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Executive Summary

The primary purpose of this project is to perform crime analysis, i.e., to identify and analyze the patterns or trends in various types of crime including rape, murder, robbery, burglary, larceny, assault etc. Spatial analysis can help in devising more accurate solutions to crime-related problems and hence plays a vital role in formulating strategies for crime prevention. Crime Analysis and mapping is often used in enhancing public safety, in identifying the emerging trends and in organizing the law enforcement operations. This project helps in reducing crime by giving an optimal solution for decision makers to allocate resources and further improve the police operations. It can be used to formulate crime reduction strategies and allocating police resources wherever high security is necessary. Whenever one needs to find the rate of spread of crime in various places and to spot out a better location which is crime-free, this project comes in picture. It primarily concentrates in the criminal activities that took place across the neighborhoods of **Palm Beach** county, which is an important county in Florida state.

Objective

The objective of this project is to determine the safest and not so safe neighborhoods of Palm Beach with respect to various types of crime including theft, rape, murder, robbery etc. The Primary goal is to highlight the roads, bicycle lanes, bridges and the amenities that are at potentially more prone to criminal activities. Analyzing crime activities can be achieved by collecting the appropriate crime data and building up a PostgreSQL database. Further spatial SQL queries can be built with the help of PostGIS Extension and its output be displayed as a map, which is a pictorial representation of many areas or lands with spatial data using QGIS.

Software used

- **PostgreSQL**
    - It is a powerful and open-source object relational database system with over 30 years of active development
    - It has earned a strong reputation for reliability, feature robustness and performance
- **PostGIS**
    - This is a spatial database extender for PostgreSQL object relational database
    - It is an additional support for geographic objects that allows to perform spatial location queries in SQL

- **QGIS**
    - QGIS is a free and open-source cross platform desktop geographic information system application
    - It supports viewing, editing and analyzing the geospatial data
- **Citrix Server - Geoscience Desktop**
    - Citrix Server is a virtual application delivery tool that enables users to access the required applications from anywhere, without considering the fact of hardware that they use
    - Geoscience desktop is a remote desktop that can be connected through the citrix server, which helps in accessing all the windows application present in the system
- **ArcGIS**
    - It helps in working with geospatial information
    - It allows to create, view, edit and query the spatial data in both two dimension and three dimensions
    - It provides an infrastructure for GIS data management and manipulation of necessary tasks
- **Visual Studio Code**
    - This is a streamlined code editor, which is a free and open-source IDE for a quick code-build-debug cycle
    - It helps in debugging, task running and version control

Data Source

Data for this project has been collected from various open-source resources. The necessary data for the crime analysis and mapping project includes the neighborhoods, roads, bridges, bicycle lanes, amenities of the Palm beach county. Apart from these, elevation data can also be included to generate the three-dimensional map of the neighborhoods with respect to the criminal activity. Neighborhood data for the project has been collected from the **Open Data Portal** of Palm Beach county, whereas the roads, bridges and bicycle lane information has been downloaded from the **Florida Department of Transportation** website. All the point of interests and the amenities have been extracted from **Open street map** and the **USGS** provided the aspect data for Florida, which can be further clipped and extracted only for Palm Beach county.

Crime data for this project has been extracted using the **ESRI GeoEnrichment** tool, which enhances the geographic data with many localized information about people, places. By giving the neighborhood data as an input to this tool, all the crime indices inside the Palm Beach county have been reported by the tool.

1. Neighborhoods - https://opendata2-pbcgov.opendata.arcgis.com/datasets/municipal-boundaries?geometry=-82.451%2C26.158%2C-78.542%2C27.018

