GRID2DEMAND: A tool for generating zone-to-zone travel demand based on grid zones

1. What is GRID2DEMAND?

GRID2DEMAND is a quick trip generation and distribution tool based on the four-step travel model. First, the research region is divided into grid zones of the same scale. POI nodes are used to generate node production/attraction. Second, trip distribution is achieved by a typical gravity model.

1.1. Data files

Input files are the network files in GMNS format (*node.csv, link.csv, poi.csv*), which can be automatically generated by the OSM2GMNS tool. Node and POI files will be used for generating demand, and *poi.csv* may need manual edition.

Output files are *zone.csv, accessibility.csv, poi_trip_rate.csv,* and *demand.csv*. Final zone-to-zone demand is listed in *demand.csv* with geometry.

1.2. Grid partition

Grids are automatically generated by a given scale of degree or number of zones in the research region. Each grid is regarded as TAZ used for trip generation and distribution. The grid information is stored in *zone.csv*.

1.3. Node demand

All types of POI nodes are collected from *poi.csv*. The values of production and attraction under each trip purpose and POI type are defined by default or by users. Therefore, the production and attraction values of each node can be calculated. The POI node production/attraction rates used in the model are summarized in *poi_trip_rate.csv*. The node information is updated in *node.csv*.

1.4. Accessibility

Accessibility is measured by zone-to-zone distance according to zone centroid coordinates. A degree at different latitudes represents different lengths on a flat surface. According to a given latitude, the closest latitude in the following table is selected to calculate the longitudinal length.

Longitudinal length equivalents at selected latitudes

Latitude	City	Degree	Minute	Second	±0.0001°
60°	Saint Petersburg	55.80 km	0.930 km	15.50 m	5.58 m
51° 28′ 38″ N	Greenwich	69.47 km	1.158 km	19.30 m	6.95 m
45°	Bordeaux	78.85 km	1.31 km	21.90 m	7.89 m
30°	New Orleans	96.49 km	1.61 km	26.80 m	9.65 m
0°	Quito	111.3 km	1.855 km	30.92 m	11.13 m

1.5. Gravity model

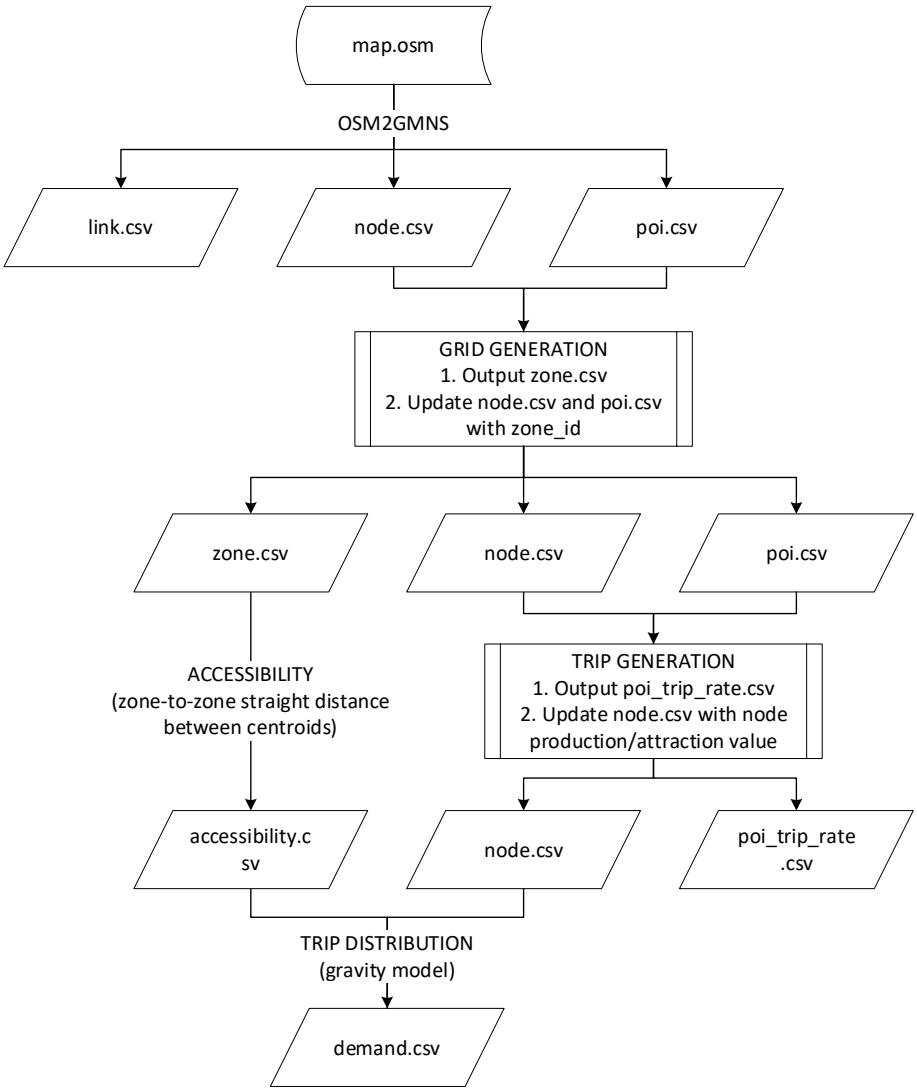
For each OD pair, a typical gravity model is applied to calculate zone-to-zone demand volume.

