

# **Geografski informacioni sistemi**

## **OSM, PostGIS QGIS, OpenLayers i SUMO**

**Andrija Tošić 1711**

# Setup

- homebrew: postgresql, qgis, pgadmin4, beekeeper-studio, timescaledb
- <https://download.geofabrik.de/europe-serbia-latest.osm.pbf> (184 MB)
- CREATE DATABASE osm;
- CREATE EXTENSION postgis;
- osm2pgsql -c -d osm -U postgres -H localhost projects/gis/srbia-latest.osm.pbf

# Uvežene tabele

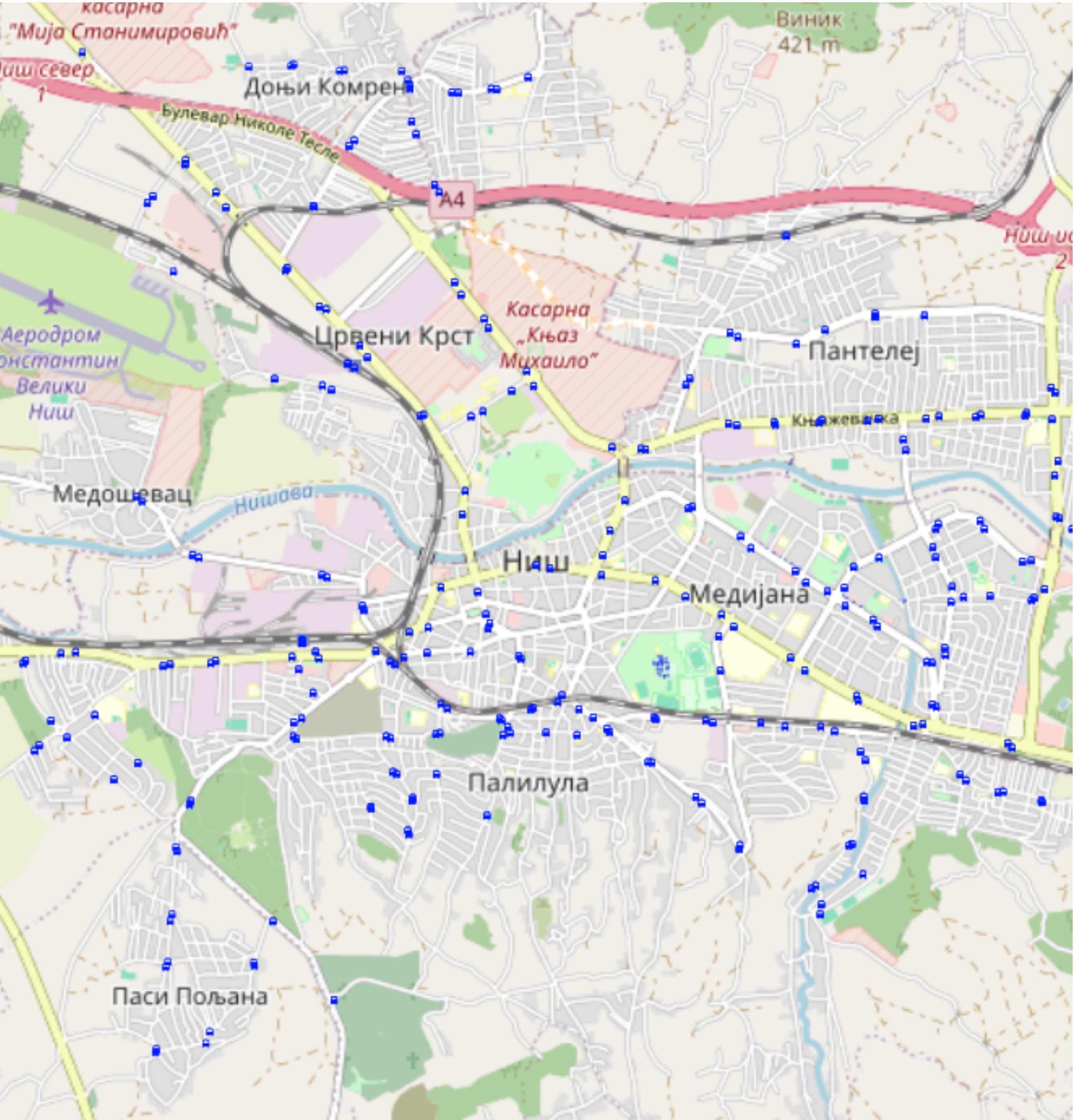
ENTITIES 1307

- ✓ public
  - emission\_output
  - fcd\_output
  - fcd\_output\_old
  - osm2pgsql\_properties
  - planet\_osm\_line
  - planet\_osm\_point
  - planet\_osm\_polygon
  - planet\_osm\_roads

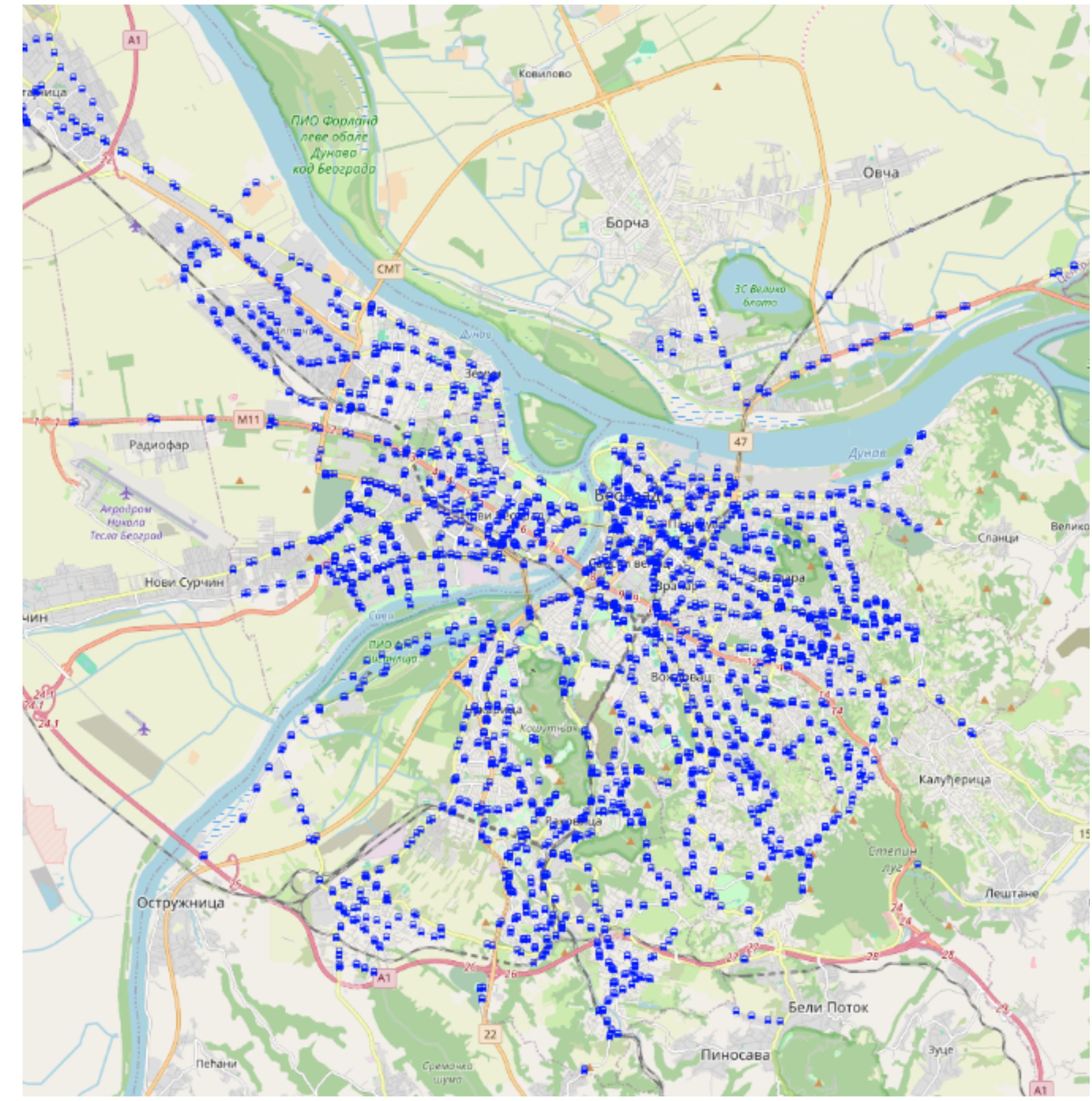
## Columns

Name	Type	Nullable
osm_id	int8(64,0)	<input checked="" type="checkbox"/>
access	text	<input checked="" type="checkbox"/>
addr:housename	text	<input checked="" type="checkbox"/>
addr:housenumber	text	<input checked="" type="checkbox"/>
addr:interpolation	text	<input checked="" type="checkbox"/>
admin_level	text	<input checked="" type="checkbox"/>
aerialway	text	<input checked="" type="checkbox"/>
aeroway	text	<input checked="" type="checkbox"/>
amenity	text	<input checked="" type="checkbox"/>
area	text	<input checked="" type="checkbox"/>
barrier	text	<input checked="" type="checkbox"/>
bicycle	text	<input checked="" type="checkbox"/>