2. Roads - https://ftp.fdot.gov/file/d/FTP/FDOT/co/planning/transtat/gis/shapefiles/basemap_route_road.zip

3. Bridges - https://ftp.fdot.gov/file/d/FTP/FDOT/co/planning/transtat/gis/shapefiles/bridges.zip

4. Bicycle Lanes - https://ftp.fdot.gov/file/d/FTP/FDOT/co/planning/transtat/gis/shapefiles/bike_lane.zip

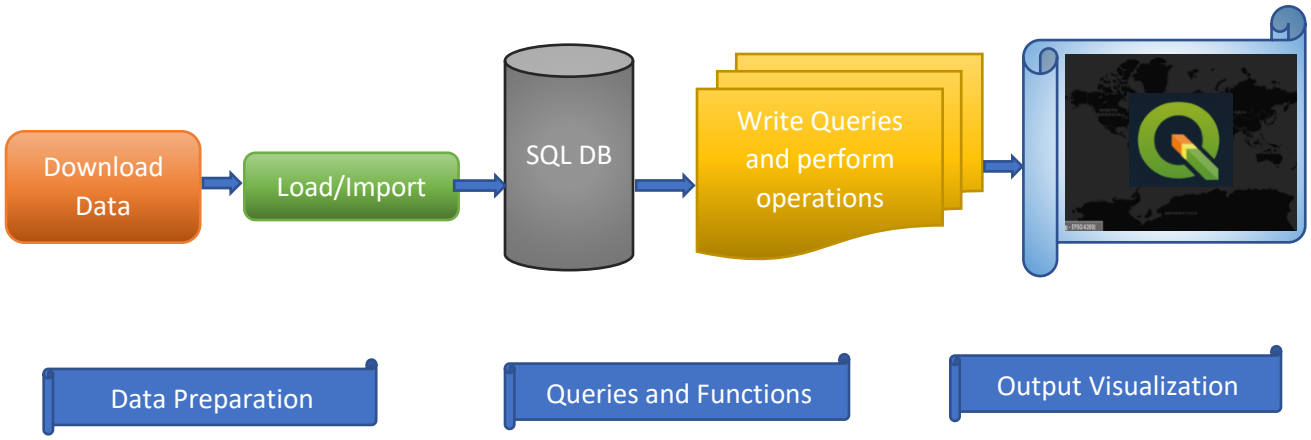
5. POI - https://www.openstreetmap.org/about

6. Elevation, Aspect - https://dds.cr.usgs.gov/

7. Crime -

   https://www.esri.com/en-us/arcgis/products/location-services/services/geoenrichment

Workflow



Procedure

The necessary data needs to be acquired from the respective providers and the information has to be cleaned up. The collected data has been imported to the PostgreSQL database as tables after creation of a new database and schema. Queries have been executed to create views and certain operations were performed to come up with an effective crime analysis and show its output as a map for better visualization.

Database Creation

A new spatial database, "**Crime Analysis**" has been created that defines the special data types for geometric objects and allows to store geographic data in a regular database table.

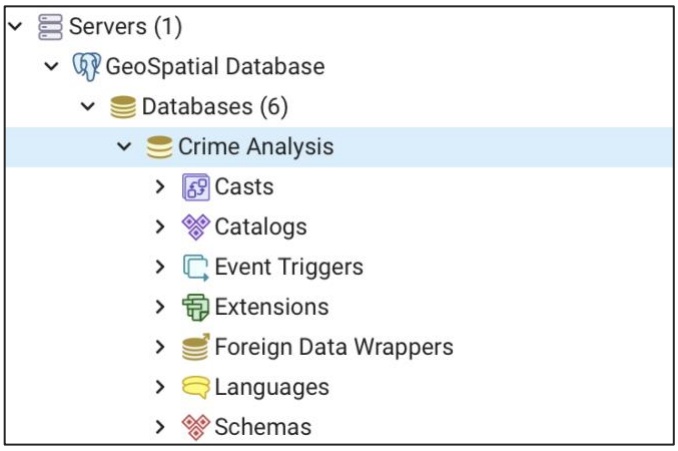


Figure 1: Crime Analysis Database

POSTGIS Extension has been added to the created database, so that it allows user to store GIS data and perform the spatial queries.

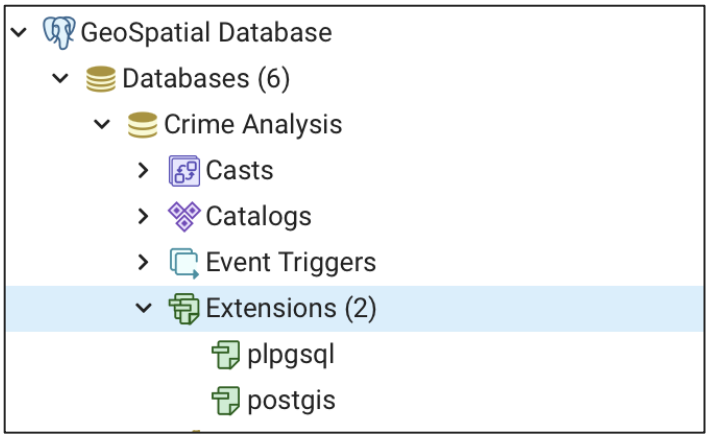


Figure 2: Enabling postgis extension

Schema Creation

A new schema, "**Palm Beach county**" has been created inside the spatial database representing a logical view. Schema defines how the data can be organized and how the relations among the data associates.

