Cost Distances & Centering Analysis

ISTANBUL**TECHNICAL**UNIVERSITY

Sp. Anly. and Alg. in GIS
Lab 6

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Aim of the Study

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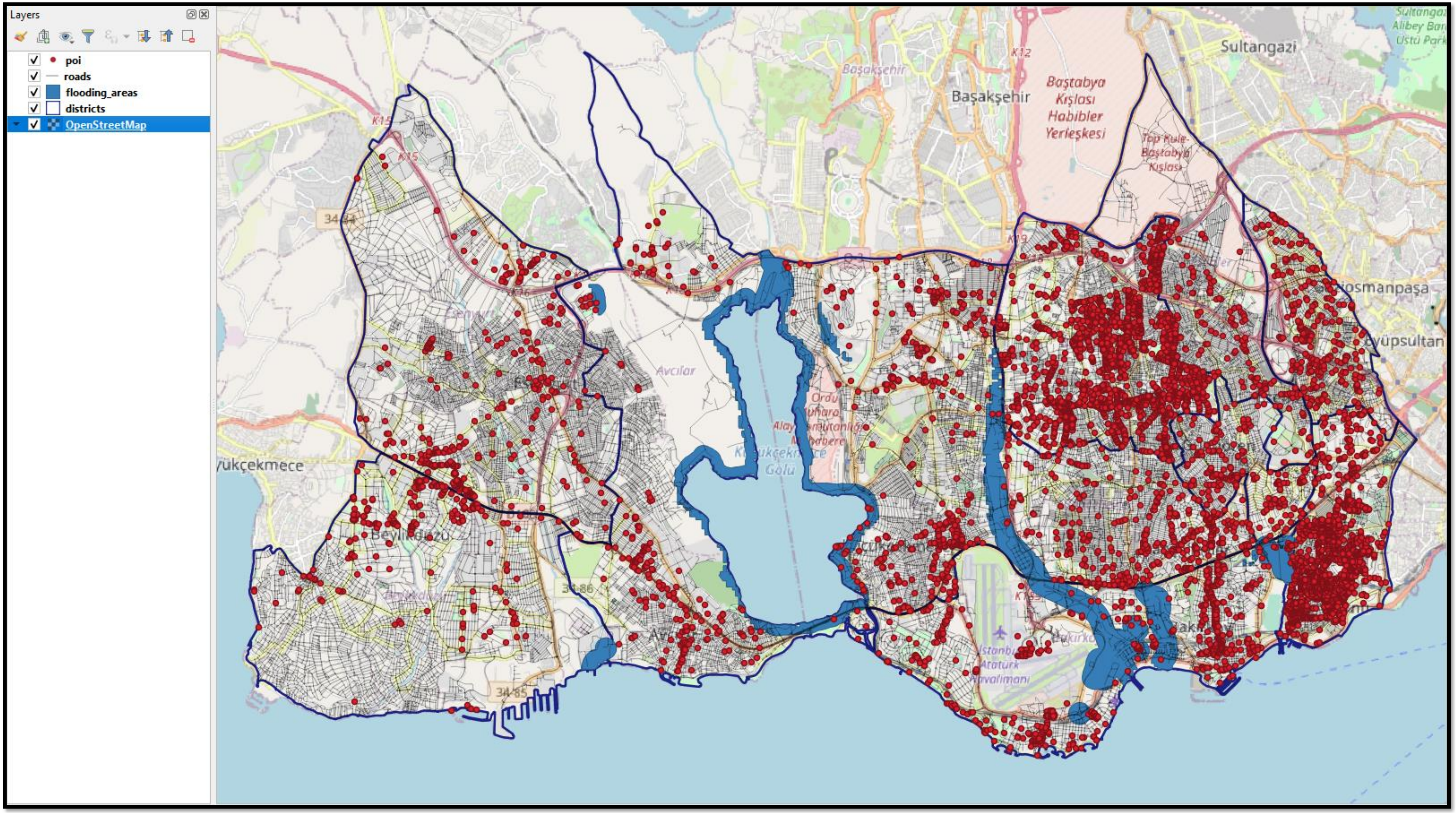
- *Analyze the different type of distance calculation methods and their affects on centering algorithms*
- *Observe the hospitals distribution over districts and find the center of hospitals to analyze the distances between the centers and flooding areas*

Input Data:

- *Data (Geopackage)*
  - *POI (Vector-Point)*
  - *Roads (Vector-Polyline)*
  - *Districts (Vector-Polygon)*
  - *Flooding Areas (Vector-Polygon)*

Exploring Data

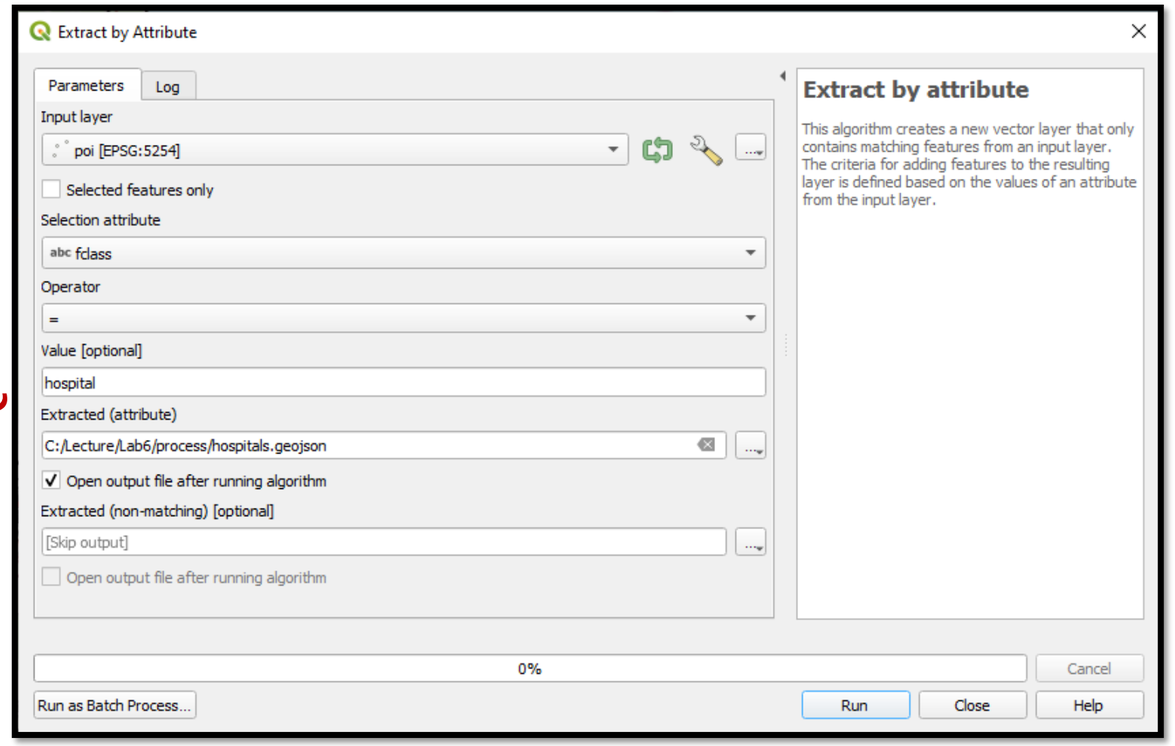


Preparing Analysis Data

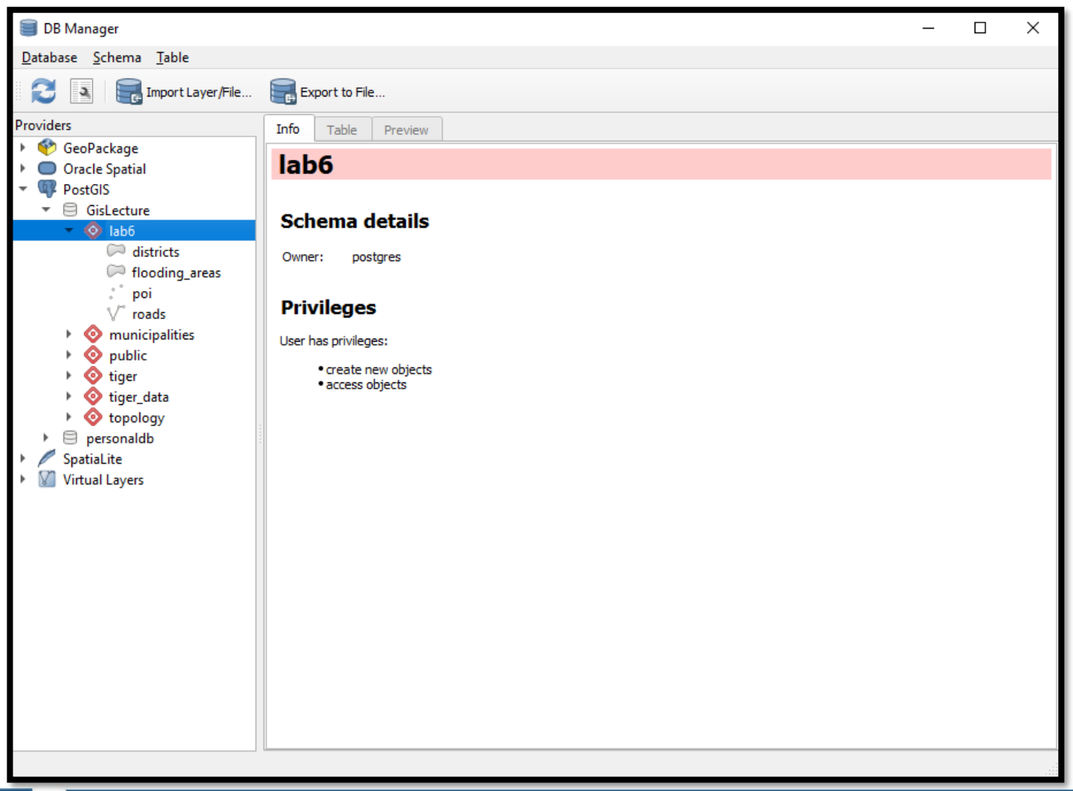
Create a PostGIS database schema named “lab” and import input data into it. Don’t forget the specify **“fid” as primary key** and **create spatial index** when importing data into PostGIS

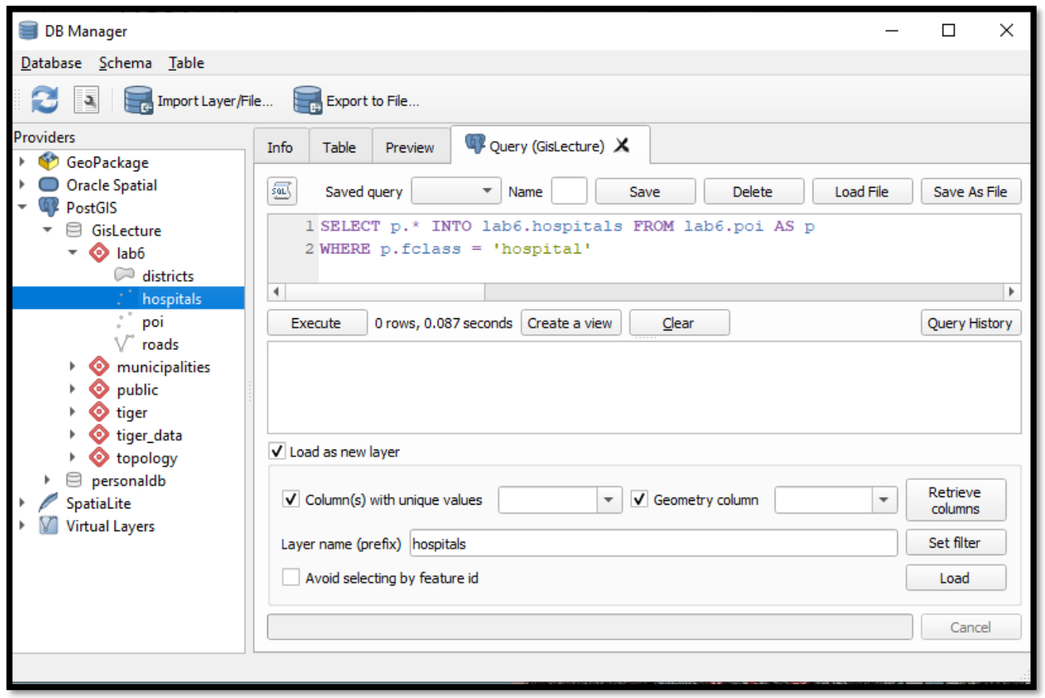
Select hospitals from poi data for further analyzes

