	Class 4_Cl	Class 5_Cl	Green area	waterbodie	MAX	MAX Class	risk
1	0	454407.911	NULL	NULL	NULL	NULL	NULL	70.389	NULL	70.389	Green Area	2
2	1	583012.583	NULL	NULL	NULL	NULL	NULL	42.748	NULL	42.748	Green Area	3
3	2	505847.983	NULL	NULL	NULL	NULL	NULL	15.783	NULL	15.783	Green Area	5
4	3	2580793.542	NULL	87.838	NULL	NULL	NULL	NULL	NULL	87.838	Class 2	5
5	4	445857.636	NULL	NULL	NULL	29.464	NULL	NULL	NULL	29.464	Class 4	5

Result: “Risk” column is added in the attribute table, showing the allocated risk score (1-5) in each DB grid (ID), with “Waterbodie” NULL (0%) returning a score of 5.

4. Reclassify values in (3) Multi-criteria analysis to each DB (ID) for “Population Density”

Population Density

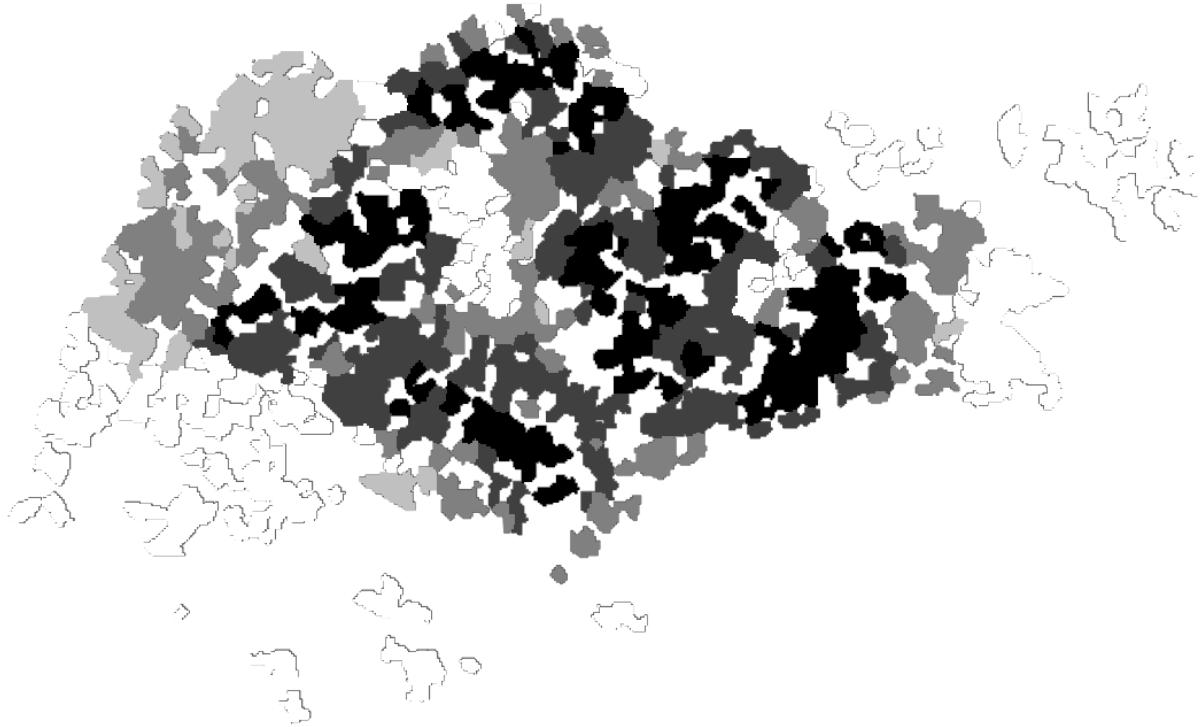
-  0 - 0
-  0 - 0.0000082
-  0.0000082 - 0.002245
-  0.002245 - 0.010972
-  0.010972 - 0.0341331