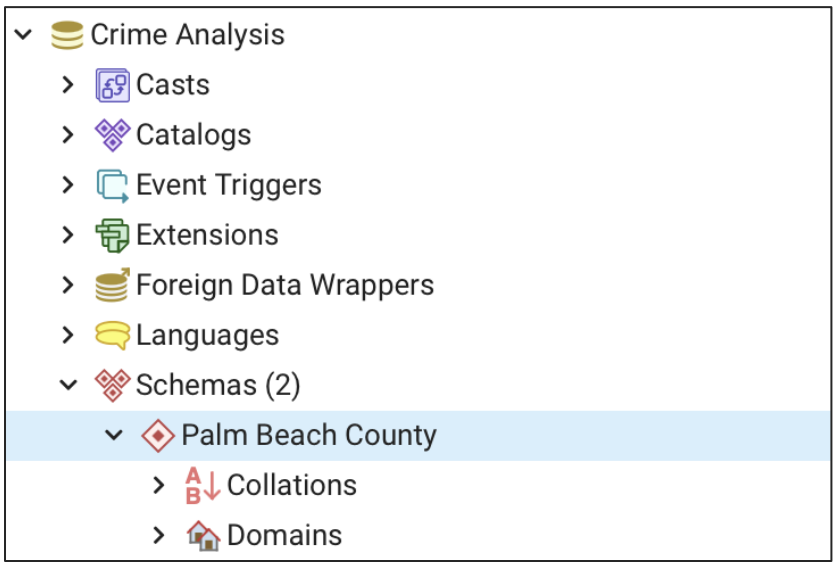


Figure 3: Schema Creation

Database Connection

The newly created spatial database, "**Crime Analysis**" has been then connected in the QGIS using PostGIS Connection.

Figure 4: Creation of Database connection

All the available extensions, schema, tables, views etc., of this database can be accessed through the QGIS DB Manager tool.

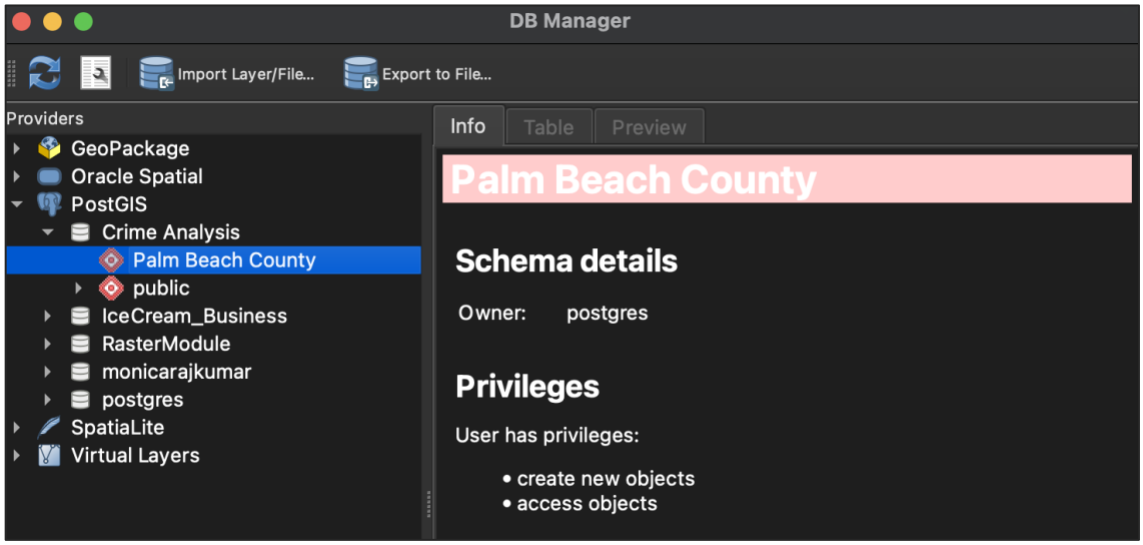


Figure 5: Visualization of database content in QGIS

Table Creation

All the required datasets were downloaded from the respective websites. Preprocessing of data were carried out to filter out the required datasets alone. For this project, 5 datasets were collected such as:

1. Neighborhood data with crime statistics
2. Point of Interest
3. Roads
4. Bridges
5. Bicycle lanes

Relational Schema

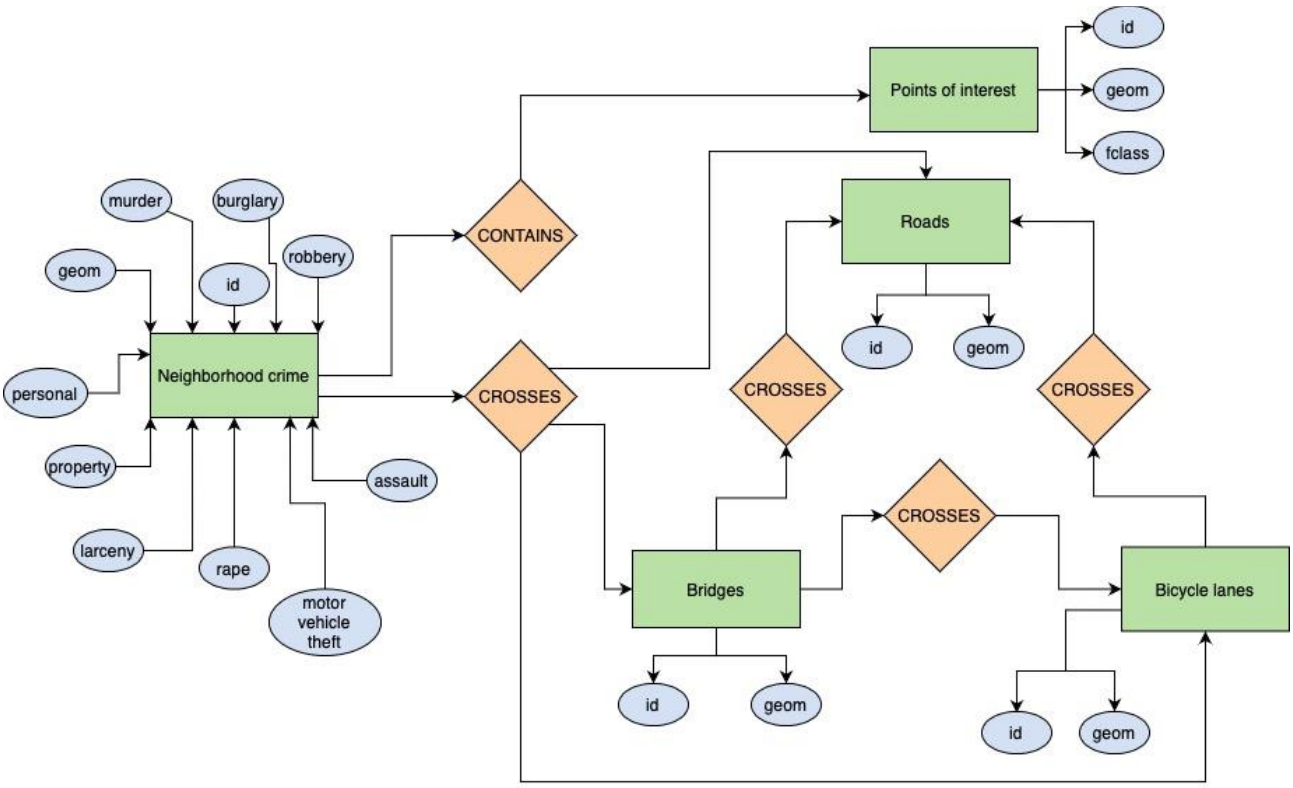


Figure 6: Relational Schema

Neighborhood crime

Neighborhood crime table stores polygon geometries of all neighborhoods with its crime indices. Initially, Neighborhood geometry data has been downloaded from the Open data of Palm Beach county and then given as input to the ESRI Geo enrichment tool in order to fetch the crime data analytics. Neighborhood crime table consists of various columns including **id, geom, name** representing the features of a neighborhood and crime index values for **personal, burglary, larceny, robbery, murder, rape, motor vehicle theft, assault** etc., with their respective data types.

neighborhood_crime

General | Columns | Advanced | Constraints | Parameters | Security | SQL

Inherited from table(s) — Select to inherit from...