QGIS



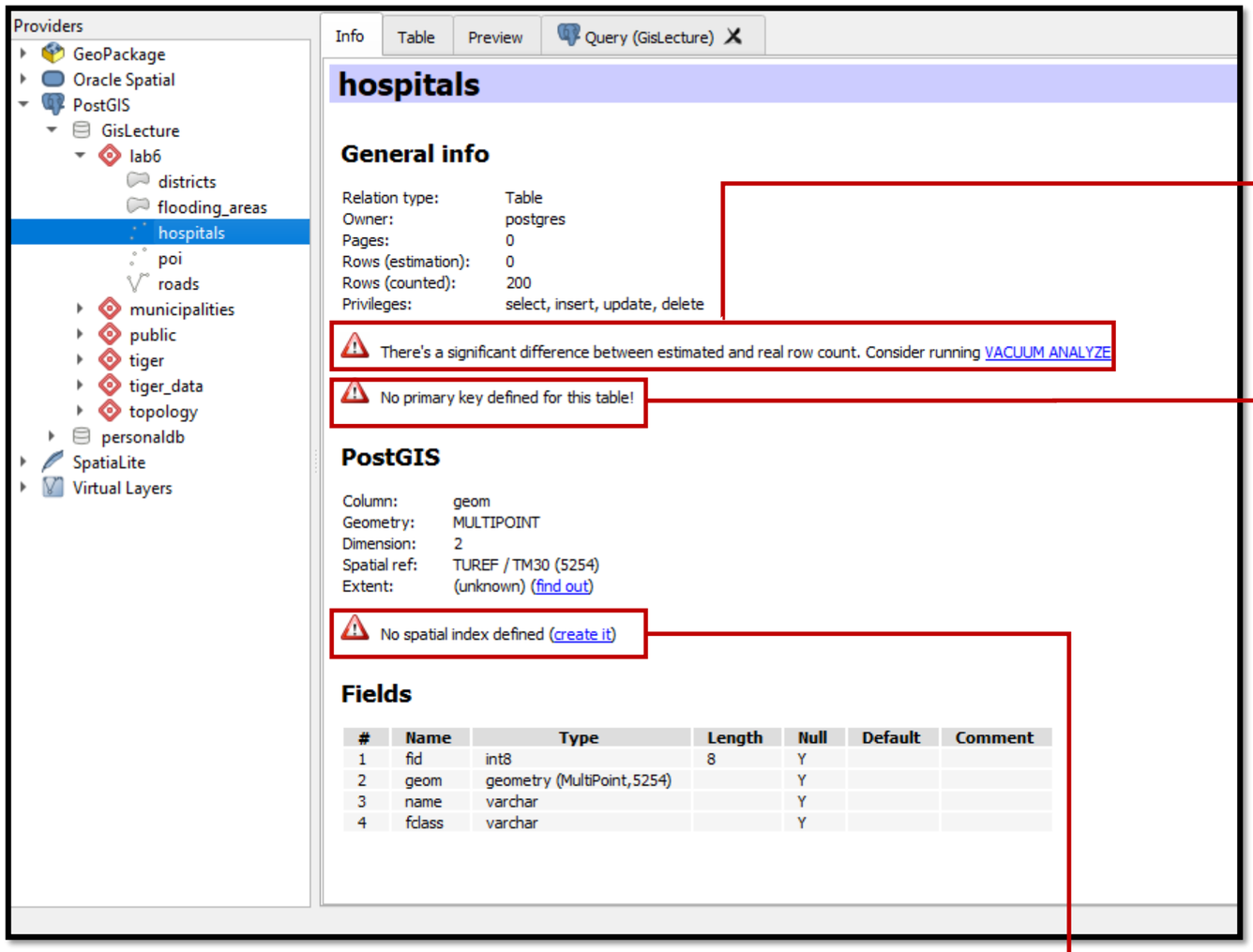
PostGIS



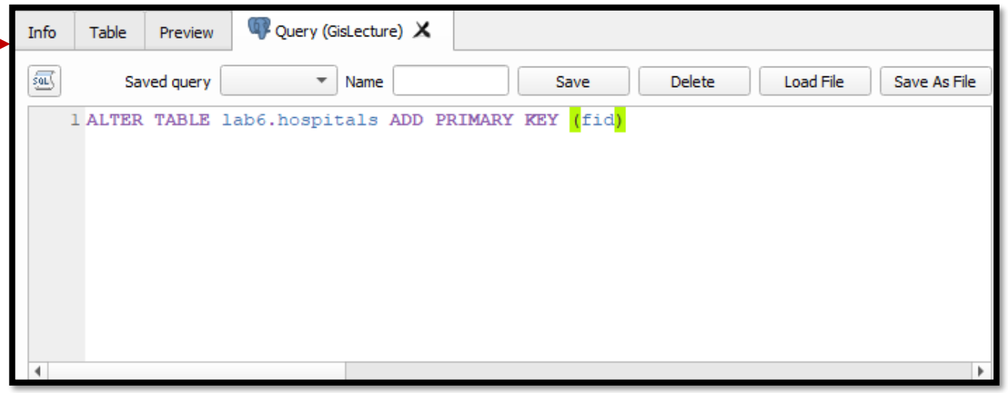


Adding Required Functionalities to PostGIS Table

Inspect the created hospitals table.



Click **VACUUM ANALYZE** to reclaim storage occupied by dead tuples (optimization)



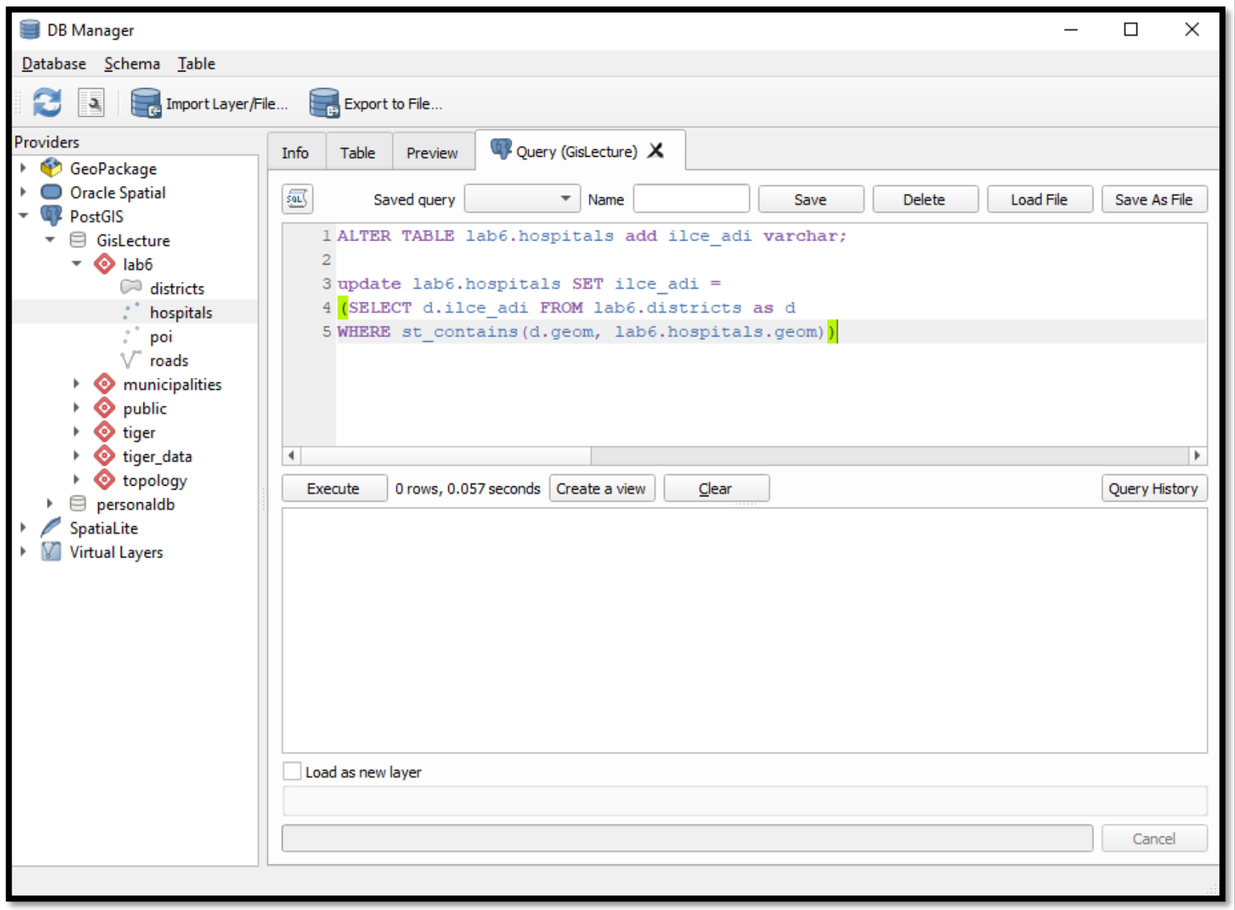
Setting **PRIMARY KEY** as “fid” column of data