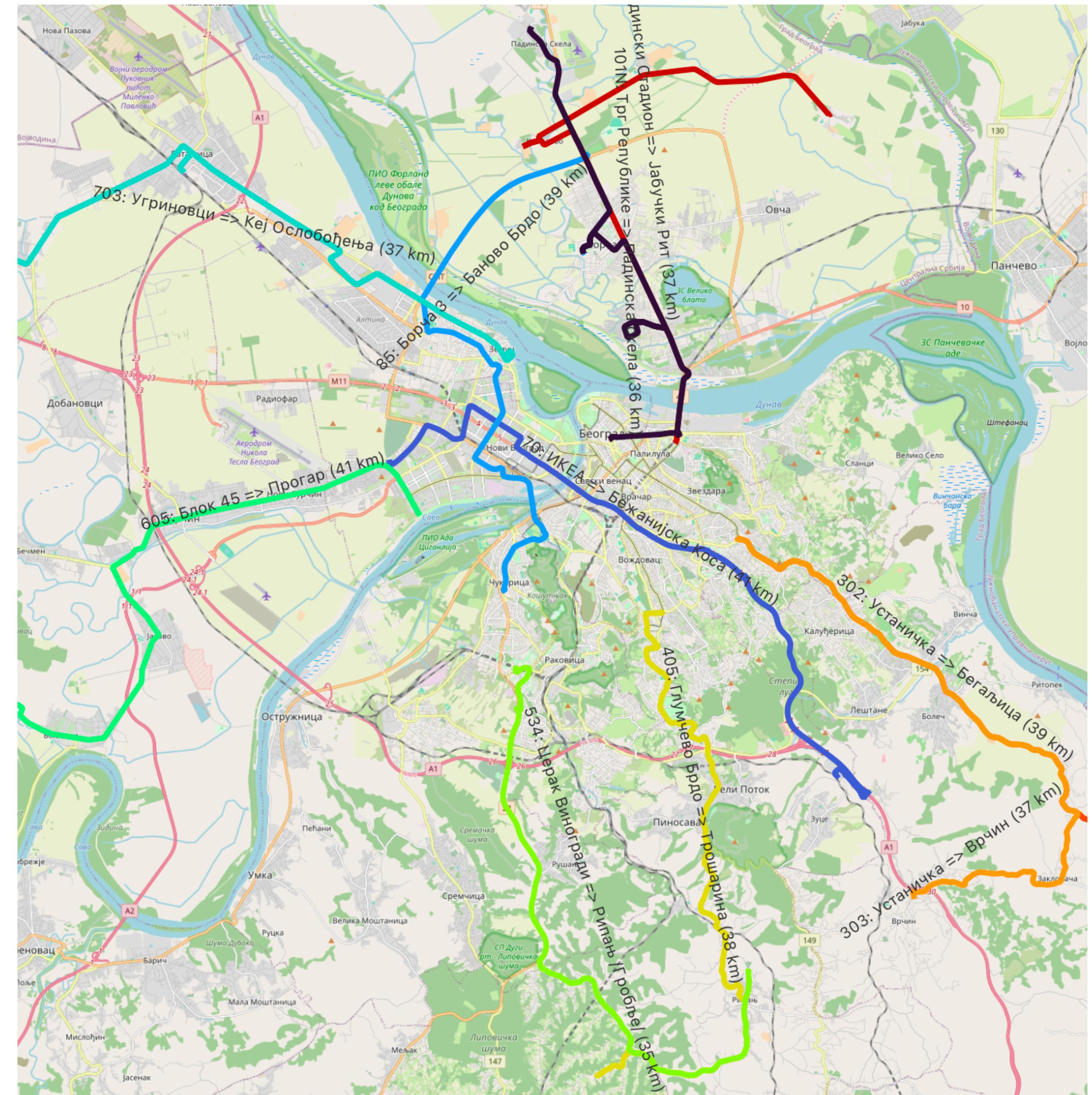
# Autobuske stanice Niša



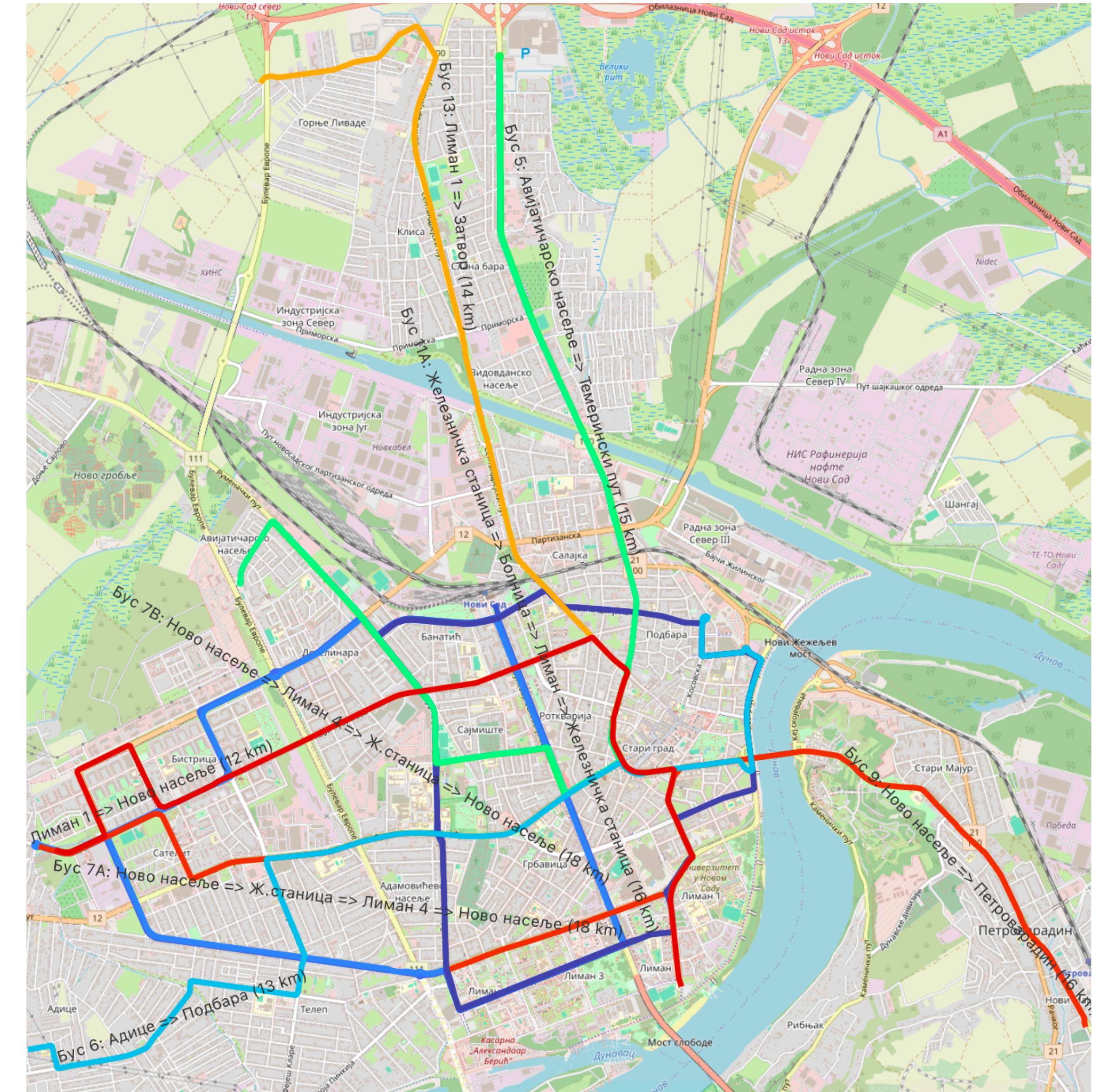
# Autobuske stanice Beograda



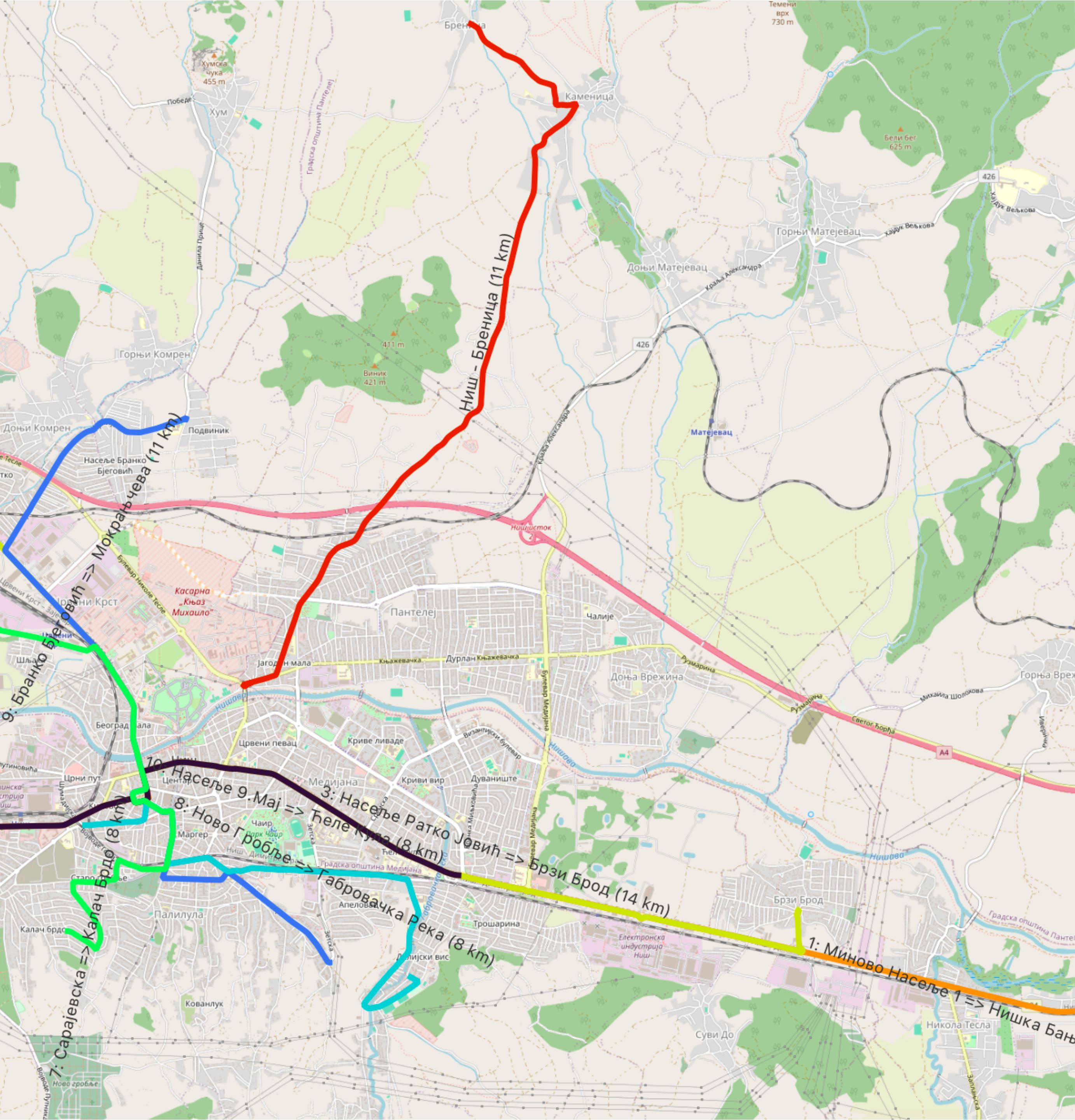
# Najduže autobuske linije Beograda



# Najduže autobuske linije Novog Sada



# Najduže autobuske linije Niša

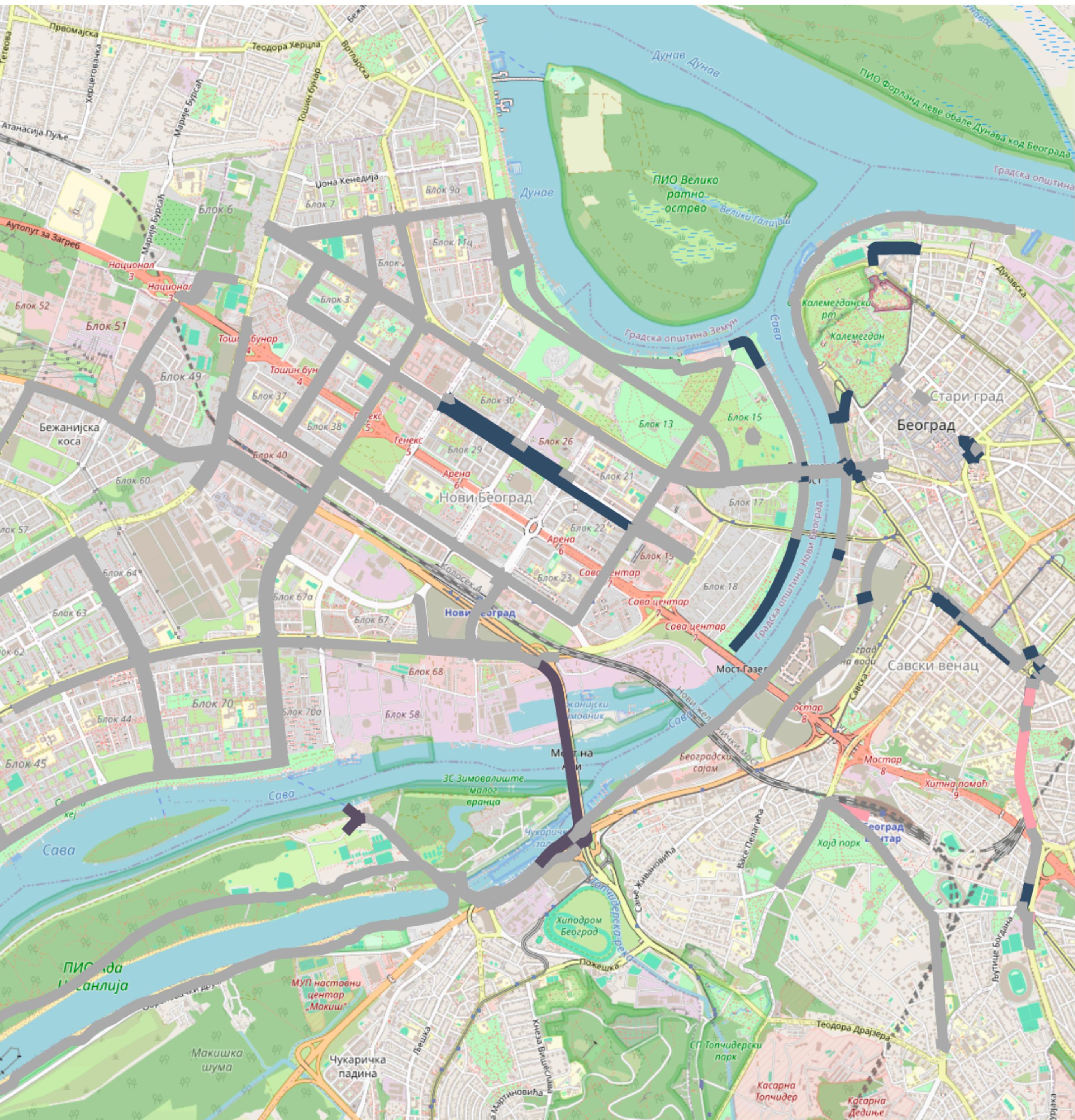


# Biciklističke staze Beograda

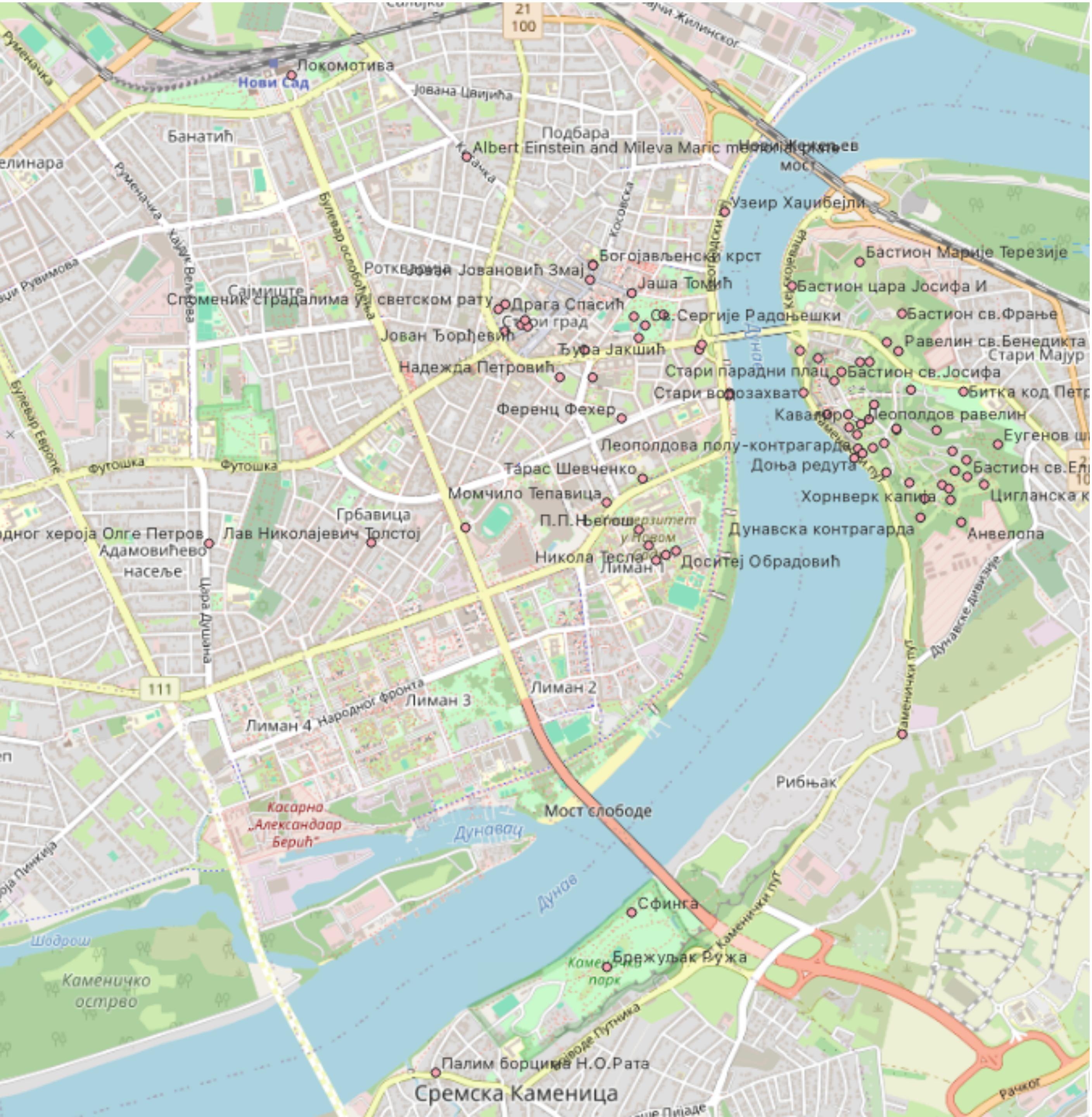
Rule-based	Label
<input checked="" type="checkbox"/>	asfalt
<input checked="" type="checkbox"/>	kaldrma
<input checked="" type="checkbox"/>	beton
<input checked="" type="checkbox"/>	poplocano
<input checked="" type="checkbox"/>	zemlja

Rule
surface='asphalt'
surface='paving_stones'
surface='concrete'
surface='paved'
surface='dirt'



# Istorijske turističke atrakcije u blizini hotela (1km)



# Dužine biciklističkih staza

```
1 SELECT c.name AS city_name, ROUND(SUM(ST_Length(l.way)))/1000 AS total_cycleway_length
2 FROM planet_osm_line l JOIN planet_osm_polygon c ON ST_Intersects(l.way, c.way)
3 WHERE (c.name LIKE '%Ниш%' OR c.name LIKE '%Београд%' OR c.name LIKE '%Нови Сад%') AND l.highway = 'cycleway'
4 GROUP BY c.name ORDER BY total_cycleway_length DESC
5
```

	city_name	total_cycleway_length
1	Град Београд	332.064
2	Град Нови Сад	186.111
3	Београдски регион	166.032
4	Београд	142.755
5	Нови Сад	141.547
6	Градска општина Нови Београд	92.191
7	Београд (Нови Београд)	92.191
8	Град Ниш	24.323
9	Нишавски управни округ	24.323
10	Београд (Савски венац)	20.491
11	Београд (Чукарица)	16.742

12	Београд (Земун)	14.414
13	Ниш (Медијана)	11.632
14	Београд (Стари град)	9.669
15	Ниш (Пантелеј)	7.252
16	Голф клуб Београд	5.834
17	Ниш (Палилула)	4.554
18	Нишка Бања	2.722
19	Градска општина Нишка Бања	2.722
20	Београд (Врачар)	2.31
21	Београд (Палилула)	2.02