In “Population Density” >> Field calculator, create a new field “ Risk ” , Query:

```
case
WHEN "popdensity" = 0 THEN 1
WHEN "popdensity" >0 AND "popdensity" <0.0000082 THEN 2
WHEN "popdensity" >= 0.0000082 AND "popdensity" < 0.002245 THEN 3
WHEN "popdensity" >= 0.002245 AND "popdensity" < 0.010972 THEN 4
WHEN "popdensity" >=0.010972 THEN 5
END
```

	fid	ID	pop	area	popdensity	Risk
94	107	106	16790	1482809.34974...	0.011323100979159345	5
95	124	123	34442	3128470.59339...	0.011009213279083814	5
96	88	87	4332	394273.006290...	0.010987310647406297	5
97	134	133	6100	557124.900193...	0.010949070841899023	4

Result: “Risk” column is added in the attribute table, showing the allocated risk score (1-5) in each DB grid (ID)



5. Reclassify values in (3) Multi-criteria analysis to each DB (ID) for “ABC strategies effectiveness”

In “ABC strategies effectiveness” >> Field calculator, create a new field “ Risk ” , Query:
WHEN "RelativeEf" < 20 THEN 5
WHEN "RelativeEf" >= 20 AND "RelativeEf" < 40 THEN 4
WHEN "RelativeEf" >= 40 AND "RelativeEf" < 60 THEN 3
WHEN "RelativeEf" >= 60 AND "RelativeEf" < 80 THEN 2
WHEN "RelativeEf" >= 80 AND "RelativeEf" <= 100 THEN 1
END

		address	Rain garde	Gravel Swa	Bioretenti	Reservoir	Canal	RelativeEf	Risk
1	2	Bedok Reservoi...		0	0	0	1	0	100
2	12	Kranji Reservoir,...		0	0	0	1	0	100
3	14	Lower Seletar R...		0	0	0	1	0	100
4	15	MacRitchie Res...		0	0	0	1	0	100
5	16	Pandan Reservo...		0	0	0	1	0	100
6	20	Serangoon Res...		0	0	0	1	0	100
7	23	Sungei Pinang		1	1	0	0	1	90
8	3	Bukit Timah Ca...		1	0	0	0	1	70
9	4	Geylang River, ...		1	0	0	0	1	70
10	6	Hougang Aven...		1	0	0	0	1	70
11	9	Braddell Road, ...		1	0	0	0	1	70

Result: “Risk” column is added in the attribute table, showing the allocated risk score (1-5) in each DB grid (ID)

4.2 Weighing in attribute table

Method 2 - Field calculator

Assign 0 to NULL values

- Green and Water areas

- Set Green area to a % out of 5 >> % out of 5
 $("Green area" / 100) * 5$

** needs to be inverted

- Population Density

- In “Population Density” >> Field calculator, create a new field “Risk % out of 5”, Real No.
 Query:
 $("popdensity" / maximum("popdensity")) * 5$



- Landuse by class% (Humanitarian Damages)

- In “Landuse by class” >> Field calculator, create a new field “Risk % out of 5”, Real No.
 Query:
 $(("Class 1_CI" * 5) + ("Class 2_CI" * 4) +$

("Class 3_Cl" * 3) +
 ("Class 4_Cl" * 2) +
 ("Class 5_Cl" * 1)) / 5 X

((("Class 1_Cl"/100 * 5) +
 ("Class 2_Cl"/100 * 4) +
 ("Class 3_Cl"/100 * 3) +
 ("Class 4_Cl"/100 * 2) +
 ("Class 5_Cl"/100 * 1)) / 5 X

((("Class 1_Cl"/100 * 5) +
 ("Class 2_Cl"/100 * 4) +
 ("Class 3_Cl"/100 * 3) +
 ("Class 4_Cl"/100 * 2) +
 ("Class 5_Cl"/100 * 1)) ✓