Click “create it” to enable **spatial indexing**

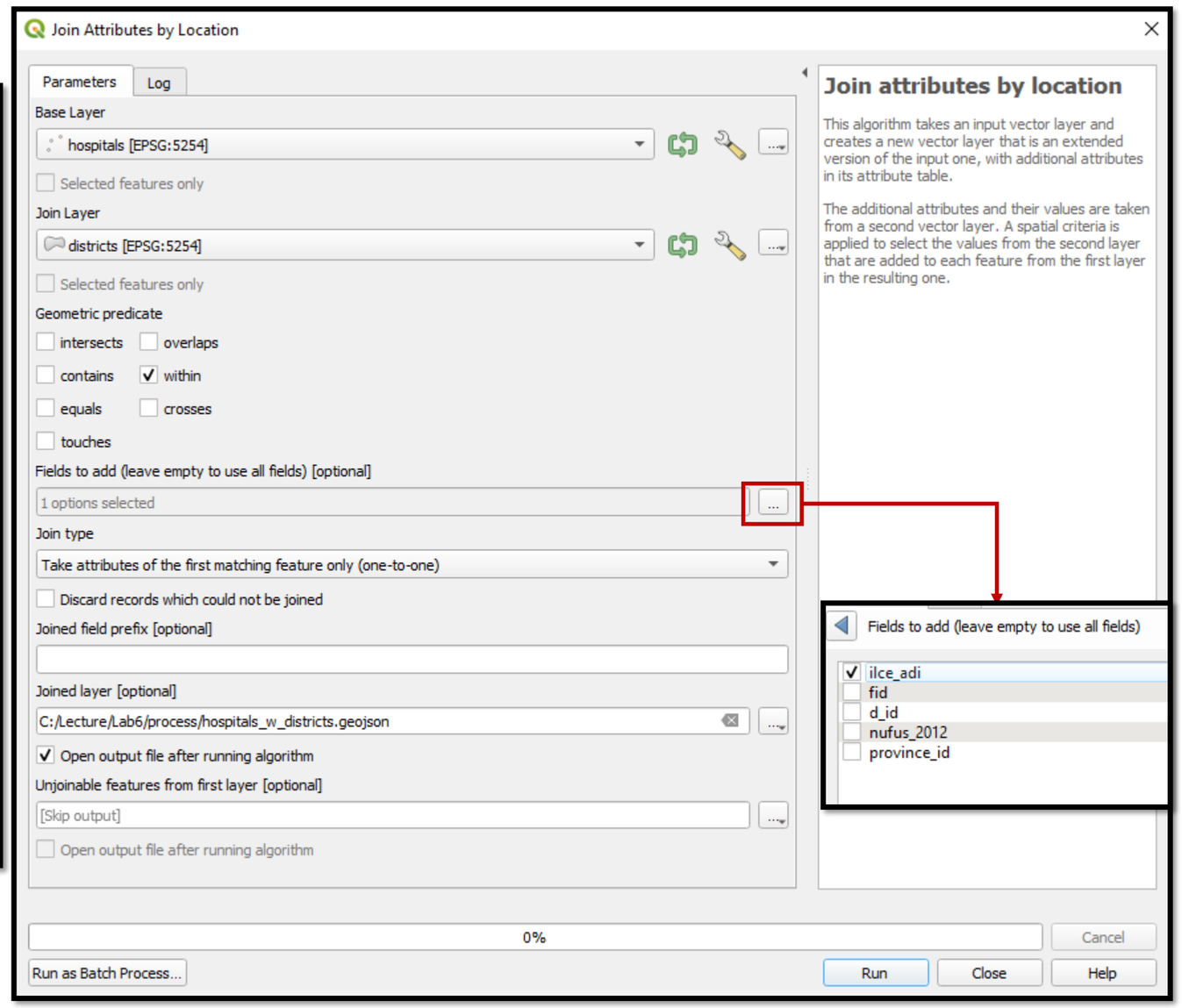
Preparing Analysis Data

Join hospitals with districts to represent district names

Spatial Join using PostGIS ST_Contains

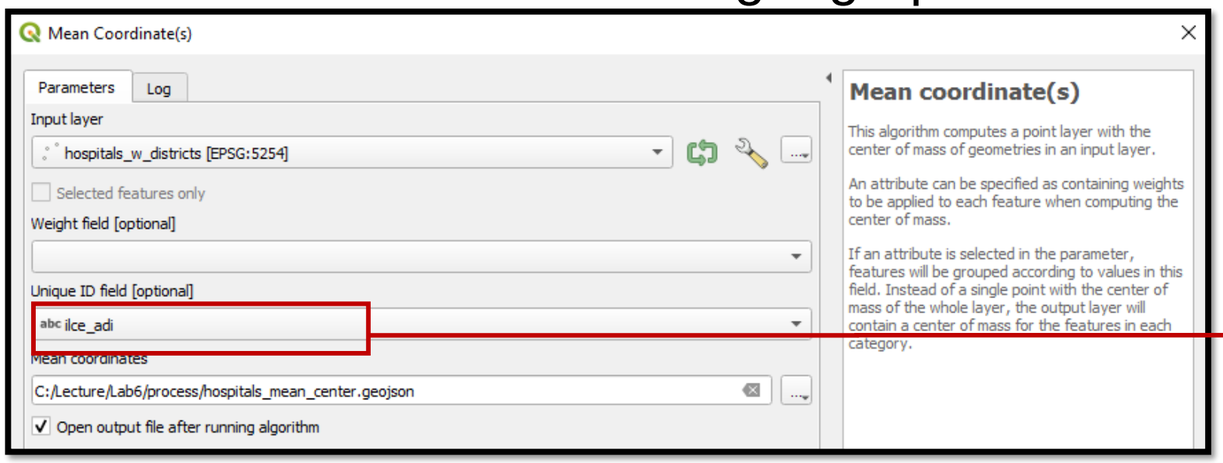


Spatial Join using QGIS

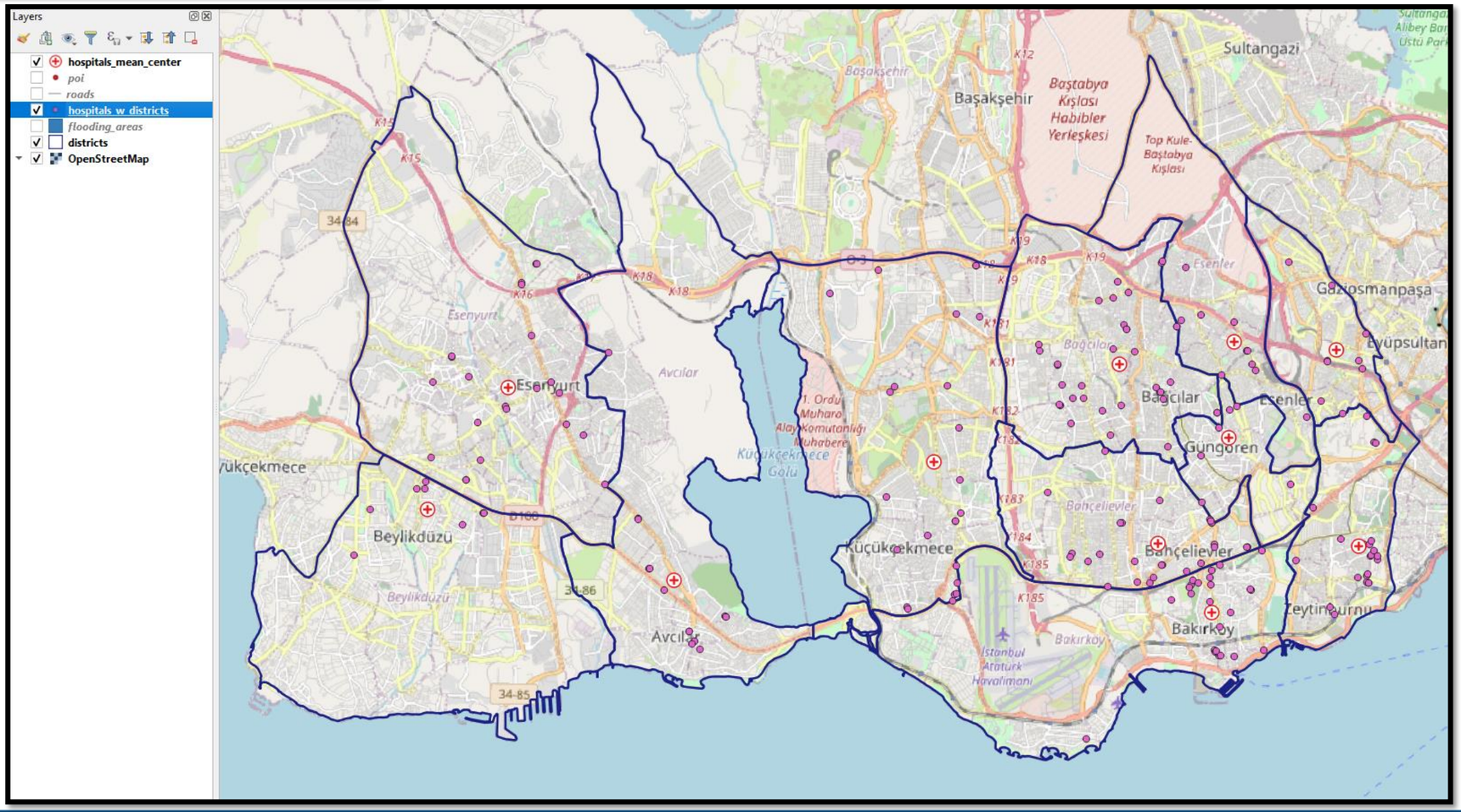


Mean Center

Mean Center: Identifies the geographic center for a set of features



Specify Unique ID field to get mean center for each attribute type (for each district in that case)



Weighted Mean Center
Euclidean Distance

Weighted Mean Center: The geographic center of a set of points as adjusted for the influence of a value (distance, time, cost, attribute etc.) associated with each point

Euclidean Distance

To find the weighted mean of each district in QGIS, below work schema is need to be followed.

Filter Hospital data by using **ilce_adi** column to calculate each district's weighted mean center separately

↓

Create distance matrix for the hospitals in each district to find average distance between them

↓

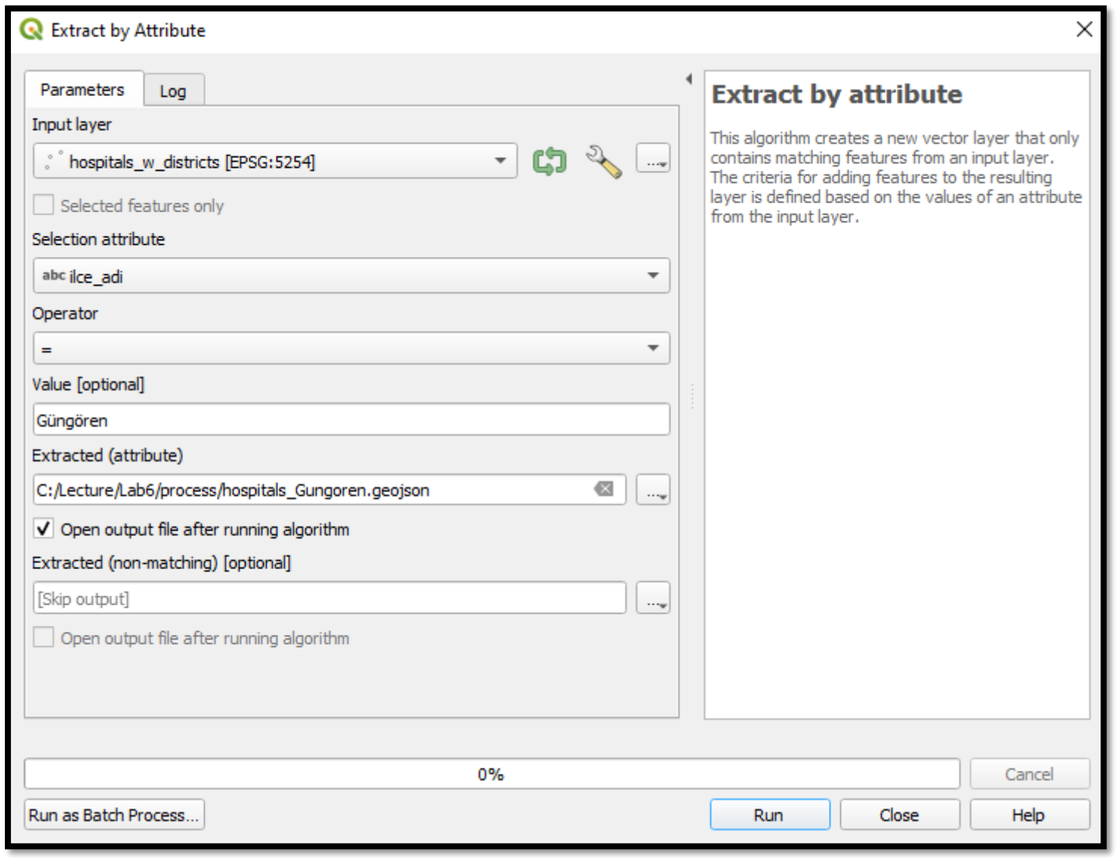
Merge hospitals with calculated mean distances