# Procenat povrsine pokriven biciklističkim stazama

Cycling Infrastructure Coverage — Update SQL

```
SELECT row_number() over () AS _uid_ ,* FROM (SELECT c.name AS area_name,
ROUND(SUM(ST_Length(l.way)) / ST_Area(c.way) * 100) AS cycleway_coverage_percentage FROM planet_osm_line l
JOIN planet_osm_polygon c ON ST_Within(l.way, c.way) WHERE l.highway = 'cycleway' and c.name IS NOT NULL
GROUP BY c.name, c.way order by cycleway_coverage_percentage desc
) AS _subq_1_
```

Clear Fetched rows: 373/373 10866 ms Execute Stop

_uid_	area_name	cycleway_coverage_percentage
1	Саобраћајни полигон	12
2	Катићев Сквер	6
3	Пупинов мост	5
4	Мост на Ади	2
5	Перон VI	1
6	МЗ Центар II	1
7	Савски кеј	1
8	Дунавски парк	1

# Dodavanje indeksa

```
<> Query #1 +  
1  SELECT  
2      tablename,  
3      indexname,  
4      indexdef  
5  FROM  
6      pg_indexes  
7  WHERE  
8      schemaname = 'public'  
9  ORDER BY  
10     tablename,  
11     indexname;
```

	tablename	indexname	indexdef
1	osm2pgsql_properties	osm2pgsql_properties_pkey	CREATE UNIQUE INDEX osm2pgsql_properties_pkey ON public.osm2pgsql_properties USING btree (property)
2	planet_osm_line	planet_osm_line_way_idx	CREATE INDEX planet_osm_line_way_idx ON public.planet_osm_line USING gist (way) WITH (fillfactor='100')
3	planet_osm_point	idx_osm_point_amenity	CREATE INDEX idx_osm_point_amenity ON public.planet_osm_point USING btree (amenity)
4	planet_osm_point	planet_osm_point_way_idx	CREATE INDEX planet_osm_point_way_idx ON public.planet_osm_point USING gist (way) WITH (fillfactor='100')
5	planet_osm_polygon	idx_osm_polygon_name	CREATE INDEX idx_osm_polygon_name ON public.planet_osm_polygon USING btree (name)
6	planet_osm_polygon	planet_osm_polygon_way_idx	CREATE INDEX planet_osm_polygon_way_idx ON public.planet_osm_polygon USING gist (way) WITH (fillfactor='100')
7	planet_osm_roads	planet_osm_roads_way_idx	CREATE INDEX planet_osm_roads_way_idx ON public.planet_osm_roads USING gist (way) WITH (fillfactor='100')
8	spatial_ref_sys	spatial_ref_sys_pkey	CREATE UNIQUE INDEX spatial_ref_sys_pkey ON public.spatial_ref_sys USING btree (srid)

# Poređenje s indeksom i bez indeksa

Query #1

```
1 explain SELECT c.name AS city_name, SUM(ST_Length(l.way)) / ST_Area(c.way) * 100 AS cycleway_coverage_percentage
2 FROM planet_osm_line l
3 JOIN planet_osm_polygon c ON ST_Within(l.way, c.way)
4 WHERE l.highway = 'cycleway'
5 GROUP BY c.name, c.way
6 order by cycleway_coverage_percentage desc
```

13.783s 1m, 46.834s

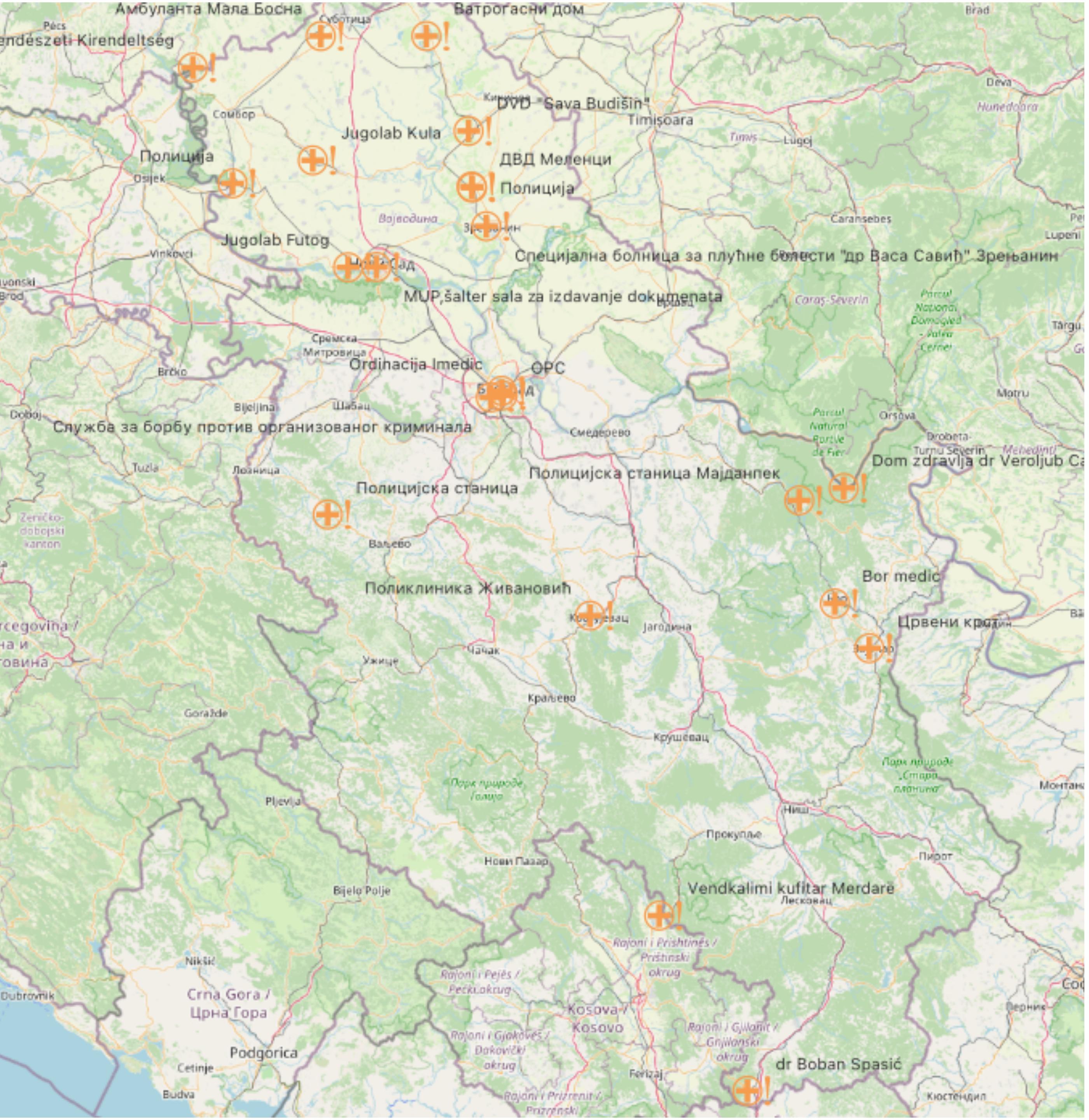
QUERY PLAN	
1	Sort (cost=51847245.39..51851634.30 rows=1755562 width=296)
2	Sort Key: (((sum(st_length(l.way)) / st_area(c.way)) * '100'::double precision)) DESC
3	-> Finalize GroupAggregate (cost=50173848.59..51185123.88 rows=1755562 width=296)
4	Group Key: c.name, c.way
5	-> Gather Merge (cost=50173848.59..50913011.77 rows=3511124 width=296)
6	Workers Planned: 2
7	-> Partial GroupAggregate (cost=50172848.57..50506740.91 rows=1755562 width=296)
8	Group Key: c.name, c.way
9	-> Sort (cost=50172848.57..50178706.66 rows=2343235 width=850)
10	Sort Key: c.name, c.way
11	-> Nested Loop (cost=0.29..47281925.98 rows=2343235 width=850)
12	-> Parallel Seq Scan on planet_osm_line l (cost=0.00..37828.10 rows=1073 width=562)
13	Filter: (highway = 'cycleway'::text)
14	-> Index Scan using planet_osm_polygon_way_idx on planet_osm_polygon c (cost=0.29..44028.15 rows=176 width=288)
15	Index Cond: (way ~ l.way)
16	Filter: st_within(l.way, way)

QUERY PLAN	
1	Sort (cost=727845664.94..727845728.29 rows=25339 width=296)
2	Sort Key: (((sum(st_length(l.way)) / st_area(c.way)) * '100'::double precision)) DESC
3	-> Finalize GroupAggregate (cost=727825750.24..727840346.51 rows=25339 width=296)
4	Group Key: c.name, c.way
5	-> Gather Merge (cost=727825750.24..727836418.97 rows=50678 width=296)
6	Workers Planned: 2
7	-> Partial GroupAggregate (cost=727824750.22..727829569.44 rows=25339 width=296)
8	Group Key: c.name, c.way
9	-> Sort (cost=727824750.22..727824834.77 rows=33821 width=850)
10	Sort Key: c.name, c.way
11	-> Nested Loop (cost=288.80..727809486.93 rows=33821 width=850)
12	Join Filter: st_within(l.way, c.way)
13	-> Parallel Seq Scan on planet_osm_line l (cost=0.00..37828.10 rows=1073 width=562)
14	Filter: (highway = 'cycleway'::text)
15	-> Bitmap Heap Scan on planet_osm_polygon c (cost=288.80..44530.38 rows=25339 width=288)
16	Recheck Cond: (name IS NOT NULL)
17	-> Bitmap Index Scan on idx_osm_polygon_name (cost=0.00..282.47 rows=25339 width=0)
18	Index Cond: (name IS NOT NULL)