Calculate values in (3) Multi-criteria analysis to each DB (ID) for “ABC strategies effectiveness”

In “ABC strategies effectiveness” >> Field calculator, create a new field “Final @ 1 ” , real no. , Query:

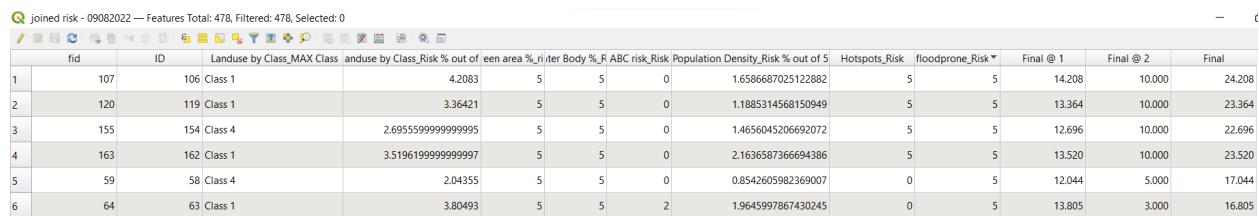
("ABC risk_Risk" + "Green area %_risk" + "Water Body %_Risk" + " Landuse by Class_Risk " + "Population Density_Risk") / 5

- Calculate Final values

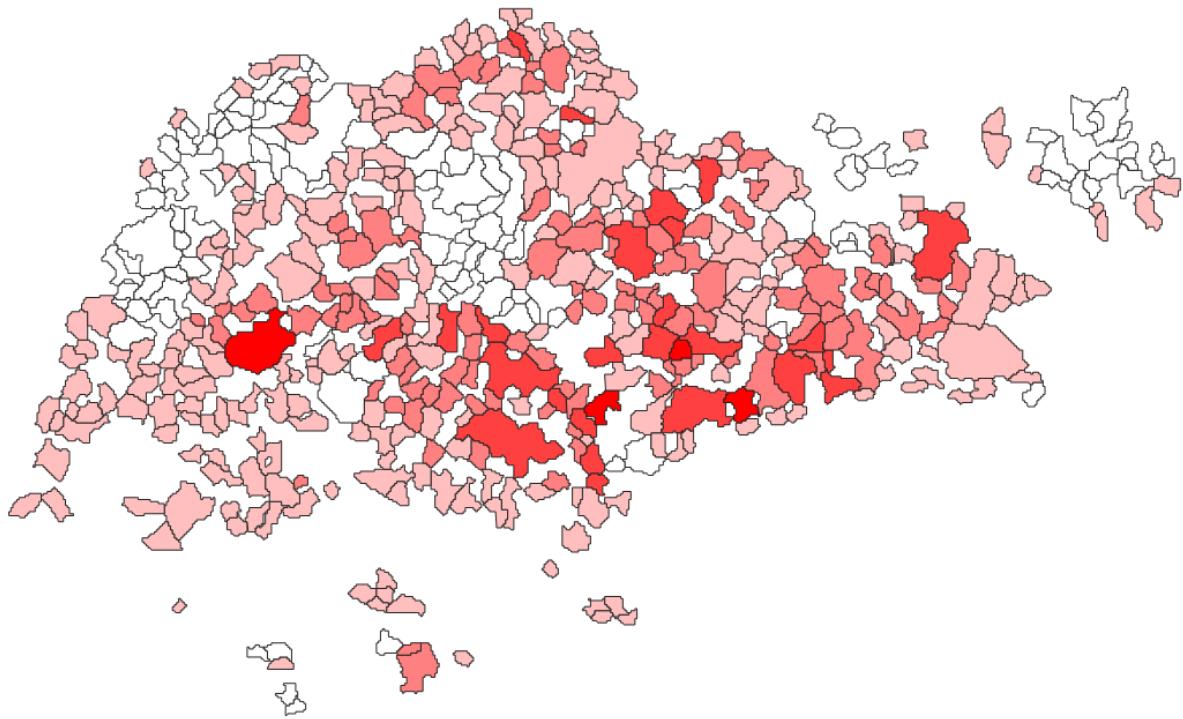
In “Joined risk - 09082022” >> Field calculator, create a new field “Final @ 1 ” , real no. , Query:

" Landuse by Class_Risk % out of 5" - ("Green area %_risk"+"Water Body %_Risk") - "ABC risk_Risk" + "Hotspots_Risk" + "floodprone_Risk" + Popdens (resi) + surface area

joined risk - 09082022 — Features Total: 478, Filtered: 478, Selected: 0



	fid	ID	Landuse by Class_MAX Class	landuse by Class_Risk % out of 5	een area %_risk	Water Body %_Risk	ABC risk_Risk	Population Density_Risk % out of 5	Hotspots_Risk	floodprone_Risk	Final @ 1	Final @ 2	Final
1	107	106 Class 1		4.2083	5	5	0	1.6586667025122882	5	5	14.208	10.000	24.208
2	120	119 Class 1		3.36421	5	5	0	1.1885314568150949	5	5	13.364	10.000	23.364
3	155	154 Class 4		2.6955599999999995	5	5	0	1.4656045206692072	5	5	12.696	10.000	22.696
4	163	162 Class 1		3.5196199999999997	5	5	0	2.1636587366694386	5	5	13.520	10.000	23.520
5	59	58 Class 4		2.04355	5	5	0	0.8542605982369007	0	5	12.044	5.000	17.044
6	64	63 Class 1		3.80493	5	5	2	1.9645997867430245	0	5	13.805	3.000	16.805



Water Map - Coastal Flooding

Carbon Maps

1. CO2e map SG Data (comparable with other CO2 maps same MKgCO2e categories).

2. CO2e map Satellite Data (comparable with other CO2 maps same MKgCO2e categories).

3. CO2e map energy electricity use for AC (comparable with other CO2 maps same MKgCO2e categories).

4. Road co2 emission - noise. road surface compared with footprint density.

(GR)

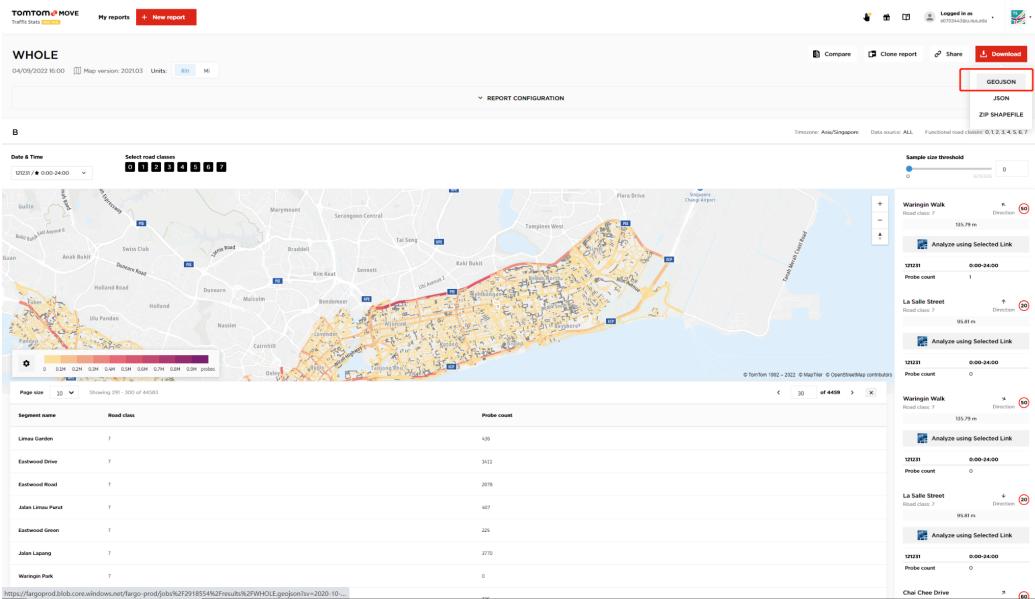
Goal: to look for road co2e of the site area >> calculate traffic density >> count the number of vehicles passing by each road in a certain period of time >> figure out how to convert it to co2e map.