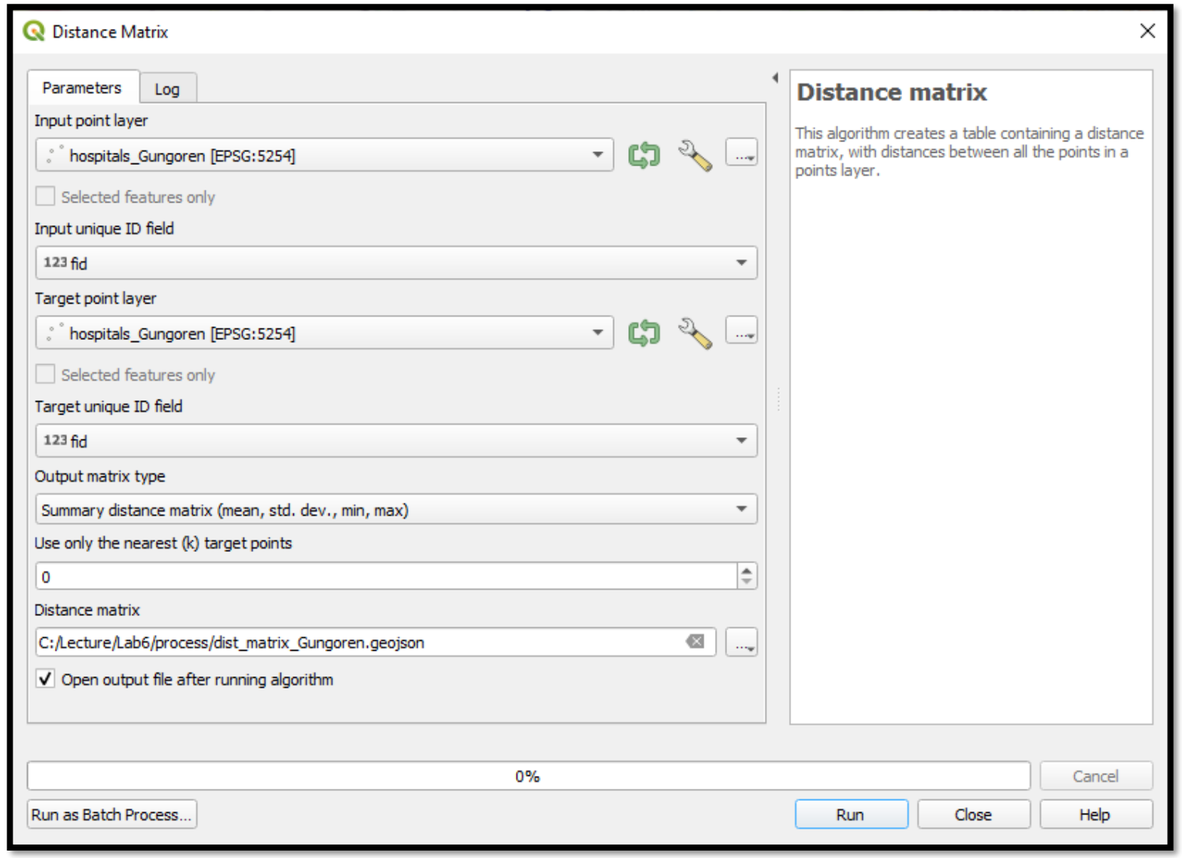
↓

Use mean distances as **weight field** in Mean Coordinate tool

Weighted Mean Center
Euclidean Distance

Implementing the schema for only Gungoren district

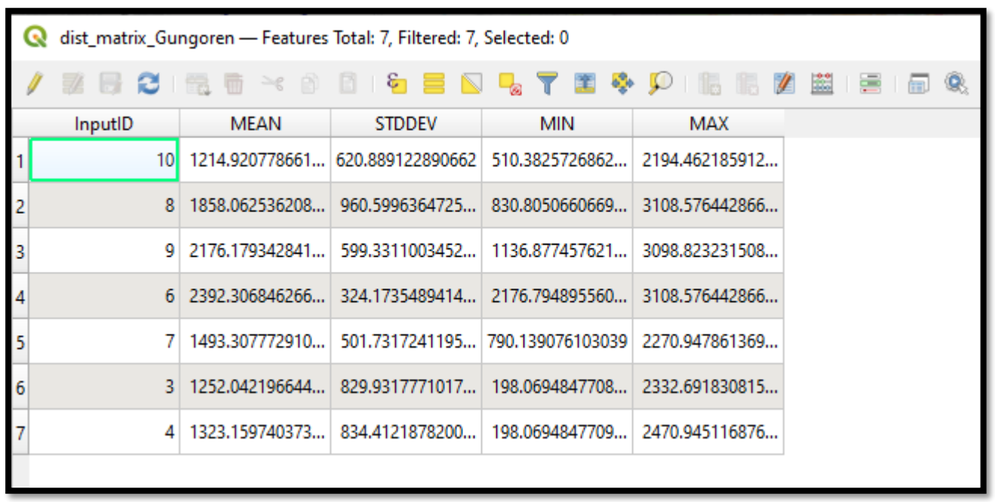




Note: If the following warning is encountered

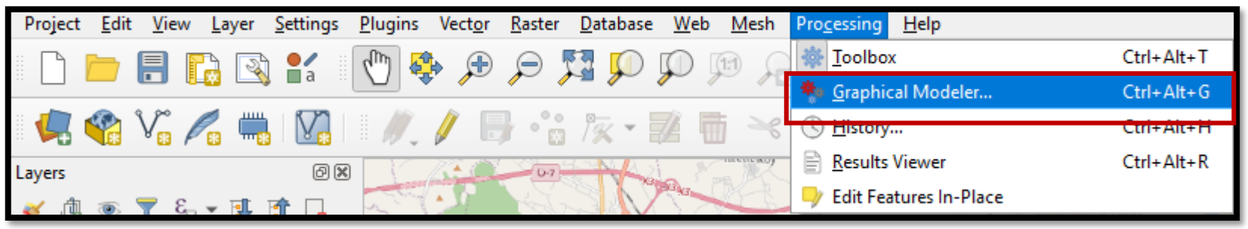
Input point layer is a MultiPoint layer - first convert to single points before using this algorithm.
Execution failed after 0.07 seconds

Use **Multipart to Singlepart** tool to fix the problem

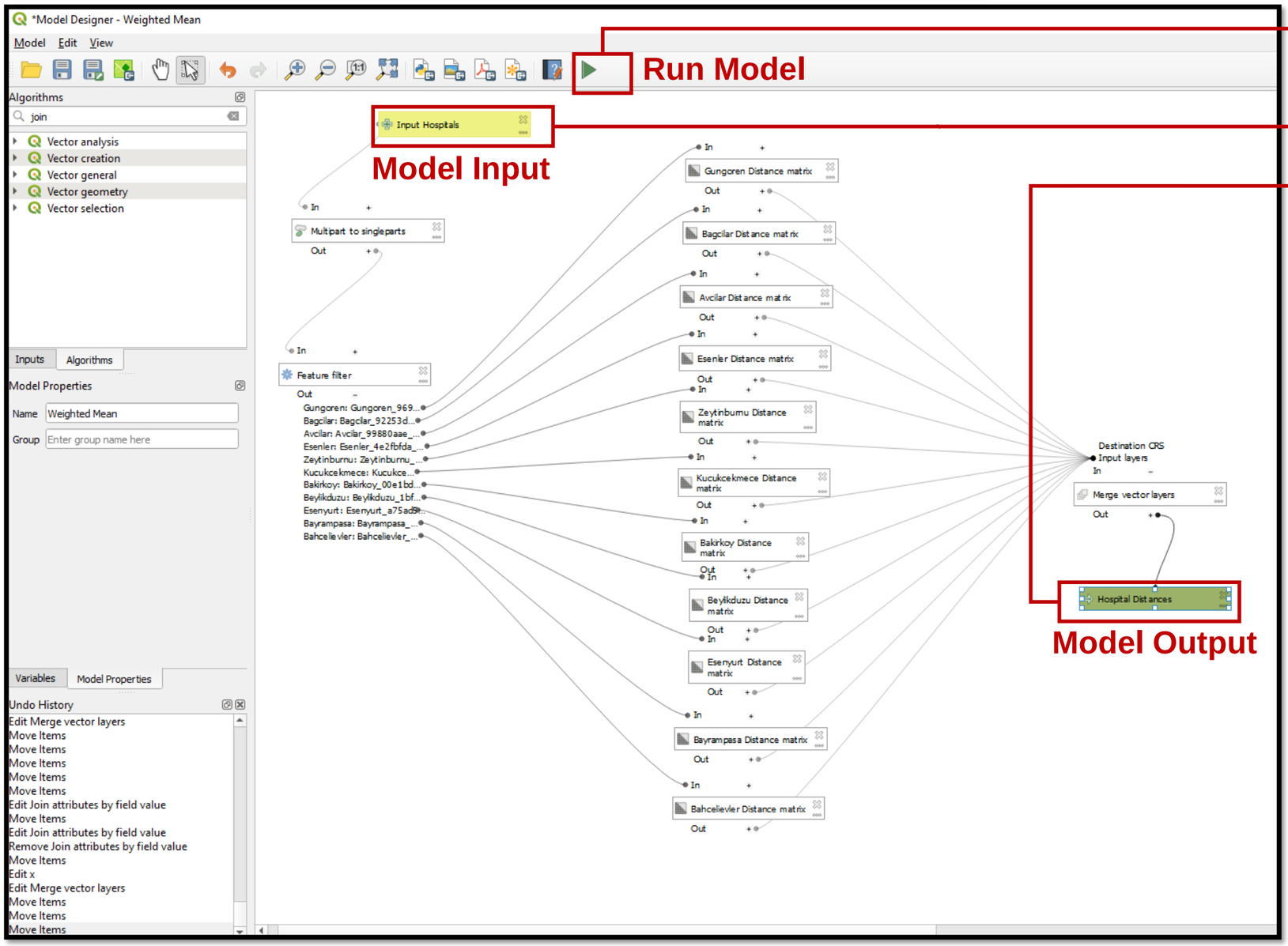


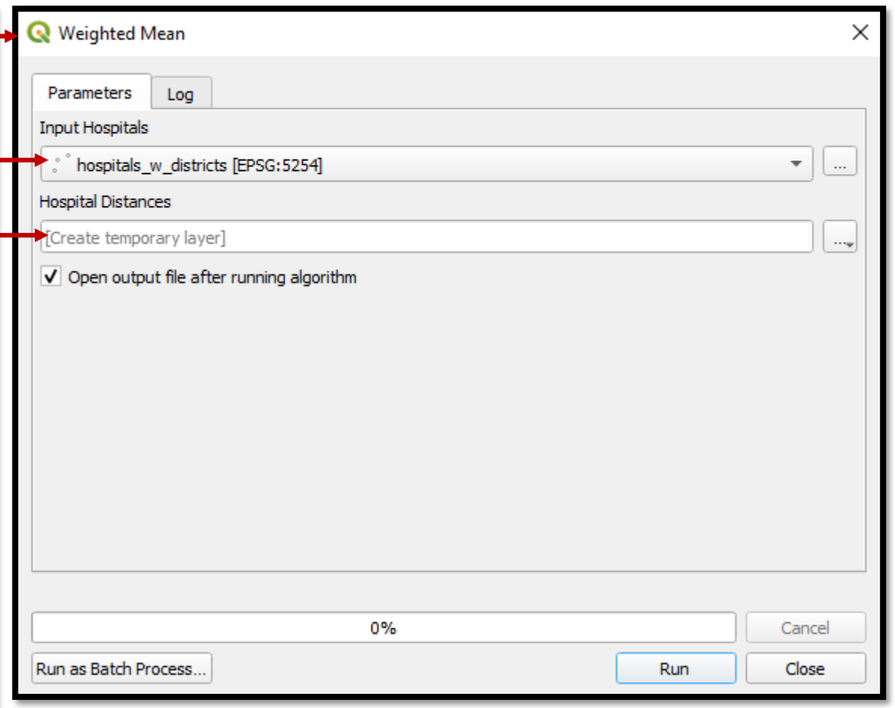
	InputID	MEAN	STDDEV	MIN	MAX
1	10	1214.920778661...	620.889122890662	510.3825726862...	2194.462185912...
2	8	1858.062536208...	960.5996364725...	830.8050660669...	3108.576442866...
3	9	2176.179342841...	599.3311003452...	1136.877457621...	3098.823231508...
4	6	2392.306846266...	324.1735489414...	2176.794895560...	3108.576442866...
5	7	1493.307772910...	501.7317241195...	790.139076103039	2270.947861369...
6	3	1252.042196644...	829.9317771017...	198.0694847708...	2332.691830815...
7	4	1323.159740373...	834.4121878200...	198.0694847709...	2470.945116876...