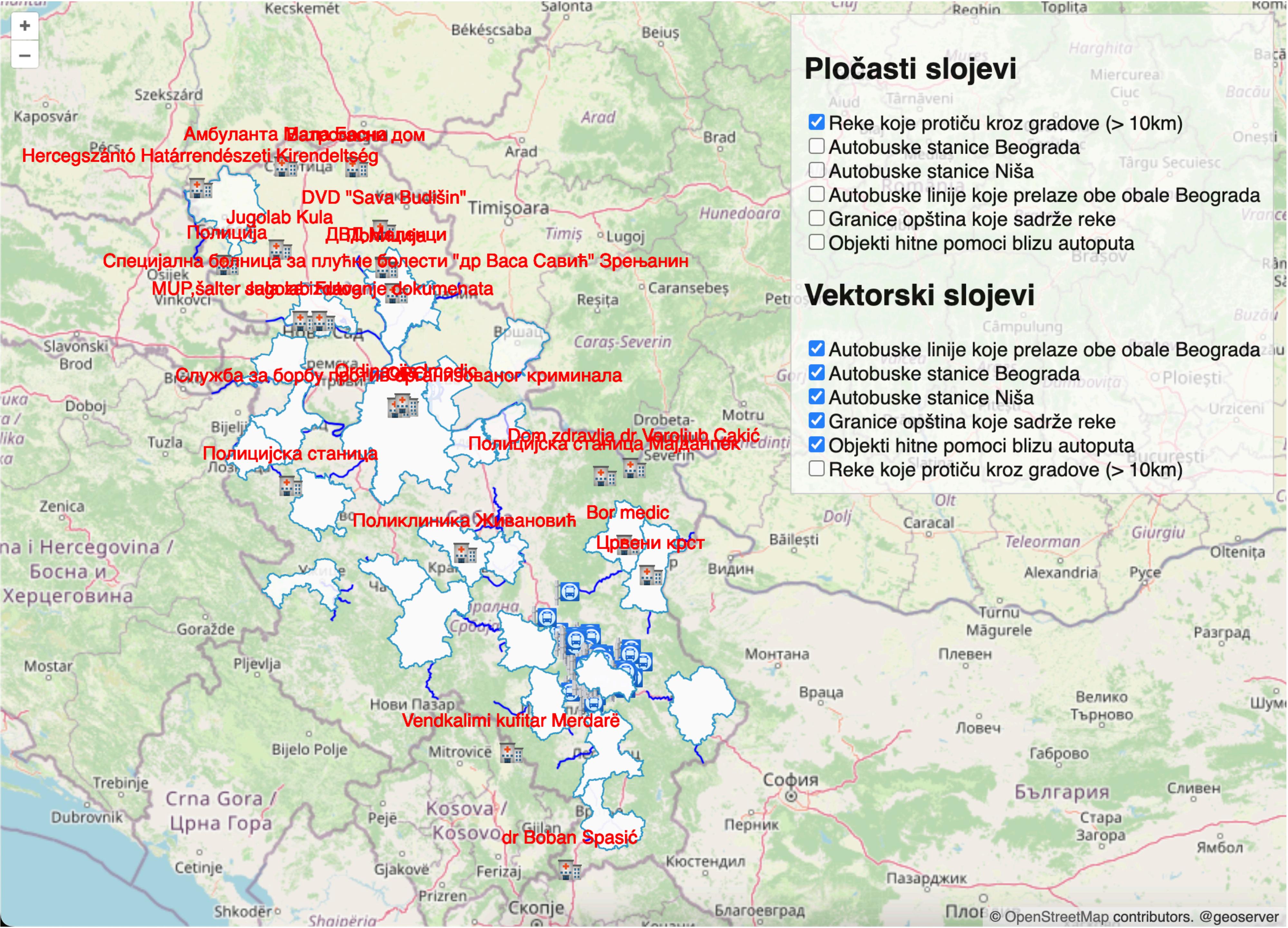
# Objekti za hitne slučajeve u blizini autoputa (200m)

```
SELECT DISTINCT e.* FROM planet_osm_point e
JOIN planet_osm_line l ON ST_DWithin(e.way, l.way, 200)
WHERE e.amenity IN ('hospital', 'fire_station', 'police')
AND e.name IS NOT NULL
AND l.highway IN ('motorway', 'trunk', 'primary')
```

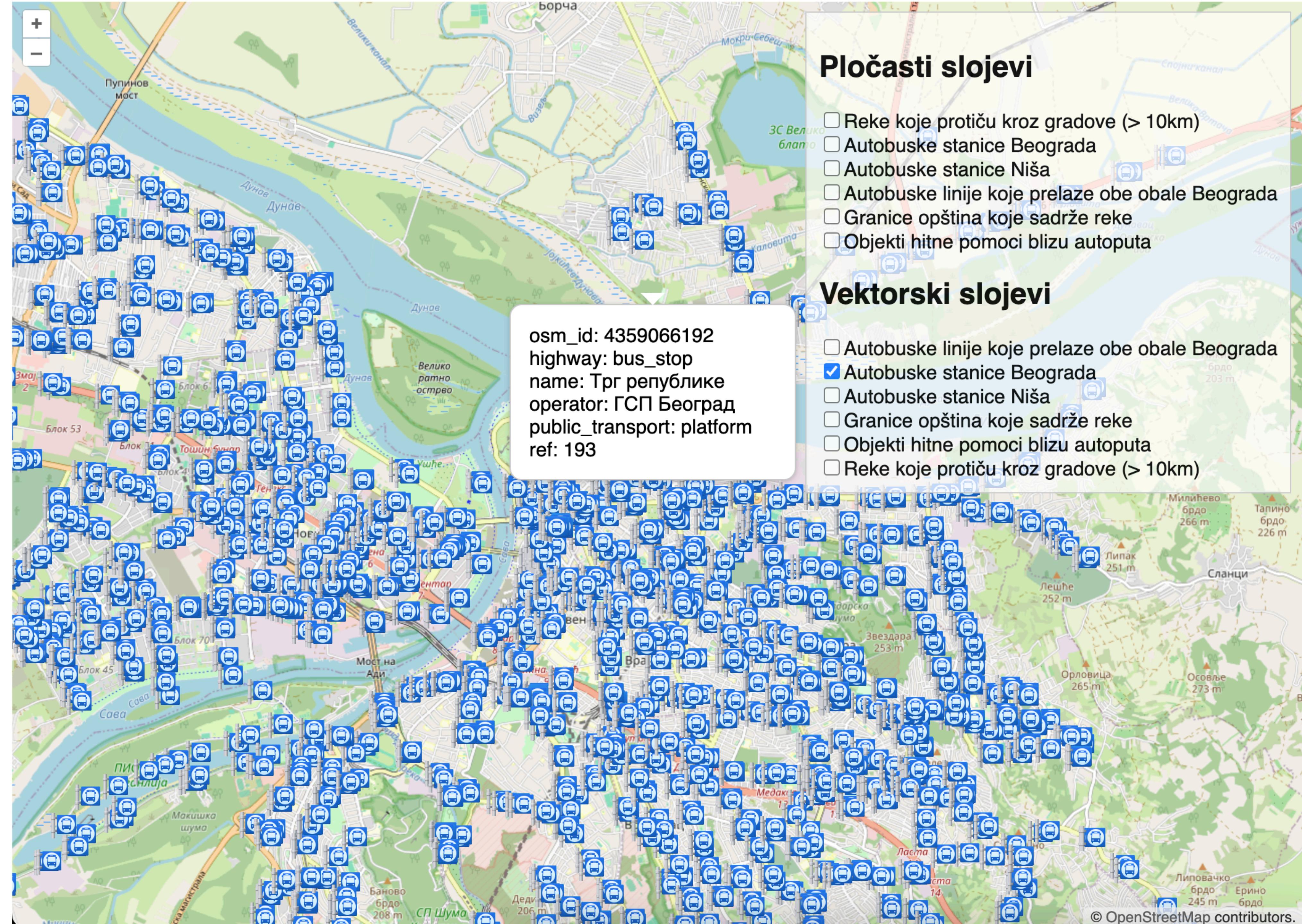
	<b>Sa indeksom</b>	<b>Bez indeksa</b>
<b>Vreme izvršenja [ms]</b>	97	806
<b>Broj izvršenja</b>	1000	1000