Steps:

1.Fetch traffic density data from TomTom Historical Traffic Services.

Go to <https://ts.tomtom.com/reports>. Sign up and get a free trial of “Traffic Density”analysis: focused analysis only on sample size (number of vehicles that traversed a segment).

With a simple set of input parameters, the user can specify a customized query for their own road network, the specific days and the time periods that need to be studied.



So we have data on traffic density of the target area in the whole January 2021 (Free Trial has a date range limitation).

2.The problem is “probe count” is calculated from variable data like time periods , not a originally fixed value. So, the data format of “segmentProbeCounts” cannot be read directly by QGIS . The user needs to rewrite and simplify it with Python or Visual Studio Code.

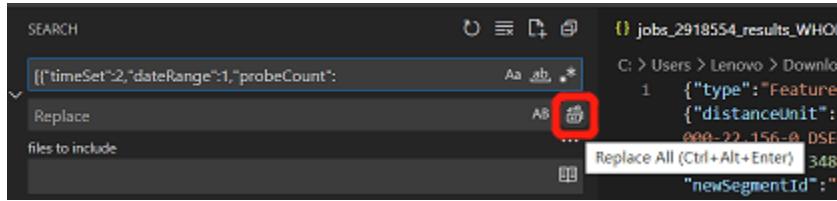
Open the file in vscode. Delete selected paragraphs.

```

{
  "type": "FeatureCollection",
  "features": [
    {
      "type": "Feature",
      "geometry": null,
      "properties": {
        "jobName": "WHOLE",
        "creationTime": "2022-09-04T08:17:17.991941Z",
        "userPreference": {
          "distanceUnit": "KILOMETERS",
          "includedSpeedLimits": "ALL"
        },
        "dateRanges": [
          {
            "id": 1,
            "name": "121231",
            "from": "2021-01-01",
            "to": "2021-01-31",
            "exclusions": [],
            "excludedDaysOfWeek": []
          }
        ],
        "timeSets": [
          {
            "id": 2,
            "name": "0:00-24:00",
            "dayToTimeRanges": [
              {
                "dayOfWeek": "MONDAY",
                "timeRanges": [
                  "00:00-24:00"
                ]
              },
              {
                "dayOfWeek": "TUESDAY",
                "timeRanges": [
                  "00:00-24:00"
                ]
              },
              {
                "dayOfWeek": "WEDNESDAY",
                "timeRanges": [
                  "00:00-24:00"
                ]
              },
              {
                "dayOfWeek": "THURSDAY",
                "timeRanges": [
                  "00:00-24:00"
                ]
              },
              {
                "dayOfWeek": "FRIDAY",
                "timeRanges": [
                  "00:00-24:00"
                ]
              },
              {
                "dayOfWeek": "SATURDAY",
                "timeRanges": [
                  "00:00-24:00"
                ]
              },
              {
                "dayOfWeek": "SUNDAY",
                "timeRanges": [
                  "00:00-24:00"
                ]
              }
            ]
          }
        ],
        "networkName": "B",
        "zoneId": "Asia/Singapore",
        "probeSource": "ALL",
        "mapsVersions": [
          "Asia_TelektasMNR_sea2021.03.000-22.156-0_DSEG_NOSPLIT"
        ],
        "geometry": {
          "type": "LineString",
          "coordinates": [
            [103.96414, 1.34834],
            [103.96409, 1.34832],
            [103.96405, 1.34831],
            [103.96397, 1.34829],
            [103.96388, 1.34827],
            [103.96378, 1.34825],
            [103.96365, 1.34822],
            [103.96357, 1.34816],
            [103.96346, 1.34804]
          ]
        },
        "properties": {
          "segmentId": -17020001126972,
          "newSegmentId": "-00005347-5000-0400-0000-00000002cd3",
          "speedLimit": 50,
          "frc": 2,
          "distance": 85.36,
          "segmentProbeCounts": [
            {
              "timeSet": 2,
              "dateRange": 1,
              "probeCount": 348
            }
          ]
        }
      }
    }
  ]
}