Using QGIS Graphical Modeler

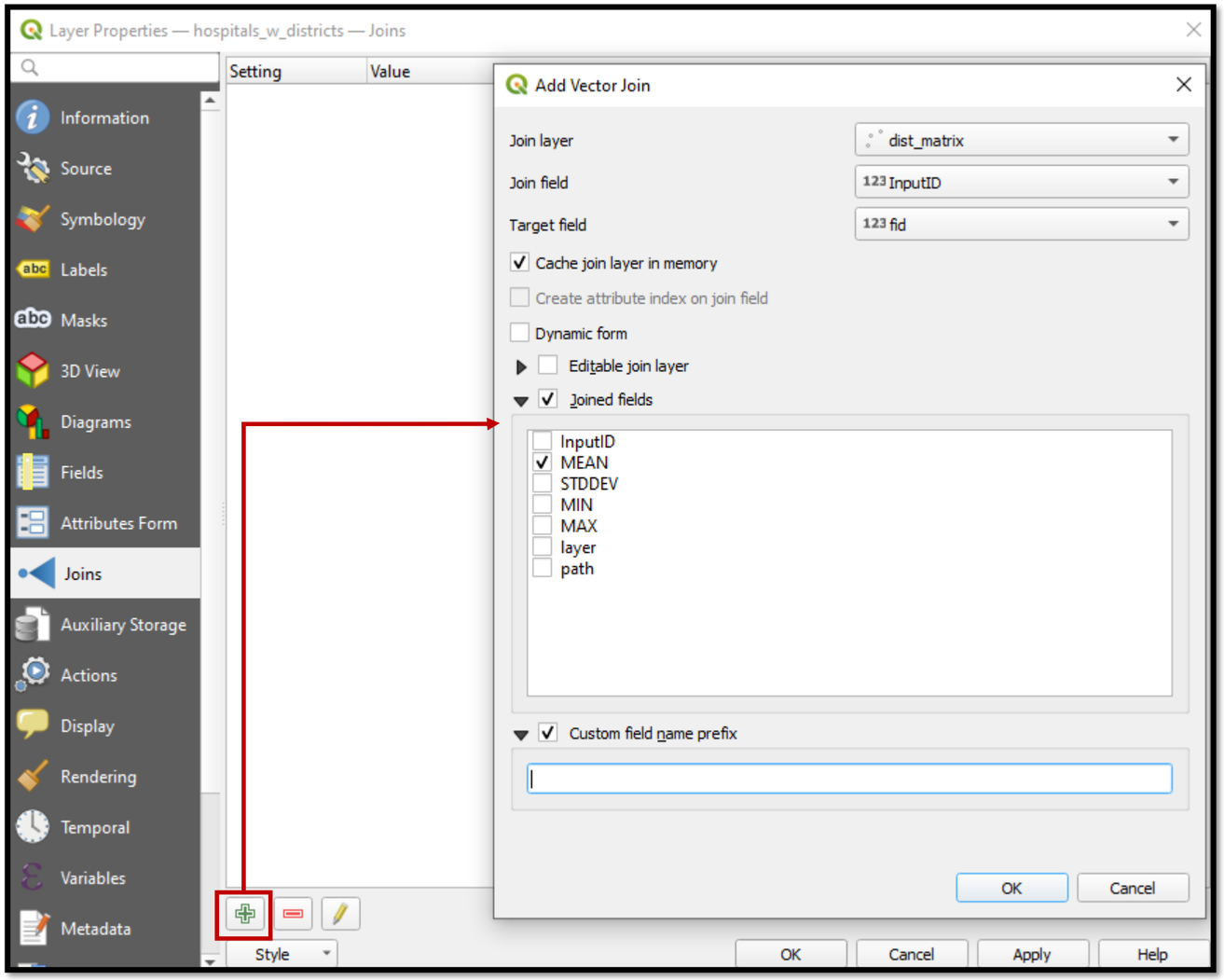


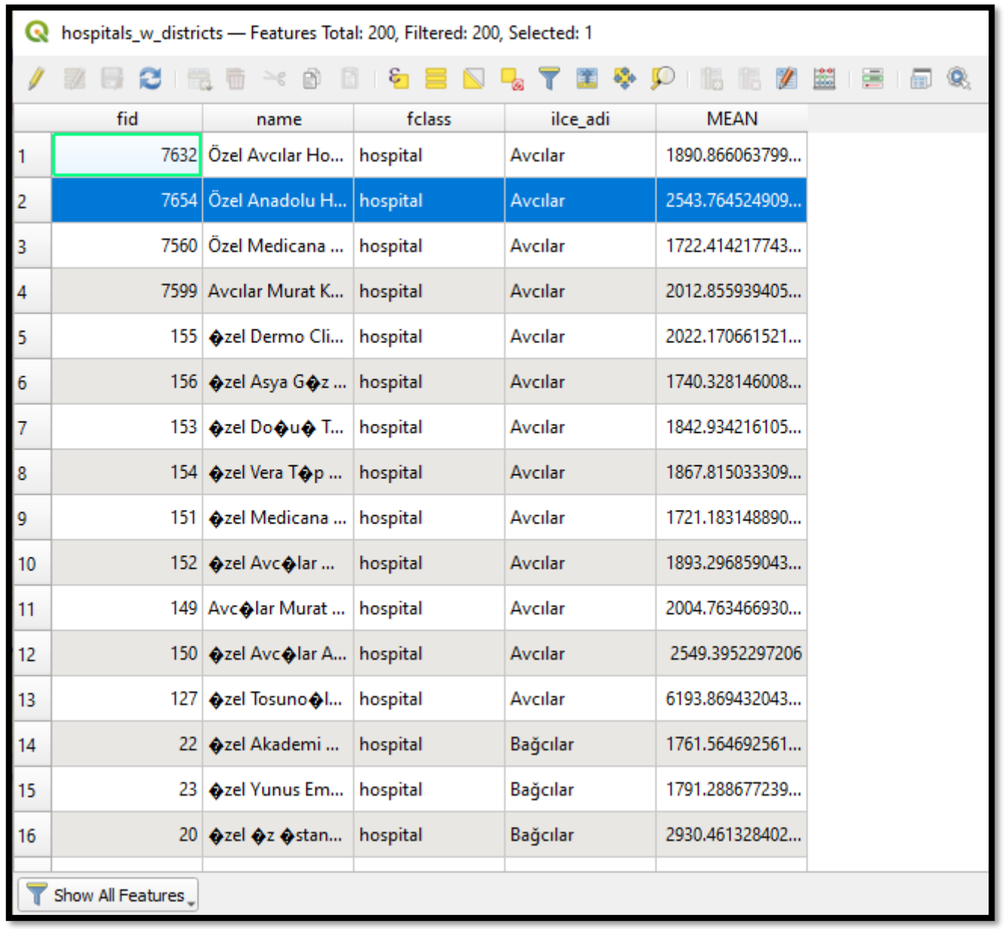
To implement the model for each district, QGIS Graphical Modeler can be used.





Join Result





hospitals_w_districts — Features Total: 200, Filtered: 200, Selected: 1

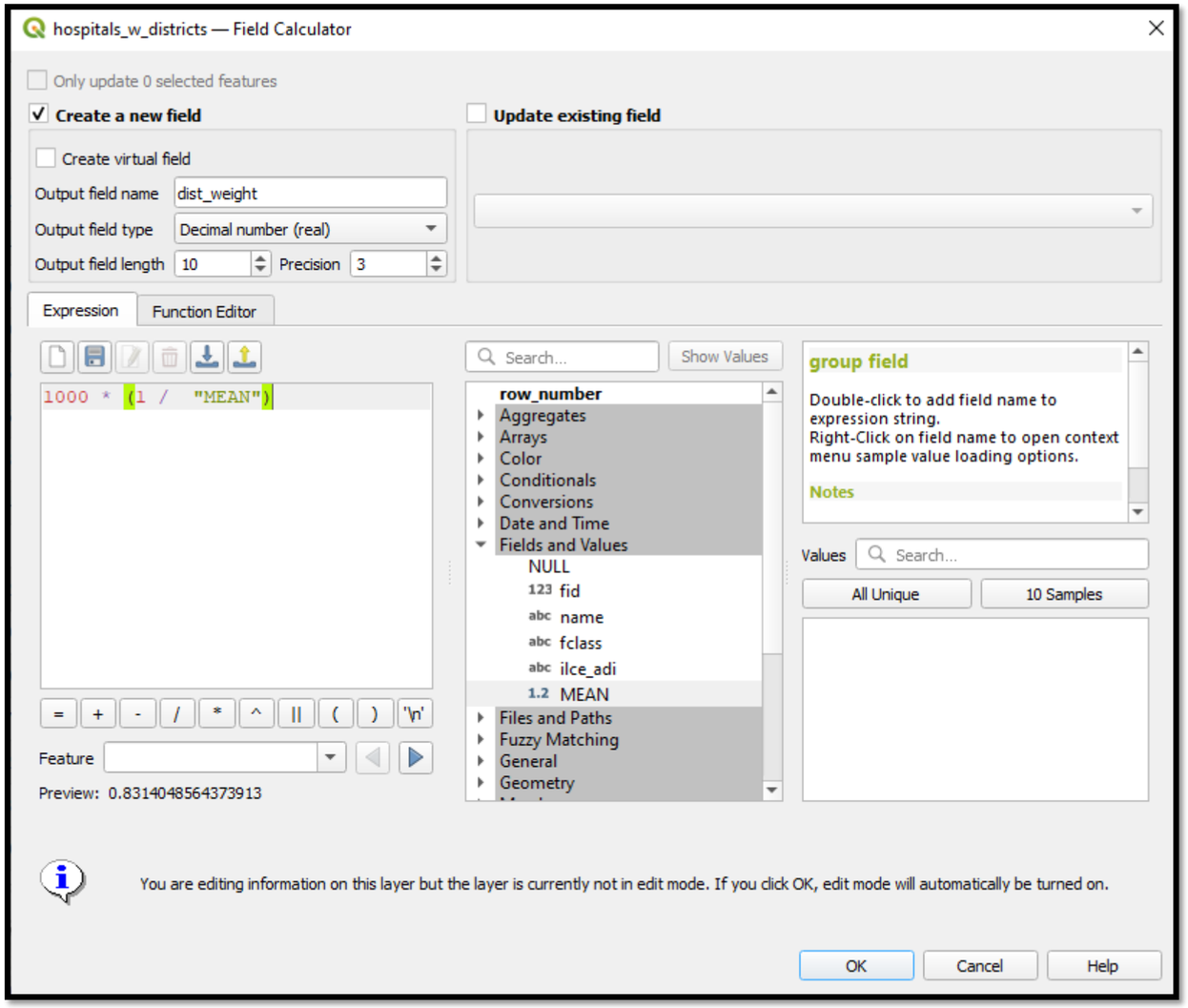
	fid	name	fclass	ilce_adi	MEAN
1	7632	Özel Avcılar Ho...	hospital	Avcılar	1890.866063799...
2	7654	Özel Anadolu H...	hospital	Avcılar	2543.764524909...
3	7560	Özel Medicana ...	hospital	Avcılar	1722.414217743...
4	7599	Avcılar Murat K...	hospital	Avcılar	2012.855939405...
5	155	özel Dermo Cli...	hospital	Avcılar	2022.170661521...
6	156	özel Asya G&z ...	hospital	Avcılar	1740.328146008...
7	153	özel Do&u& T...	hospital	Avcılar	1842.934216105...
8	154	özel Vera T&p ...	hospital	Avcılar	1867.815033309...
9	151	özel Medicana ...	hospital	Avcılar	1721.183148890...
10	152	özel Avc&lar ...	hospital	Avcılar	1893.296859043...
11	149	Avc&lar Murat ...	hospital	Avcılar	2004.763466930...
12	150	özel Avc&lar A...	hospital	Avcılar	2549.3952297206
13	127	özel Tosuno&l...	hospital	Avcılar	6193.869432043...
14	22	özel Akademi ...	hospital	Bağcılar	1761.564692561...
15	23	özel Yunus Em...	hospital	Bağcılar	1791.288677239...
16	20	özel &z &stan...	hospital	Bağcılar	2930.461328402...