# OpenLayers



# Overlay



Generate Scenario



### Cars

5 Through Traffic  
12 Count



### Trucks

5 Through Traffic  
4 Count



### Bus

5 Through Traffic  
4 Count



### Motorcycles



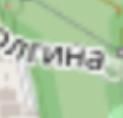
### Bicycles

2 Through Traffic  
6 Count



### Pedestrians

1 Through Traffic  
10 Count



### Trams

20 Through Traffic  
2 Count



### Urban trains



### Trains



### Ships



# python3 osmWebWizard.py

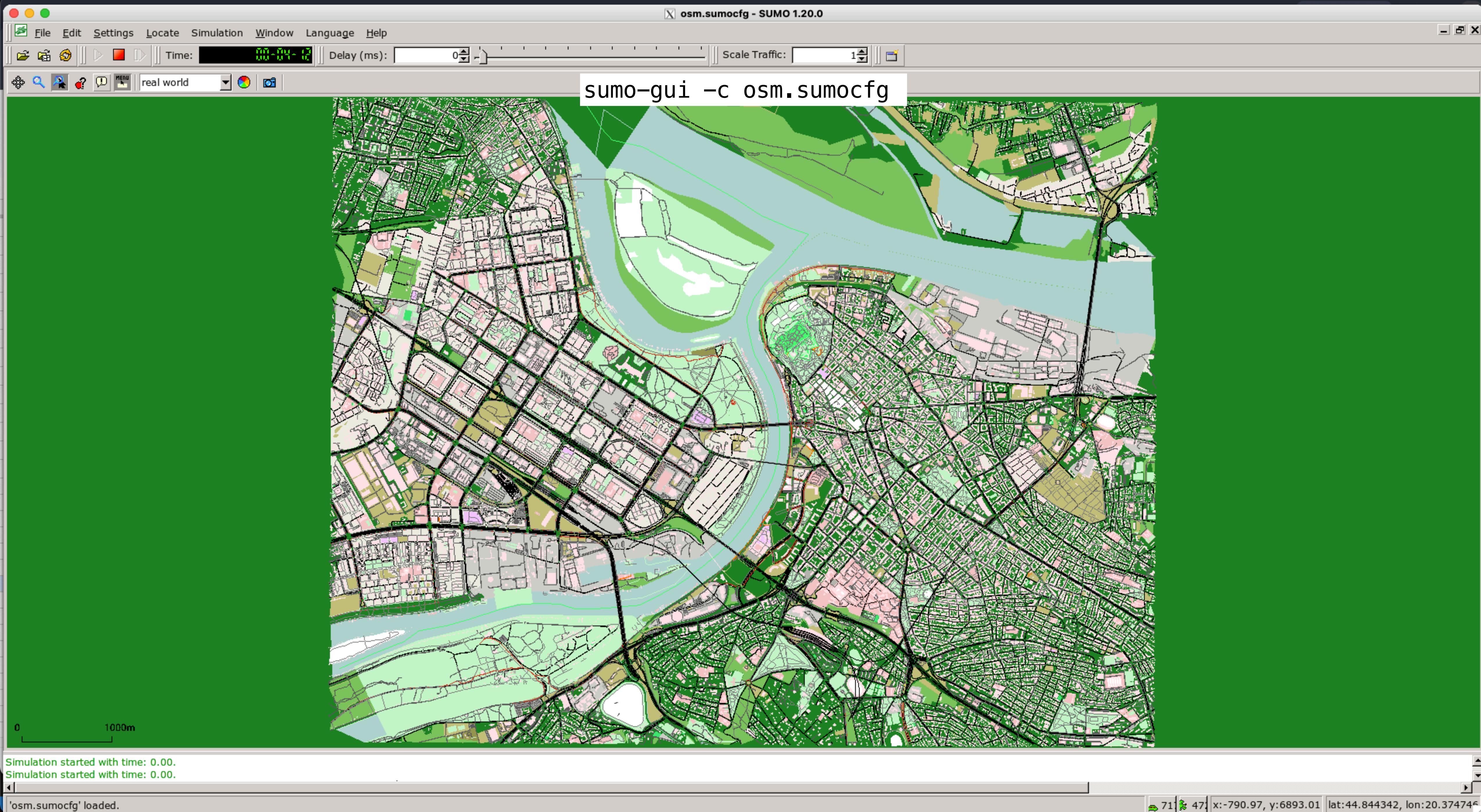
```
sumo -c osm.sumocfg \
--fcd-output osm.fcdoutput.xml --fcd-output.geo \
--emission-output osm.emissionoutput.xml --emission-output.geo
```

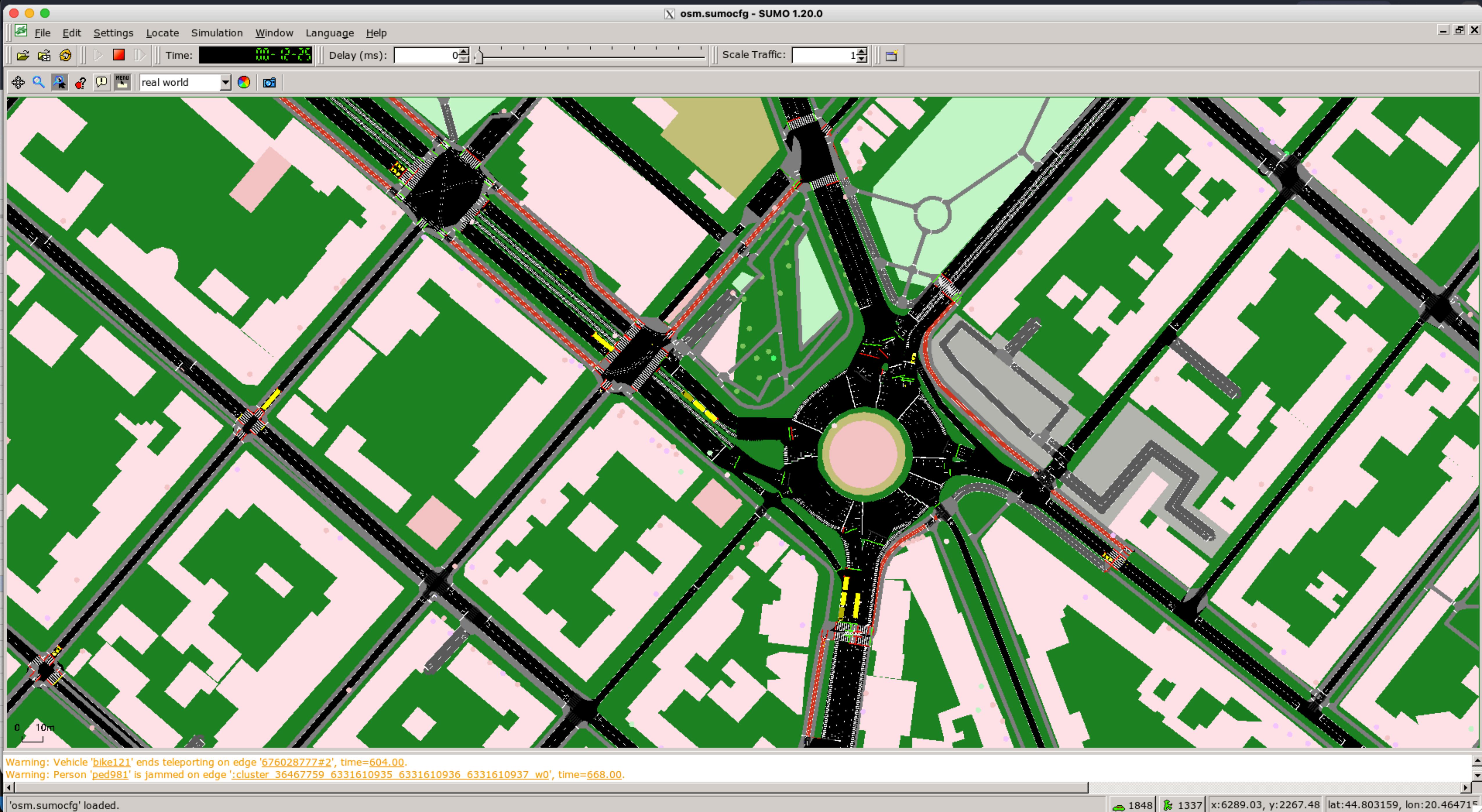
## head osm.fcdoutput.xml

```
<fcd-export xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:noNamespaceSchemaLocation="http://sumo.dlr.de/xsd/fcd_file.xsd">
  <timestep time="0.00">
    <vehicle id="bike0" x="20.464007" y="44.828797" angle="154.64" type="bike_bicycle" speed="0.00" pos="1.70" lane="23714537#1_0" slope="0.00"/>
    <vehicle id="bus0" x="20.439570" y="44.814814" angle="86.52" type="bus_bus" speed="0.00" pos="12.10" lane="26825999#1_1" slope="0.00"/>
    <vehicle id="tram0" x="20.419375" y="44.808282" angle="123.35" type="tram_tram" speed="0.00" pos="1.35" lane="694773056#0_0" slope="0.00"/>
    <vehicle id="veh0" x="20.389875" y="44.802385" angle="260.89" type="veh_passenger" speed="0.00" pos="5.10" lane="33519089#19_1" slope="0.00"/>
    <person id="ped0" x="20.452471" y="44.824719" angle="258.973634" speed="0.00000" pos="0.00000" edge="-80823287#4" slope="0.00000"/>
  </timestep>
  <timestep time="1.00">
    <vehicle id="bike0" x="20.464010" y="44.828792" angle="154.64" type="bike_bicycle" speed="0.61" pos="2.31" lane="23714537#1_0" slope="0.00"/>
    <vehicle id="bike1" x="20.455947" y="44.818490" angle="38.61" type="bike_bicycle" speed="0.00" pos="1.70" lane="-477581991#1_0" slope="0.00"/>
    <vehicle id="bus0" x="20.439580" y="44.814815" angle="86.52" type="bus_bus" speed="0.81" pos="12.91" lane="26825999#1_1" slope="0.00"/>
    <vehicle id="tram0" x="20.419386" y="44.808277" angle="123.36" type="tram_tram" speed="1.00" pos="1.00" lane=":3940745464_1_0" slope="0.00"/>
    <vehicle id="veh0" x="20.389849" y="44.802382" angle="260.81" type="veh_passenger" speed="2.10" pos="0.82" lane=":6051465681_0_0" slope="0.00"/>
    <person id="ped0" x="20.452467" y="44.824724" angle="190.303378" speed="1.175970" pos="3.516232" edge=":635734039_w0" slope="0.00000"/>
    <person id="ped2" x="20.468274" y="44.810197" angle="132.128195" speed="0.00000" pos="0.00000" edge="683691801" slope="0.00000"/>
  </timestep>
```