$$T_{ij} = P_i \cdot \frac{A_j \cdot F_{ij} \cdot K_{ij}}{\sum_j (A_j \cdot F_{ij} \cdot K_{ij})}$$

$$F_{ij} = e^{\beta d_{ij} - g}$$

where T_{ij} is total trips from zone i to zone j; P_i, A_j are productions in zone i and attractions in zone j, respectively; F_{ij} is the friction factor for travel from zone i to zone j ; K_{ij} is the correction factor for travel from zone i to zone j, equal to 1 by default; parameter β is equal to -0.1 by default; parameter g is equal to 0 by default.

The framework of GRID2DEMAND is illustrated in the following figure.

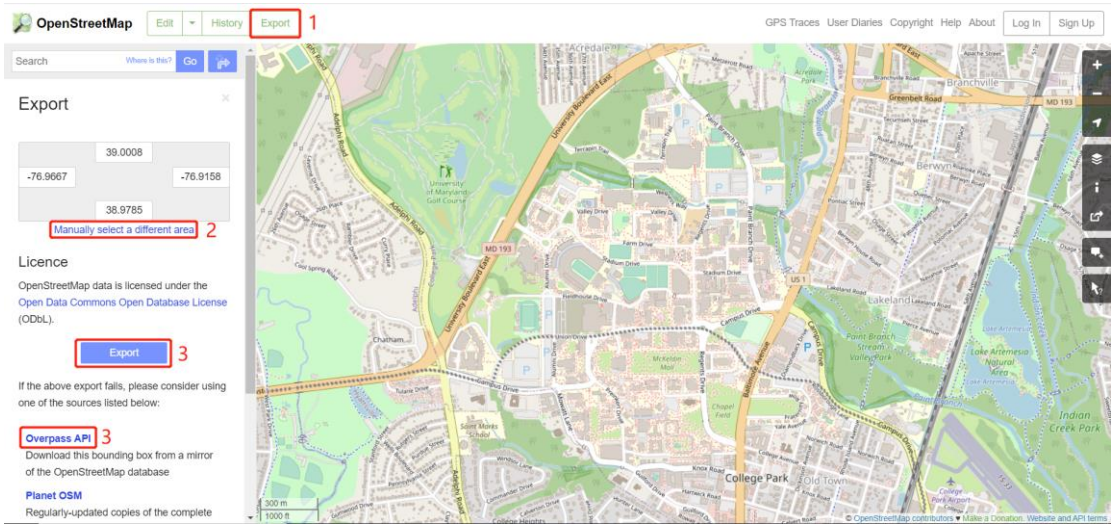


2. How to use GRID2DEMAND?

We will use University of Maryland, College Park as an example to illustrate how to use GRID2DEMAND.