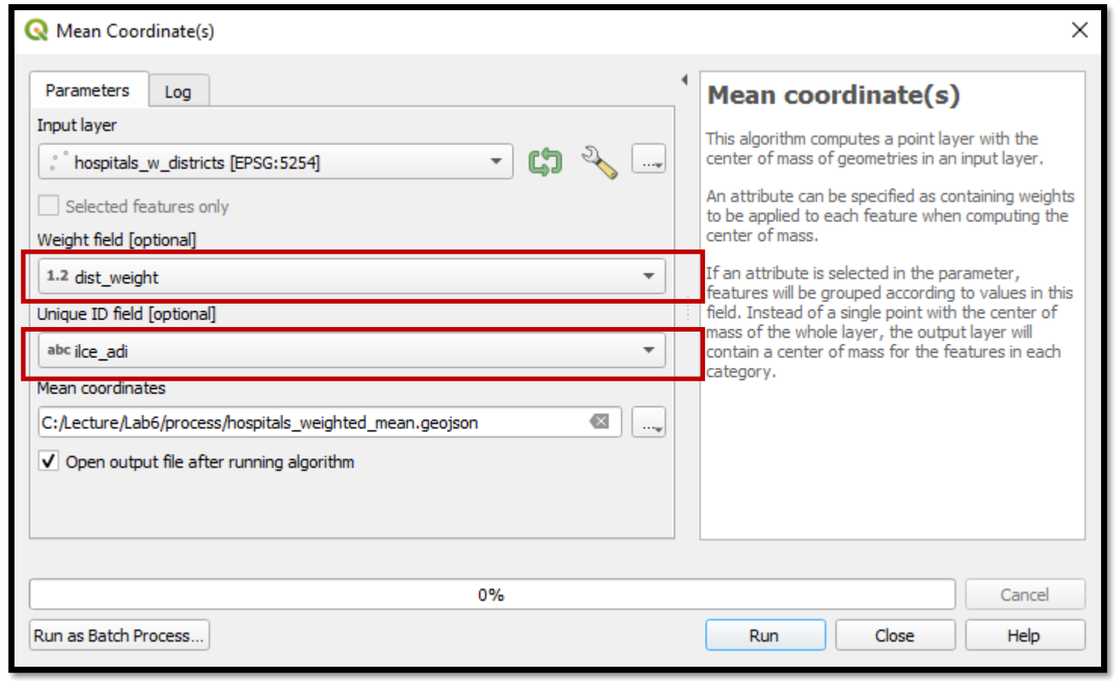
Show All Features

Distances between hospitals for each districts are calculated separately

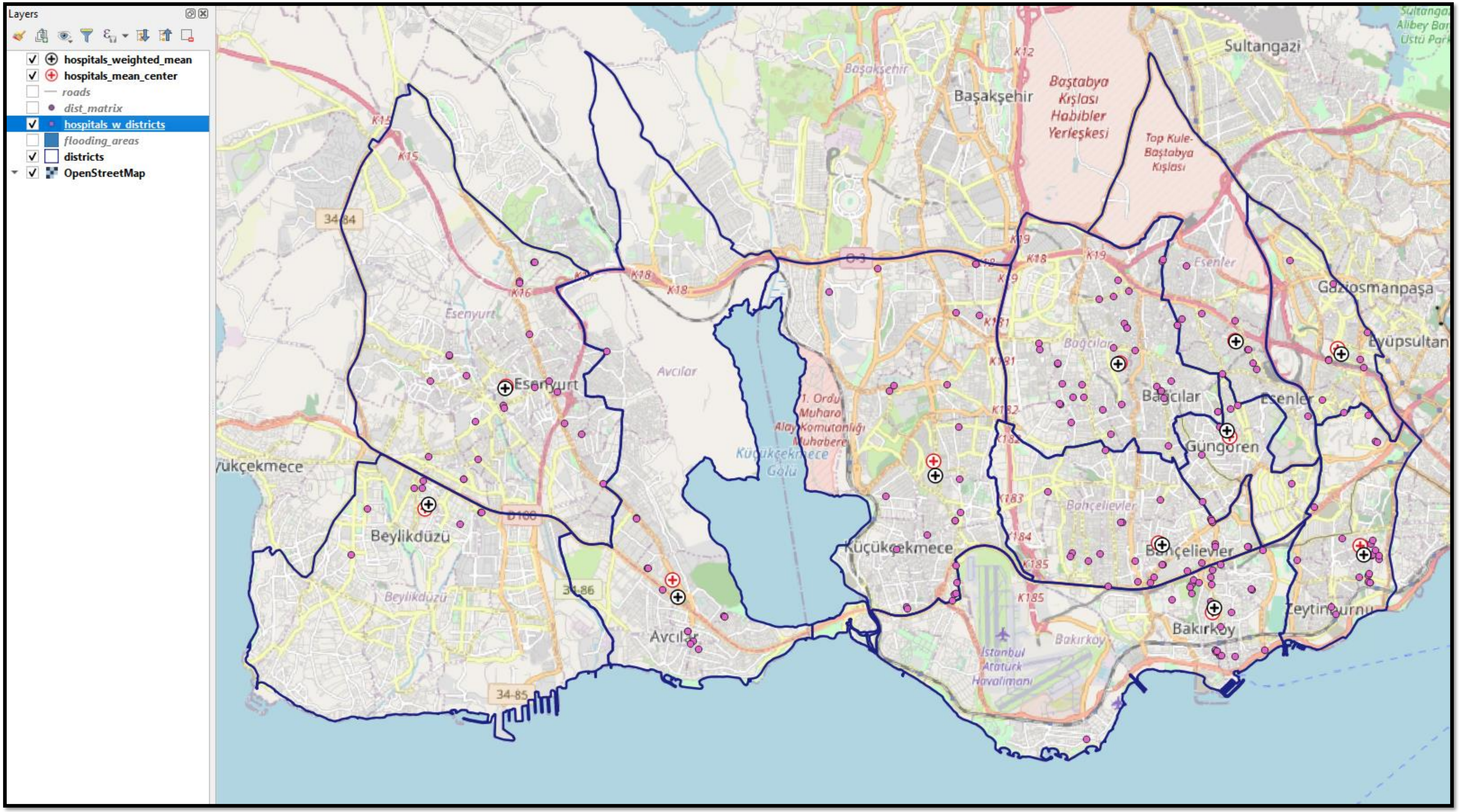
Weighted Mean Center
Euclidean Distance

Creating the inverse distance weight attribute by using **1000 * (1 / MEAN)** formula (1000 multiplier is for discarding the decimal numbers)





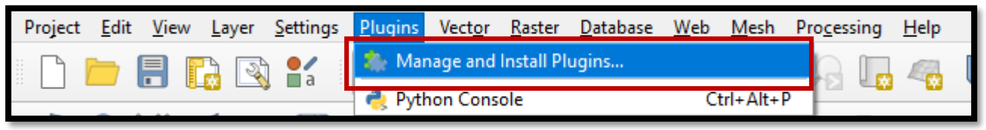
Weighted Mean Center
Euclidean Distance



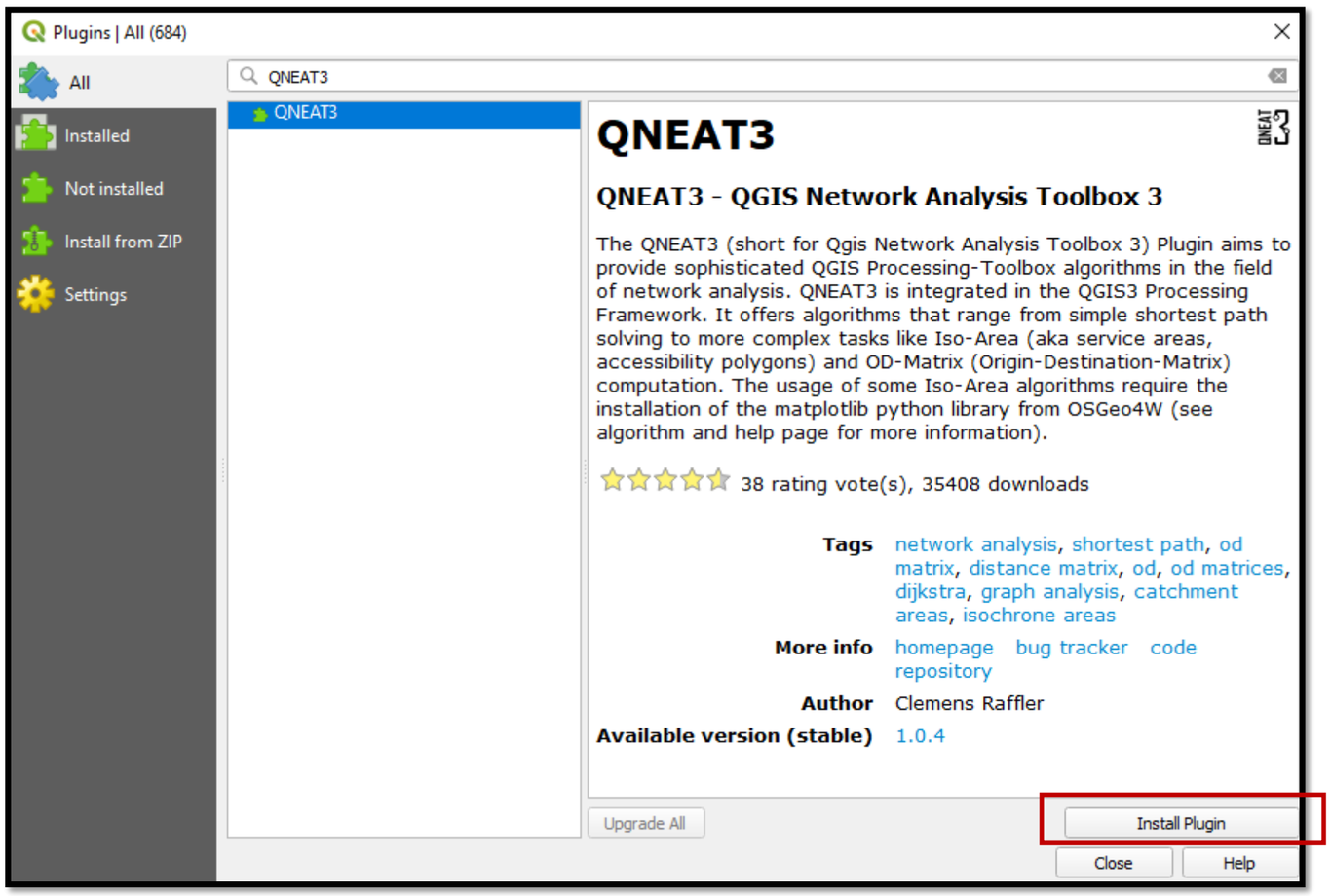
Weighted Mean Center
Network Distance

Weighted Mean Center: The geographic center of a set of points as adjusted for the influence of a value (distance, time, cost, attribute etc.) associated with each point

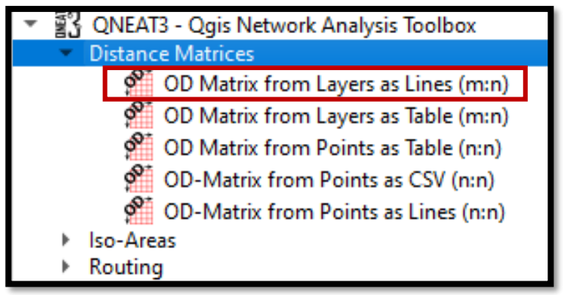
Network Distance



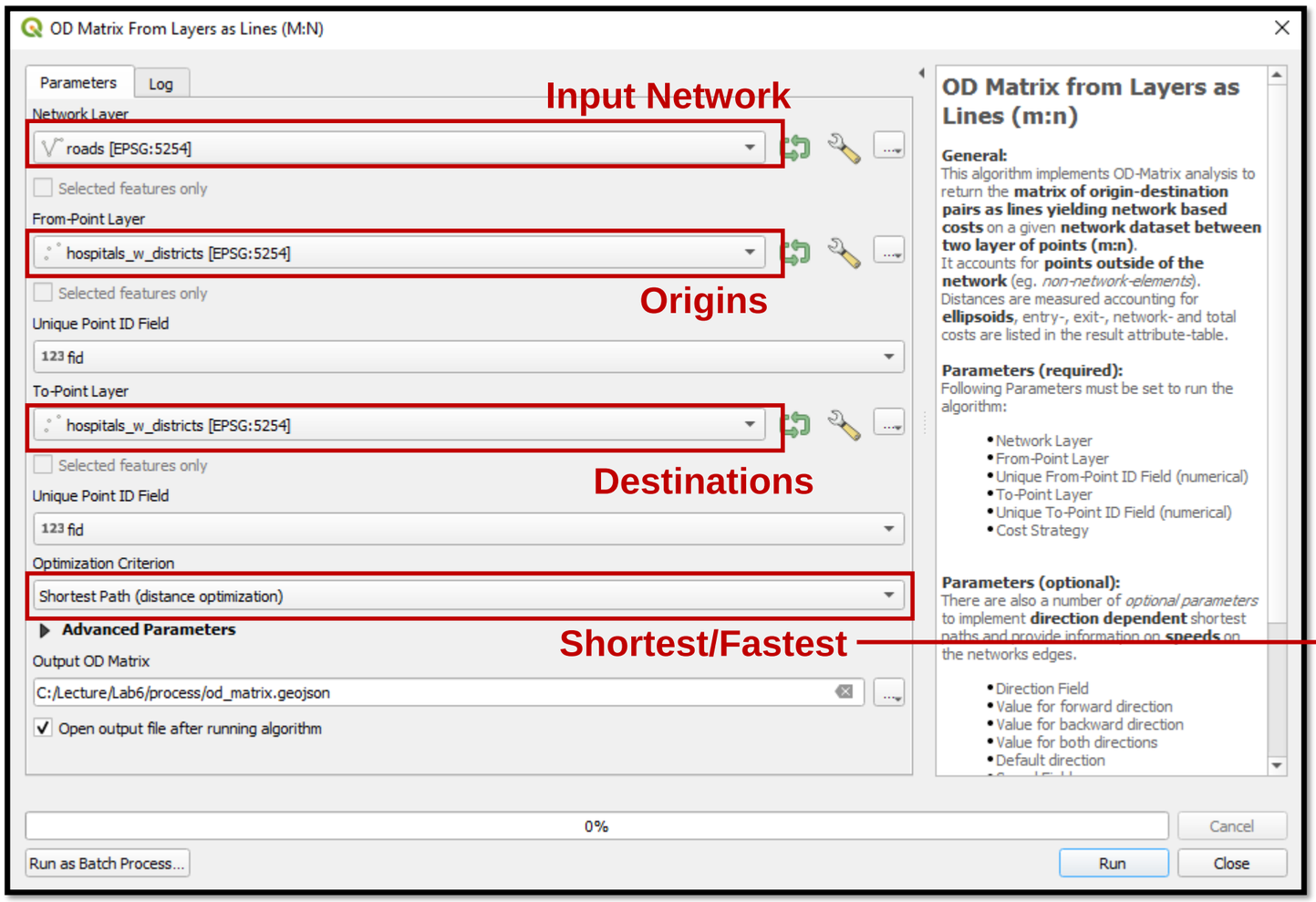
To calculate network distances, **QNEAT3** plugin is needed.