```

Ctrl+Shift+H to replace `["timeSet":2,"dateRange":1,"probeCount":]` with a blank field. (If the number of the selected is too large, repeat this conduct until all paragraphs have been all replaced)



Same as above, replace `}]` with a blank field. Change the end text to `} } }` to fix the grammar.

```

[{"segmentId": 170200041130160, "newSegmentId": "17020001126972-485e-a356-1d96eca66435", "speedLimit": 35, "frc": 7, "streetName": "East Coast Road", "distance": 45.725, "segmentProbeCounts": 11506}, {"type": "Feature", "geometry": {"type": "LineString", "coordinates": [[103.95216, 1.31201], [103.95208, 1.31198], [103.95194, 1.31193], [103.95174, 1.31183], [103.9514, 1.31163], [103.95129, 1.31157], [103.95108, 1.31148], [103.95077, 1.31136]]}, "properties": {"segmentId": 17020004233593, "newSegmentId": "ffffd466a-bba1-485e-a356-1d96eca66435", "speedLimit": 35, "frc": 7, "streetName": "East Coast Park Service Road", "distance": 170.13, "segmentProbeCounts": 2191}}]

```

Save as a new Geojson file.

3. Open QGIS and import the file.

Change the attribute table

Toggle editing mode>>Delete unnecessary fields>>Select by expression — enter "frc=0" select feature>> Open field calculator — update existing field, — enter "1">> So far, all the 0 values in the "frc" (road type) have been changed to 1 >>According to the Singapore road category, the data can be divided into several groups (1,2,3,4....) by assigning values to "frc".

Q jobs_2918554_results_backup — Features Total: 44584, Filtered: 44584, Selected: 0

JobName	creationTime	segmentid	newSegmentid	speedLimit	frc	streetName	distance	egmentProbeCoun	userPreference	networkName	zoneid	probeSource	mapsVersions
1 WHOLE	2022/9/4 08:1...	NULL NULL	2 NULL	NULL	2 NULL	85.36	8805	NULL	NULL	NULL	NULL	NULL	Asia_TeleAtlas...
2 NULL	NULL	-17020001126...-00005347-50...	50	2 NULL	68.2	23 NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
3 NULL	NULL	-17020001000...-00005347-50...	50	7 Jalan Pelatok	28.72	0 NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
4 NULL	NULL	-17020001023...-00005347-50...	50	7 Jalan Pergam	179.41	67 NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
5 NULL	NULL	-17020001023...-00005347-50...	50	7 Jalan Pelatok	151.19	0 NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
6 NULL	NULL	-17020001317...-00005347-50...	20	7 Seagull Walk	115.6	0 NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
7 NULL	NULL	-17020001317...-00005347-50...	20	7 Seagull Walk	57.33	464 NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
8 NULL	NULL	-17020001022...-00005347-50...	20	7 Seagull Walk	79.89	111 NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
9 NULL	NULL	-17020001317...-00005347-50...	50	7 Jalan Pergam	228.63	64 NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
10 NULL	NULL	-17020001021...-00005347-50...	20	7 Jalan Kuang	56.39	1224 NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
11 NULL	NULL	-17020001021...-00005347-50...	20	7 Seagull Walk	126.56	1 NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
12 NULL	NULL	-17020001000...-00005347-50...	50	7 Jalan Pergam	78.55	338 NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
13 NULL	NULL	-17020001023...-00005347-50...	50	7 Jalan Pelatok	73.45	396 NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
14 NULL	NULL	-17020001455...-00005347-50...	20	7 Seagull Walk	144.28	1957 NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
15 NULL	NULL	-17020001023...-00005347-50...	20	7 Seagull Walk	111.0	111 NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL