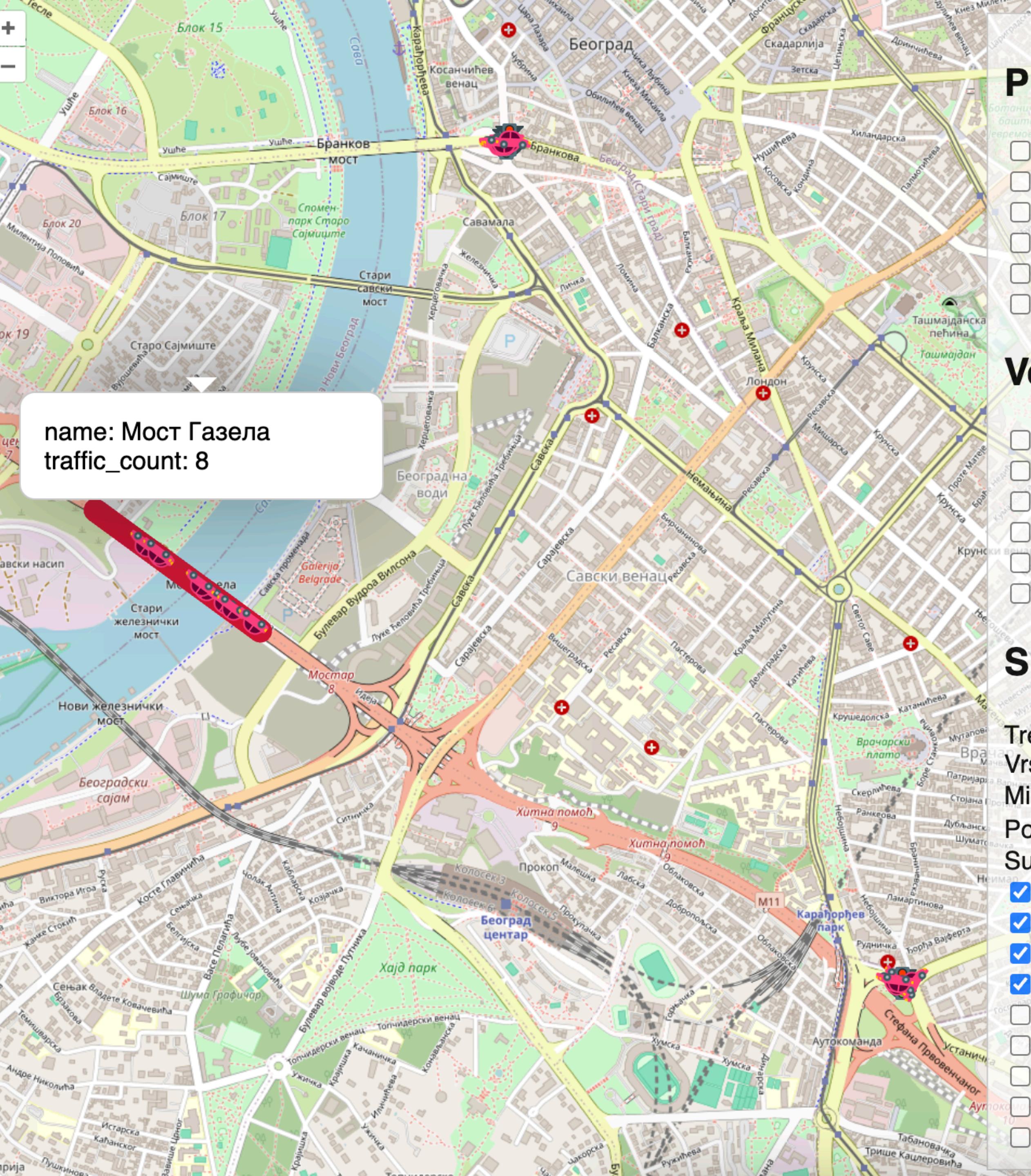
## head osm.emissionoutput.xml

```
<emission-export xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:noNamespaceSchemaLocation="http://sumo.dlr.de/xsd/emission_file.xsd">
  <timestep time="0.00">
    <vehicle id="bike0" eclass="Zero/default" CO2="0.00" CO="0.00" HC="0.00" NOx="0.00" PMx="0.00" fuel="0.00" electricity="0.00" noise="0.00" route="!bike0!var#1" type="bike_bicycle" waiting="0.00" lane="23714537#1_0" pos="1.70" speed="0.00" angle="154.64" x="20.464007" y="44.828797"/>
    <vehicle id="bus0" eclass="HBEFA3/Bus" CO2="5286.11" CO="20.17" HC="4.85" NOx="60.75" PMx="2.01" fuel="1671.11" electricity="0.00" noise="67.11" route="!bus0!var#1" type="bus_bus" waiting="0.00" lane="26825999#1_1" pos="12.10" speed="0.00" angle="86.52" x="20.439570" y="44.814814"/>
    <vehicle id="tram0" eclass="Zero/default" CO2="0.00" CO="0.00" HC="0.00" NOx="0.00" PMx="0.00" fuel="0.00" electricity="0.00" noise="0.00" route="!tram0!var#1" type="tram_tram" waiting="0.00" lane="694773056#0_0" pos="1.35" speed="0.00" angle="123.35" x="20.419375" y="44.808282"/>
    <vehicle id="veh0" eclass="HBEFA3/PC_G_EU4" CO2="2624.72" CO="164.78" HC="0.81" NOx="1.20" PMx="0.07" fuel="837.22" electricity="0.00" noise="55.94" route="!veh0!var#1" type="veh_passenger" waiting="0.00" lane="33519089#19_1" pos="5.10" speed="0.00" angle="260.89" x="20.389875" y="44.802385"/>
  </timestep>
```





# SUMO



## Pločasti slojevi

- Autobuske linije koje prelaze obe obale Beograda
- Autobuske stanice Beograda
- Autobuske stanice Niša
- Granice opština koje sadrže reke
- Objekti hitne pomoci blizu autoputa
- Reke koje protiču kroz gradove (> 10km)

## Vektorski slojevi

- Autobuske linije koje prelaze obe obale Beograda
- Autobuske stanice Beograda
- Autobuske stanice Niša
- Granice opština koje sadrže reke
- Objekti hitne pomoci blizu autoputa
- Reke koje protiču kroz gradove (> 10km)