For this concept, network distance between hospitals will be calculated to add them as weight fields

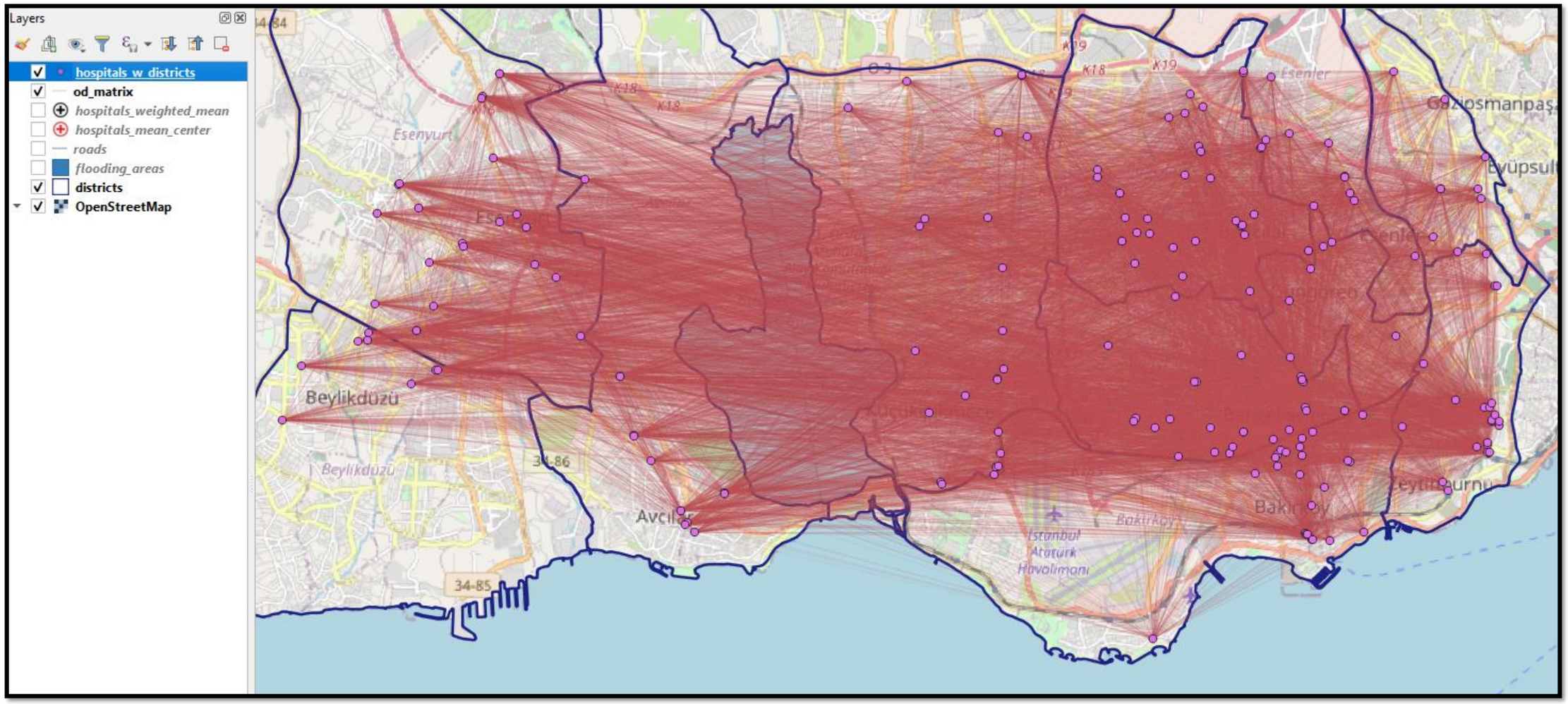


Weighted Mean Center
Network Distance



To implement the time based network analysis, speed information for roads should be specified as km/h in the data's attributes

Weighted Mean Center Network Distance



- Result of the analysis is shown as straight lines in QGIS. However the distance values in the attributes is calculated as network distances.
- Distances are calculated from each point to every point (For 200 hospitals, 200x200-40000 distance values are calculated)

Weighted Mean Center
Network Distance

- For further analysis, we need to summarize the results to show and represent each point's mean distance to other points.
- To do that the result layer need to be imported into PostGIS and SQL queries need to be used.

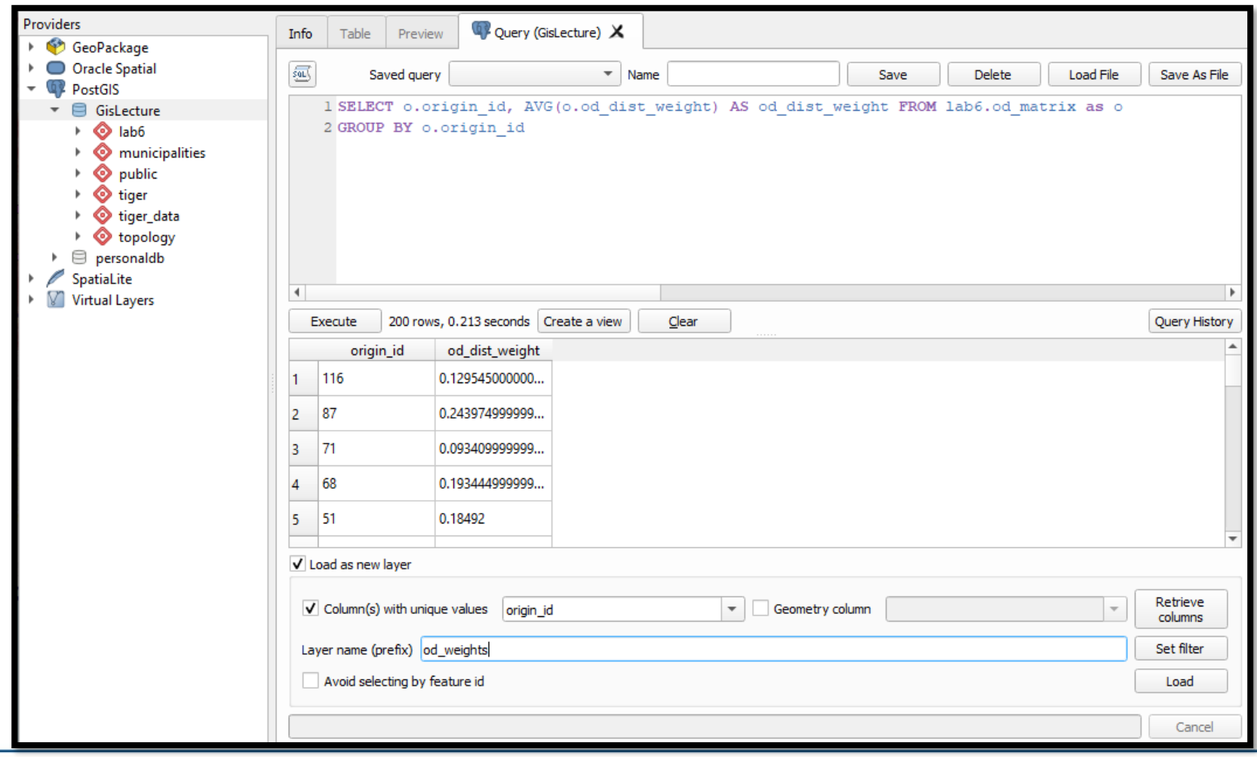
od_matrix — Features Total: 40000, Filtered: 40000, Selected: 0

123 origin_id = ε

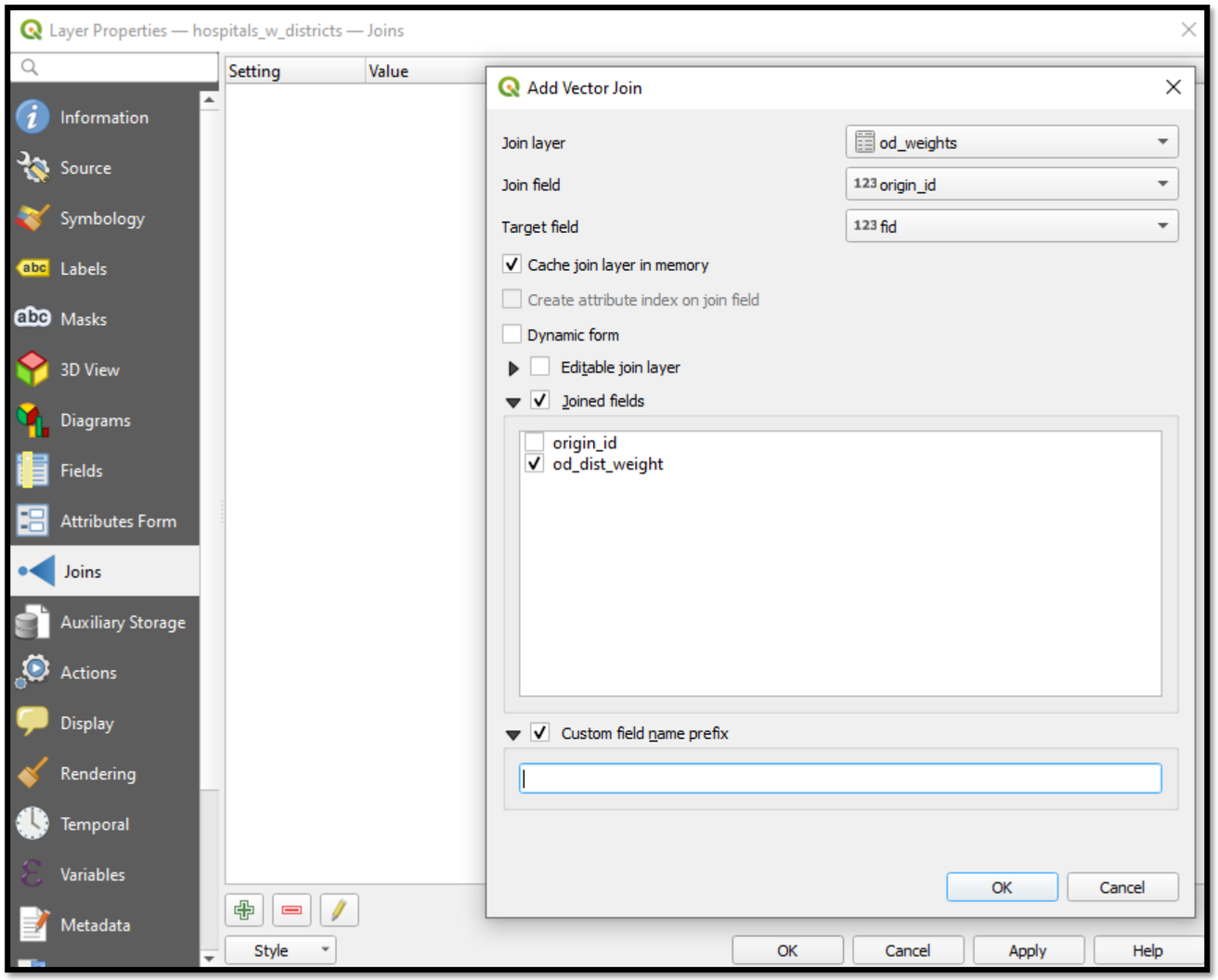
	origin_id	destination_id	entry_cost	network_cost	exit_cost	total_cost	od_dist_weight
1	3	3	NULL	NULL	NULL	NULL	NULL
2	3	4	33.0490725	318.3830214	12.3222732	363.7543672	2.749
3	3	6	33.0490725	2816.5507788	8.9807673	2858.5806187	0.35
4	3	7	33.0490725	1436.8120587	16.9347851	1486.7959164	0.673
5	3	8	33.0490725	1004.819855	9.1113386	1046.9802661	0.955
6	3	9	33.0490725	2843.1389409	7.5146746	2883.7026881	0.347
7	3	10	33.0490725	535.130288	16.3564384	584.535799	1.711
8	3	11	33.0490725	2322.0319138	8.1430755	2363.2240619	0.423
9	3	18	33.0490725	2822.0402772	10.2911806	2865.3805304	0.349
10	3	29	33.0490725	2692.1094617	28.977866	2754.1364003	0.363
11	3	32	33.0490725	1775.0087868	7.2285856	1815.2864449	0.551
12	3	33	33.0490725	1687.7779346	12.9996272	1733.8266343	0.577
13	3	35	33.0490725	2514.129174	11.5639442	2558.7421907	0.391
14	3	38	33.0490725	4003.2950695	7.7365767	4044.0807188	0.247
15	3	39	33.0490725	1404.9177432	9.6380955	1447.6049113	0.691