Step 1: Determine the research boundary and download .osm file from OpenStreetMap

Adjust the map to the location of interest and click on the Export[1] button on the top.



Then, obtain the latitude and longitude coordinates (users can manually select a different area[2]). Lastly, click on the Export[3] button found in the middle of the navigator to download an OSM data file. For a very large area of interest, users need to click the link of "Overpass API" to obtain a map file.

map.osm	12/22/2020 3:52 PM	OSM File	380,703 KB

Step 2: Execute OSM2GMNS to get network files in GMNS format

Open the Python IDE such as Pycharm for a typical configuration. Then, OSM2GMNS converts *map.osm* file in OSM format into a network file in GMNS format.

```
import osm2gmns as og
net = og.getNetFromOSMFile(r'map.osm',network_type=('railway','aeroway','auto','walk','bike'),\
                           POIs=True,default_lanes=True,default_speed=True)
og.connectPOIWithNet(net)
og.outputNetToCSV(net, output_folder)
```

link	12/27/2020 8:55 PM	Microsoft Excel Co...	370 KB
node	12/27/2020 8:56 PM	Microsoft Excel Co...	75 KB
poi	12/27/2020 8:56 PM	Microsoft Excel Co...	108 KB

Please note that *poi.csv* may need to be edited manually in case of information loss。

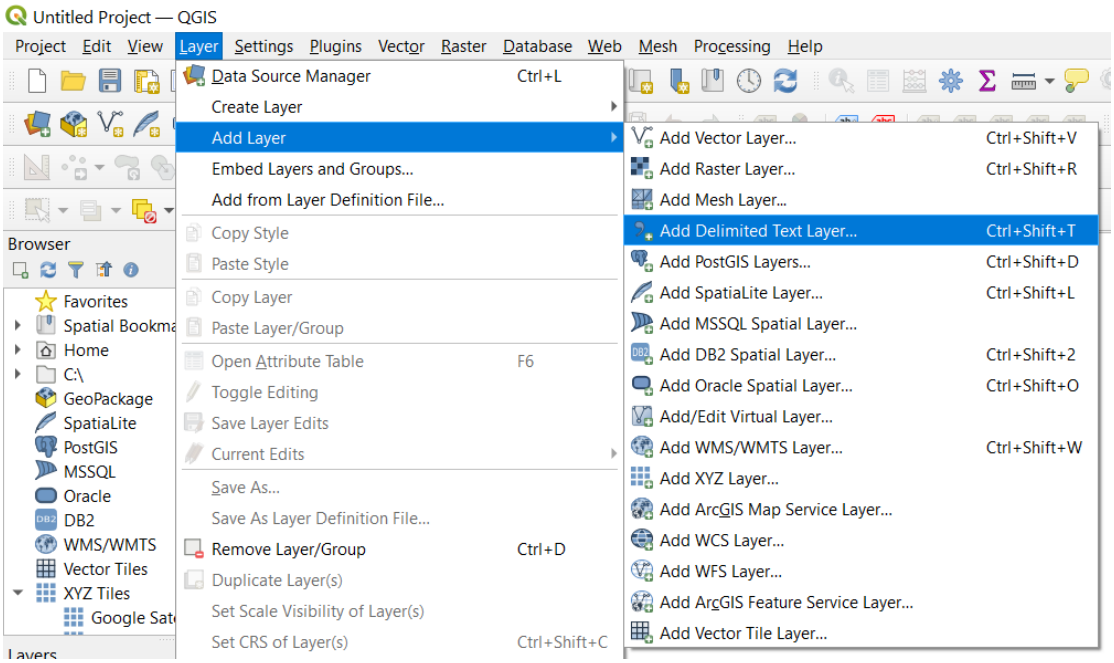
Step 3: Execute GRID2DEMAND Python code

Configurate working dictionary in the Python IDE (e.g., Pycharm). Then, execute GRID2DEMAND to get zone-to-zone demand, generating four files which are highlighted in blue.