Create a new field “traffic”>>Select by expression — enter "frc=1" select feature>> Open field calculator — update existing field — enter “112500 ”>> Repeat the action, assign values(I refer to Chinese road standards) according to the road categories.

Q jobs_2918554_results_backup — Features Total: 44584, Filtered: 44584, Selected: 0

segmentId	newSegmentId	speedLimit	frc	streetName	distance	egmentProbeCoun
1	NULL NULL	NULL	NULL	NULL	111.0	111
2	-17020001126...-00005347-50...	50	2 NULL	85.36	8805	64
3	-17020001000...-00005347-50...	50	7 Jalan Pelatok	68.2	23 NULL	NULL
4	-17020001023...-00005347-50...	50	7 Jalan Pergam	28.72	0 NULL	NULL
5	-17020001023...-00005347-50...	50	7 Jalan Pelatok	179.41	67 NULL	NULL
6	-17020001317...-00005347-50...	20	7 Seagull Walk	151.19	0 NULL	NULL
7	-17020001317...-00005347-50...	20	7 Seagull Walk	115.6	464 NULL	NULL
8	-17020001022...-00005347-50...	20	7 Seagull Walk	57.33	111 NULL	NULL
9	-17020001023...-00005347-50...	50	7 Jalan Pergam	79.89	1224 NULL	NULL
10	-17020001317...-00005347-50...	50	7 Jalan Kuang	228.63	64 NULL	NULL

Add Field

Name: TrafficCapacity

Comment:

Type: 128 Integer (64 bit)

Provider type: integer64

Length: 10

OK Cancel

Create a new field “Ratio”>>Select field “Ratio”— Open the expression dialog>> enter “traffic/segmentProbeCounts”

1. Road Category — Features Total: 44583, Filtered: 44583, Selected: 0

2. Ratios

3. Segment ID

4. Expression Dialog

Expression: traffic/segmentProbeCounts

Function Editor

row number

- Aggregates
- Arrays
- Color
- Conditionals
- Comparisons
- Date and Time
- Fields and V...
- Fuzzy Matchi...
- General
- Geometry
- Map Layers
- Maps
- Math
- Operators
- Rasters
- Record and ...
- String
- Variables
- Recent (gen...)

Feature: 4891.304347820087

Preview: 4891.304347820087

OK

To make a traffic volume map

Layer properties >> Symbology >> Gradual>>Choose “segmentProbecounts” as the value>> create a color ramp >> click “Classify” and adjust the symbols of the segments.

Layer Properties — Traffic Volume (默认) — Symbology

Graduated

Information

Source

Symbology

Labels

Masks

3D View

Diagrams

Fields

Attributes Form

Joins

Auxiliary Storage

Actions

Display

Rendering

Temporal

Variables

Elevation

Metadata

Dependencies

Legend

QGIS Server

Digitizing

Value: 123 segmentProbeCounts

Symbol: (red bar)

Legend format: %1 - %2

Precision: 4

Method: Color

Color ramp: (yellow to purple gradient)

Classes: Histogram

Symbol	Values	Legend
Light Yellow	0.000000 - 5.000000	0 - 5
Orange	5.000000 - 500.000000	5 - 500
Dark Orange	500.000000 - 3000.000000	500 - 3000
Red	3000.000000 - 10000.000000	3000 - 10000
Dark Red	10000.000000 - 30000.000000	10000 - 30000
Very Dark Red	30000.000000 - 100000.000000	30000 - 100000
Dark Purple	100000.000000 - 300000.000000	100000 - 300000
Purple	300000.000000 - 678326.000000	300000 - 678326