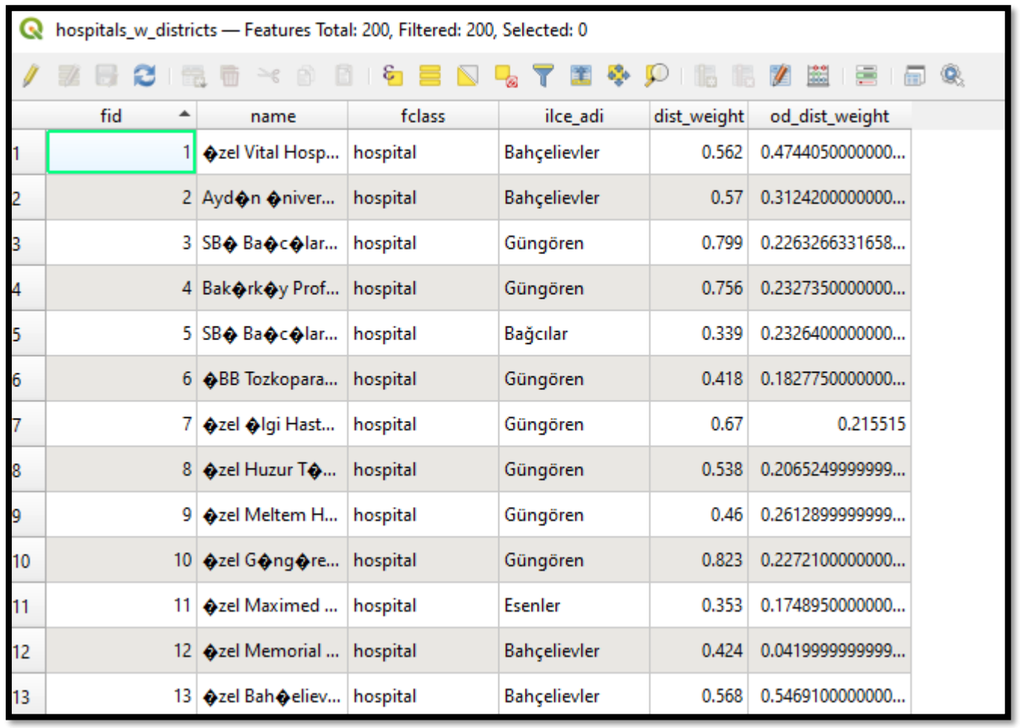
Show All Features

- First, create the inverse distance weight attribute by using **1000 * (1 / total_cost)** formula (1000 multiplier is for discarding the decimal numbers)
- Import od_matrix into PostGIS lab6 schema and run the following SQL query

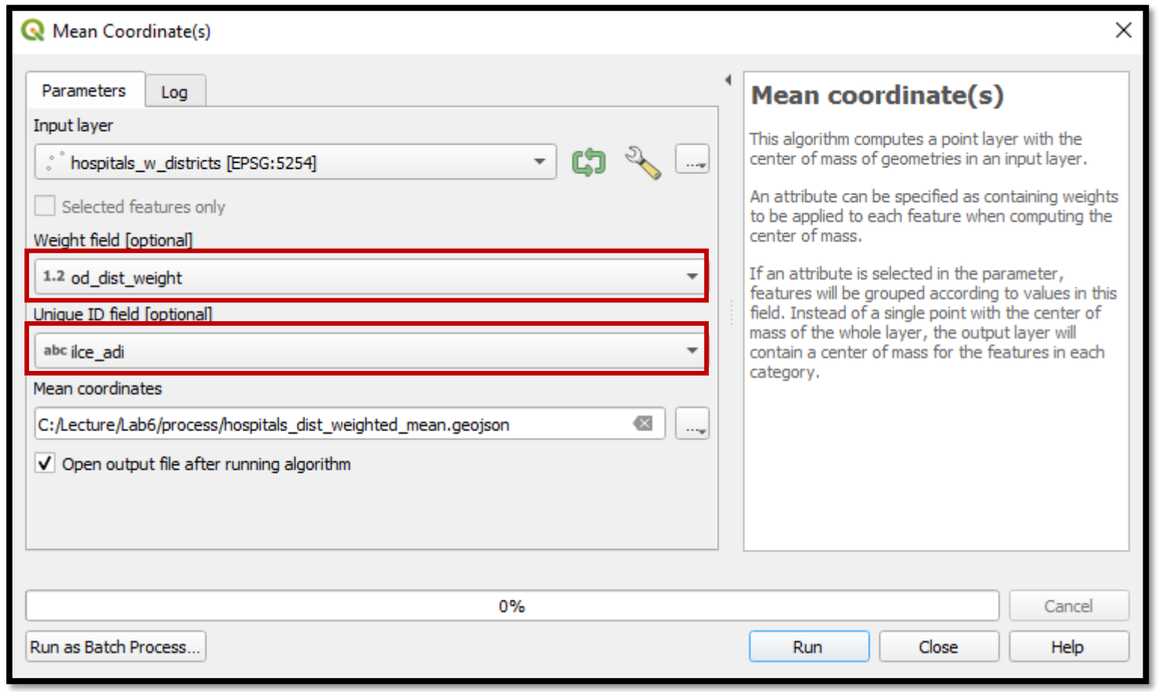


Join Result



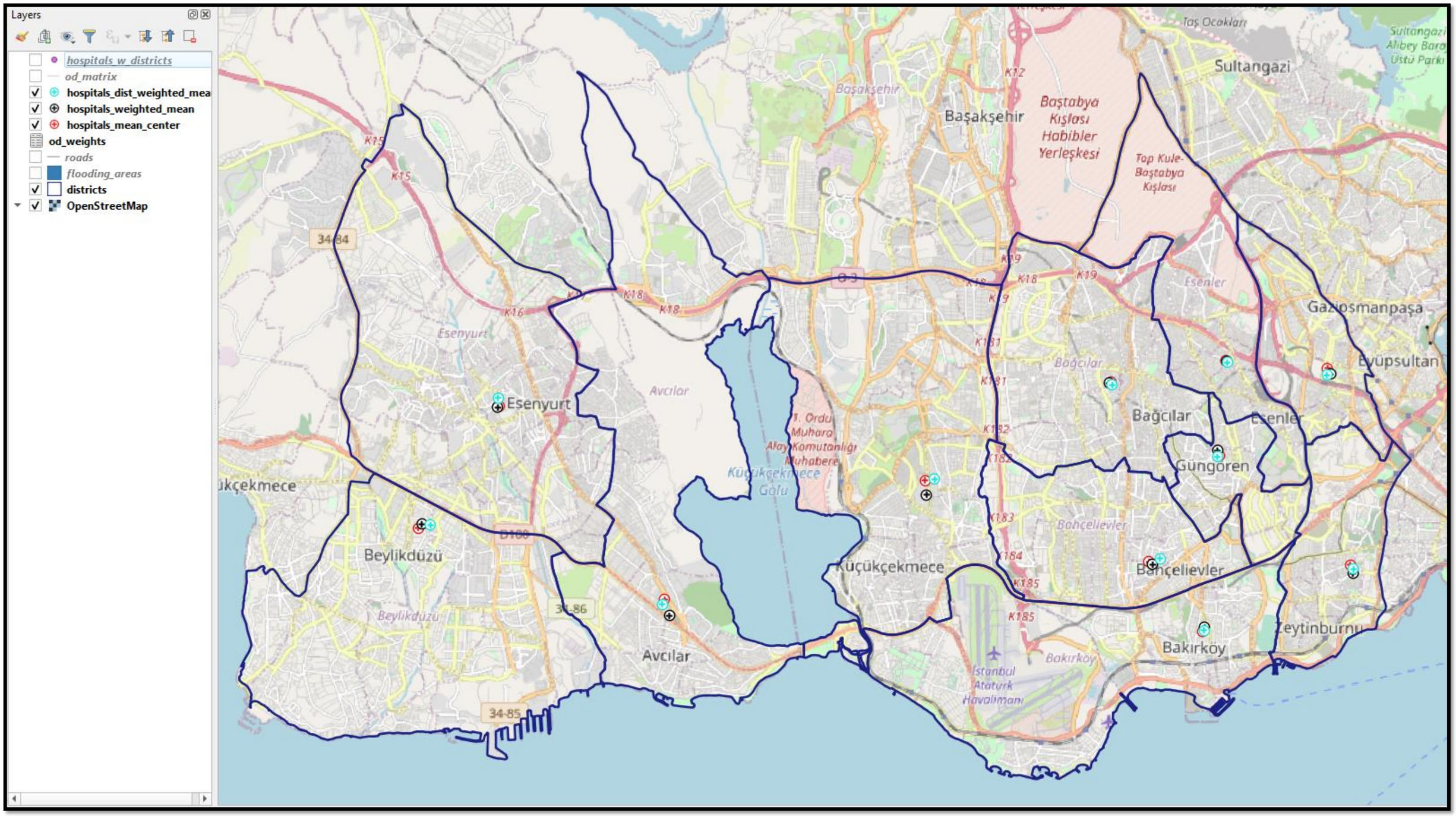


	fid	name	fclass	ilce_adi	dist_weight	od_dist_weight
1	1	Özel Vital Hosp...	hospital	Bahçelievler	0.562	0.4744050000000...
2	2	Aydın Üniver...	hospital	Bahçelievler	0.57	0.3124200000000...
3	3	SBÜ Bağcılar...	hospital	Güngören	0.799	0.2263266331658...
4	4	Bakırköy Prof...	hospital	Güngören	0.756	0.2327350000000...
5	5	SBÜ Bağcılar...	hospital	Bağcılar	0.339	0.2326400000000...
6	6	İBB Tozkopara...	hospital	Güngören	0.418	0.1827750000000...
7	7	Özel Ilgi Hast...	hospital	Güngören	0.67	0.215515
8	8	Özel Huzur TÜ...	hospital	Güngören	0.538	0.2065249999999...
9	9	Özel Meltem H...	hospital	Güngören	0.46	0.2612899999999...
10	10	Özel Güngören...	hospital	Güngören	0.823	0.2272100000000...
11	11	Özel Maximed ...	hospital	Esenler	0.353	0.1748950000000...
12	12	Özel Memorial ...	hospital	Bahçelievler	0.424	0.0419999999999...
13	13	Özel Bahçeliev...	hospital	Bahçelievler	0.568	0.5469100000000...



Join the od_matrix results into hospitals and calculate mean centers by using **od_dist_weight** column

Evaluate the Results



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