## SUMO upiti

Trenutak u vremenu

Vrsta objekta Putničko vozilo ▾

Min. broj objekata 8

Podloga biciklističke staze Asfalt ▾

Supstanca zagađenosti CO2 ▾

Ulica sa najgušćim saobraćajem

Vozila na ulici sa najgušćim saobraćajem

Semafori sa kolonama vozila

Kolona vozila na semaforima

Biciklističke staze

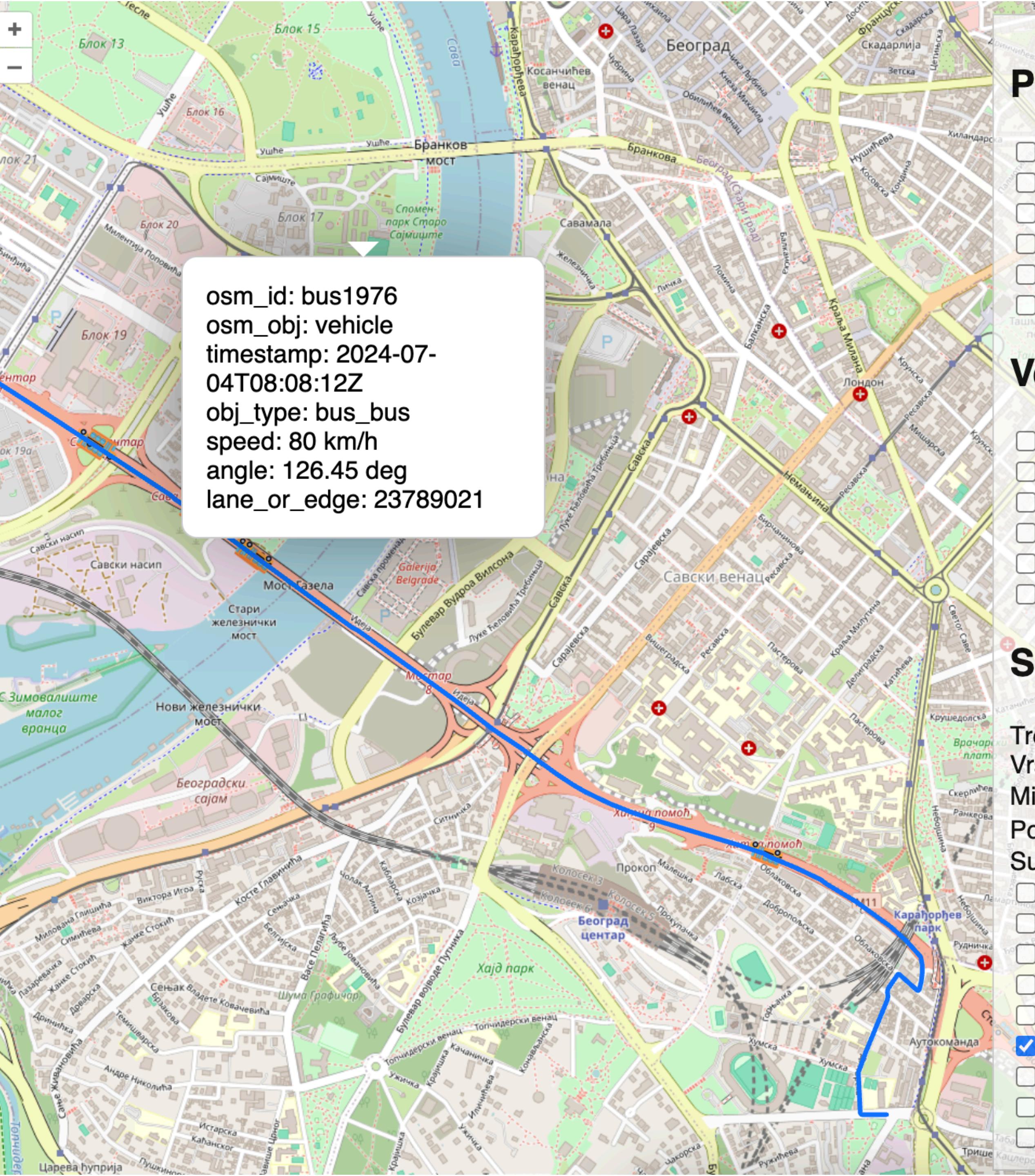
Najbrža vozila u izabranom trenutku

Toplotna karta brzine vozila

Toplotna karta gustine saobraćaja

Toplotna karta emitovanih čestica iz vozila

# SUMO



## Pločasti slojevi

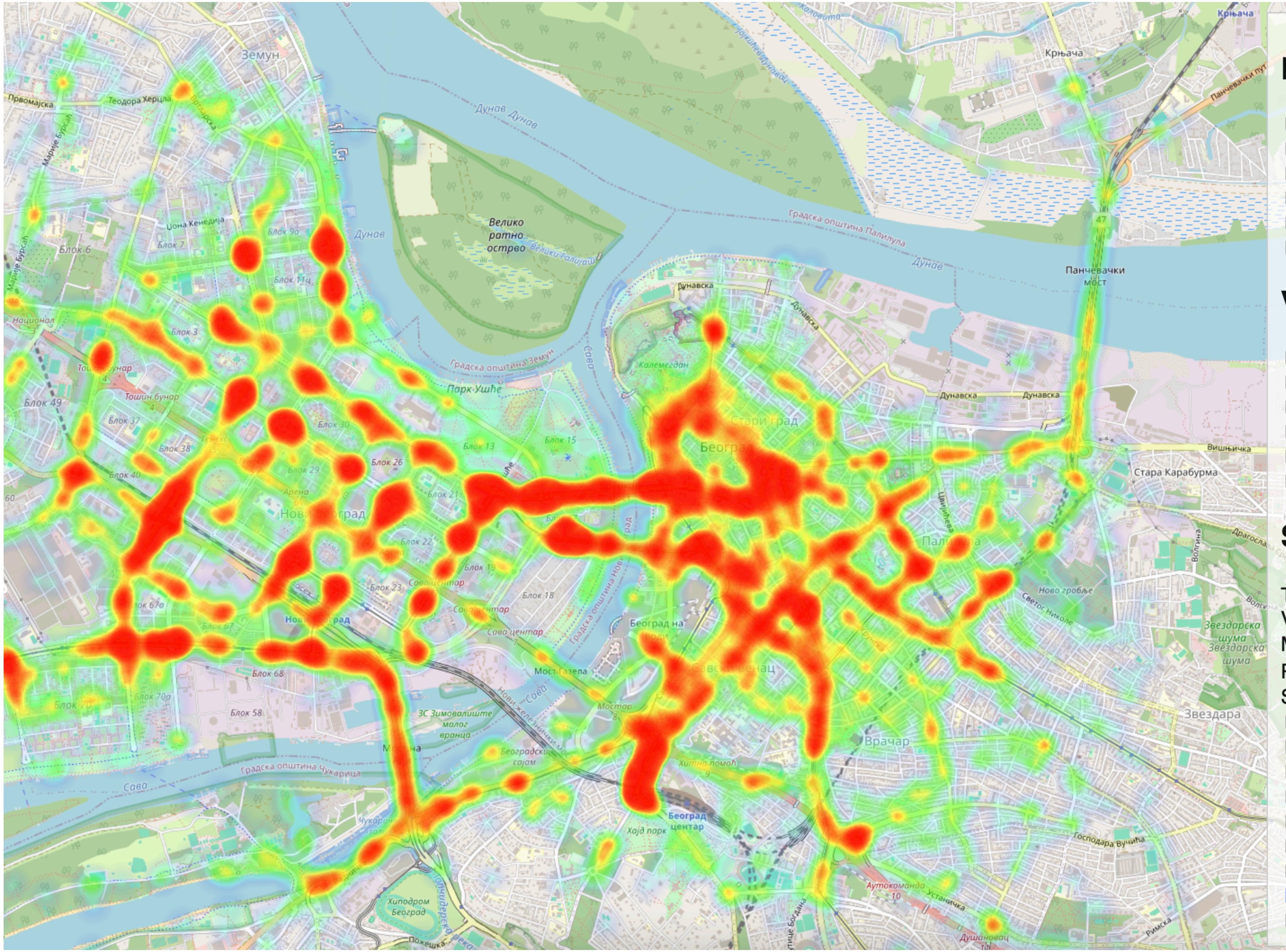
- Autobuske linije koje prelaze obe obale Beograda
- Autobuske stanice Beograda
- Autobuske stanice Niša
- Granice opština koje sadrže reke
- Objekti hitne pomoci blizu autoputa
- Reke koje protiču kroz gradove (> 10km)

## Vektorski slojevi

- Autobuske linije koje prelaze obe obale Beograda
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- Granice opština koje sadrže reke
- Objekti hitne pomoci blizu autoputa
- Reke koje protiču kroz gradove (> 10km)

## SUMO upiti

- Trenutak u vremenu: 57:00
- Putničko vozilo:  Autobus  
 Bicikl  
 Tramvaj  
 Pešak
- Vrsta objekta:  Ulica sa najgušćim saobraćajem  
 Vozila na ulici sa najgušćim saobraćajem  
 Semafori sa kolonama vozila  
 Kolona vozila na semaforima  
 Biciklističke staze  
 Najbrža vozila u izabranom trenutku
- Min. broj objekata: 10
- Podloga biciklističkih staza:
- Supstanca za vozila:
- Ulica sa najgušćim saobraćajem
  - Vozila na ulici sa najgušćim saobraćajem
  - Semafori sa kolonama vozila
  - Kolona vozila na semaforima
  - Biciklističke staze
  - Najbrža vozila u izabranom trenutku
  - Toplotna karta brzine vozila
  - Toplotna karta gustine saobraćaja
  - Toplotna karta emitovanih čestica iz vozila



## Pločasti slojevi

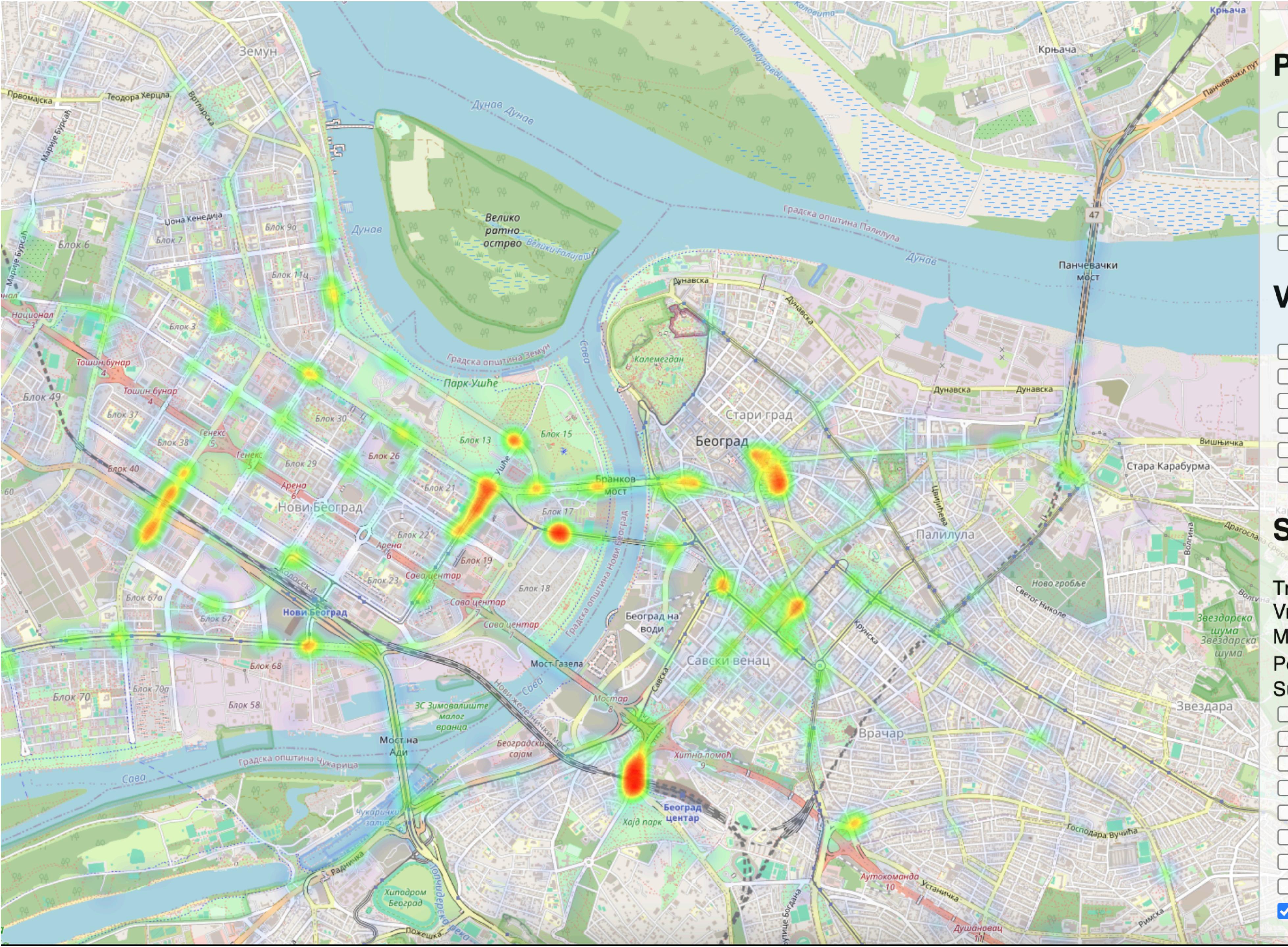
- Autobuske linije koje prelaze obe obale Beograda
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- Granice opština koje sadrže reke
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- Reke koje protiču kroz gradove (> 10km)

## Vektorski slojevi

- Autobuske linije koje prelaze obe obale Beograda
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- Reke koje protiču kroz gradove (> 10km)

## SUMO upiti

- Trenutak u vremenu
- Vrsta objekta Autobus
- Min. broj objekata 8
- Podloga biciklističke staze Asfalt
- Supstanca zagađenosti CO<sub>2</sub>
- Ulica sa najgušćim saobraćajem
  - Vozila na ulici sa najgušćim saobraćajem
  - Semafori sa kolonama vozila
  - Kolona vozila na semaforima
  - Biciklističke staze
  - Najbrža vozila u izabranom trenutku
  - Toplotna karta brzine vozila
  - Toplotna karta gustine saobraćaja
  - Toplotna karta emitovanih čestica iz vozila



# Pločasti slojevi

- Autobuske linije koje prelaze obe obale Beograda
  - Autobuske stanice Beograda
  - Autobuske stanice Niša
  - Granice opština koje sadrže reke
  - Objekti hitne pomoći blizu autoputa
  - Reke koje protiču kroz gradove (> 10km)

# Vektorski slojevi

- Autobuske linije koje prelaze obe obale Beograda
  - Autobuske stanice Beograda
  - Autobuske stanice Niša
  - Granice opština koje sadrže reke
  - Objekti hitne pomoći blizu autoputa
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# SUMO upiti

Trenutak u vremenu

Przeglądaj i wybieraj  
pierwsza obiektu Autobus

Min. broj obiekata 8

Podloga biciklističke staze PMx

**Instanca zadadenosti** / Razpis

**Ilica sa najgušćim s**

- Ulica sa najguscim saobraćajem
  - Semafori sa kolonama vozila
  - Kolona vozila na semaforima
  - Biciklističke staze
  - Najbrža vozila u izabranom trenutku
  - Toplotna karta brzine vozila
  - Toplotna karta gustine saobraćaja
  - Toplotna karta emitovanih čestica iz vozila

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