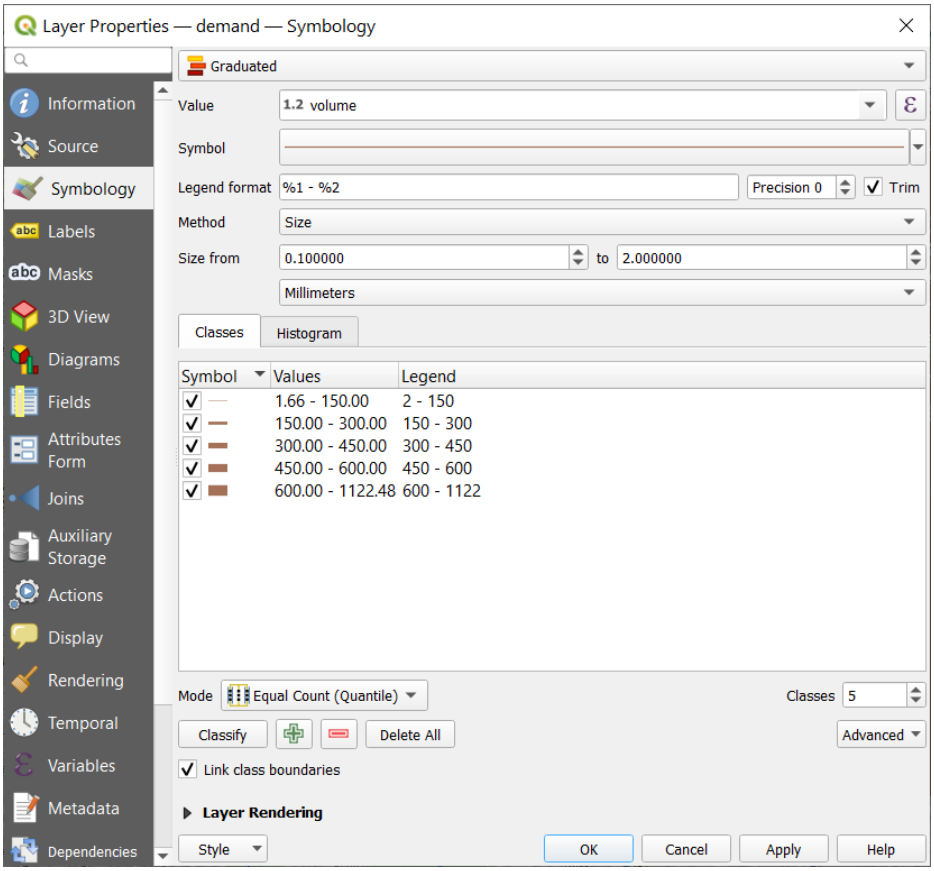
accessibility	12/27/2020 8:54 PM	Microsoft Excel Co...	277 KB
demand	12/27/2020 8:54 PM	Microsoft Excel Co...	322 KB
node	12/27/2020 8:54 PM	Microsoft Excel Co...	667 KB
poi	12/27/2020 8:54 PM	Microsoft Excel Co...	944 KB
poi_trip_rate	12/27/2020 8:54 PM	Microsoft Excel Co...	2 KB
zone	12/27/2020 8:54 PM	Microsoft Excel Co...	8 KB
link	12/25/2020 10:54 AM	Microsoft Excel Co...	2,965 KB

Step 4: Visualization in QGIS

Open QGIS and add Delimited Text Layer of the output files.



Then Open the Properties window of the demand layer. Set the symbology as graduated symbols by size.



Zone-to-zone demand can be visualized with a base map.


Paint Branch
US 1
Metzerott Road
Bridgewater Street
Yoker Street
University Boulevard East
Greenbelt
Tecumseh Street
Berwyn Road
Adelphi Road
Lakeland
Paint Branch Stream Valley Park
Campus Drive
Norwich Road
Calvert Road
College Heights Estates
Rosemary Lane
Wells Parkway
Tamarack Place
Adelphi
College Park