Mode: Equal Count (Quantile)

Classes: 8

Classify

Delete All

Link class boundaries

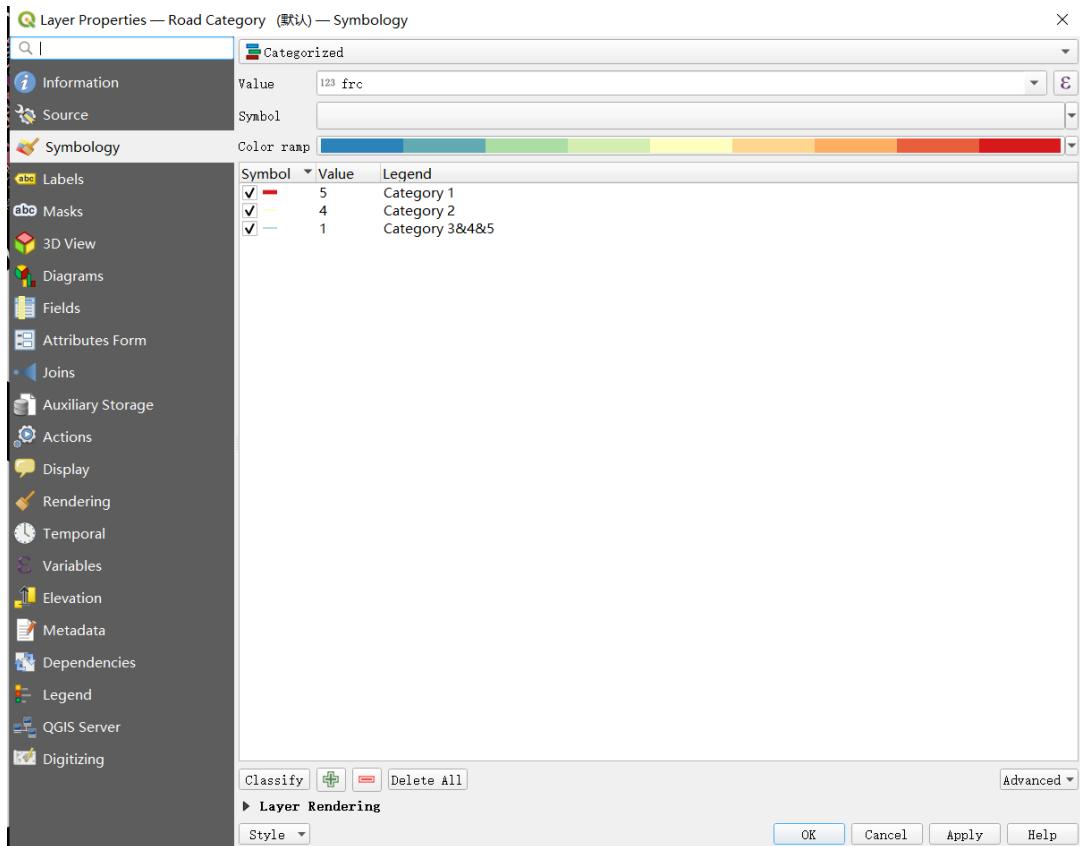
Layer Rendering

Style

OK Cancel Apply Help

To make a road category map

Duplicate Layer>> Layer properties >> Symbology >> Categorized>>Choose “frc” as the value>> create a color ramp >> click “Classify” and adjust the symbols of the segments.



To make a traffic saturation map

Duplicate Layer >> Layer properties >> Symbology >> Categorized>>Choose “Ratio” as the value>> create a color ramp >> click “Classify” and adjust the symbols of the segments.