Columns +

Name	Data type	Length/Precision	Scale	Not NULL?	Primary key?
id	integer			Yes	Yes
geom	geometry			No	No
objectid	bigint			No	No
muniname	character varying	80		No	No
fname	character varying	80		No	No
fcode	character varying	80		No	No
aggregatio	character varying	80		No	No
hasdata	bigint			No	No
original_o	bigint			No	No
sourcecoun	character varying	80		No	No

Figure 7: Neighborhood crime data - I

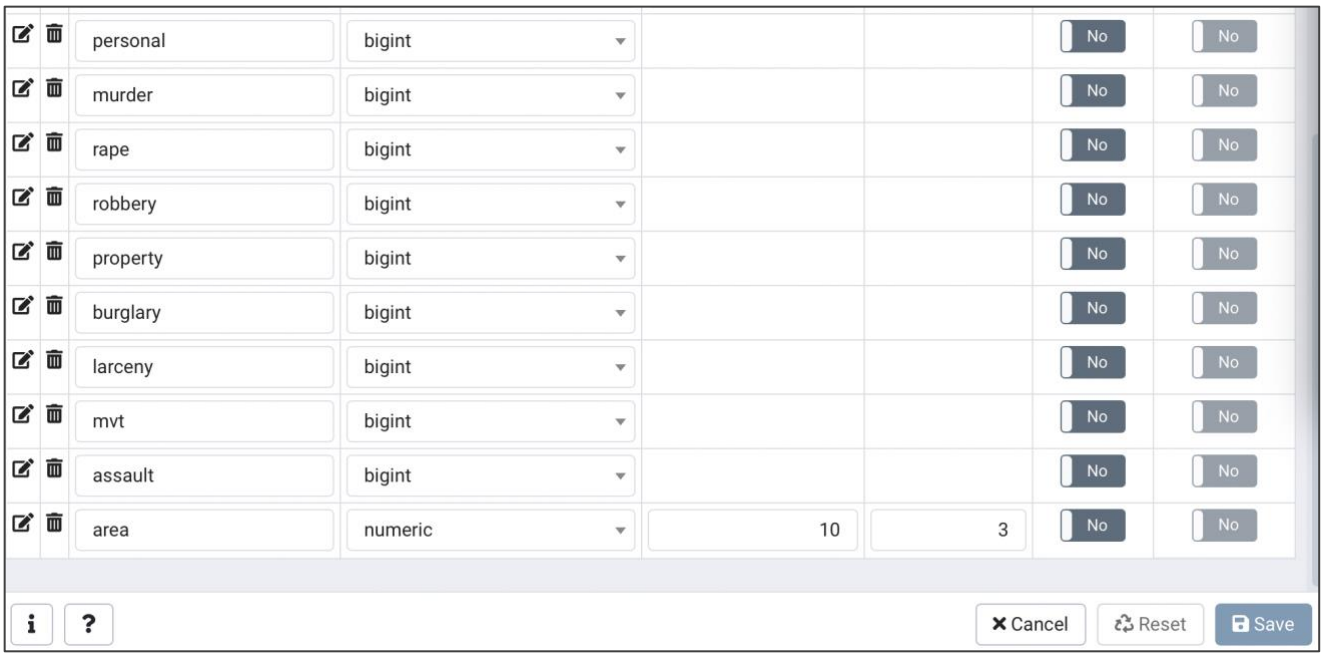


Figure 8: Neighborhood crime data - II

Road

Roads table stores line geometries of all existing roads in the Palm Beach county. The Collected road data from **Florida Department of Transportation** has been imported into the PostgreSQL, which consists of all necessary information such as, **id, geom, road_id, status, length** etc., Corresponding data types such as integer, geometry, character varying, double precision etc., where set to all the columns in the road table.

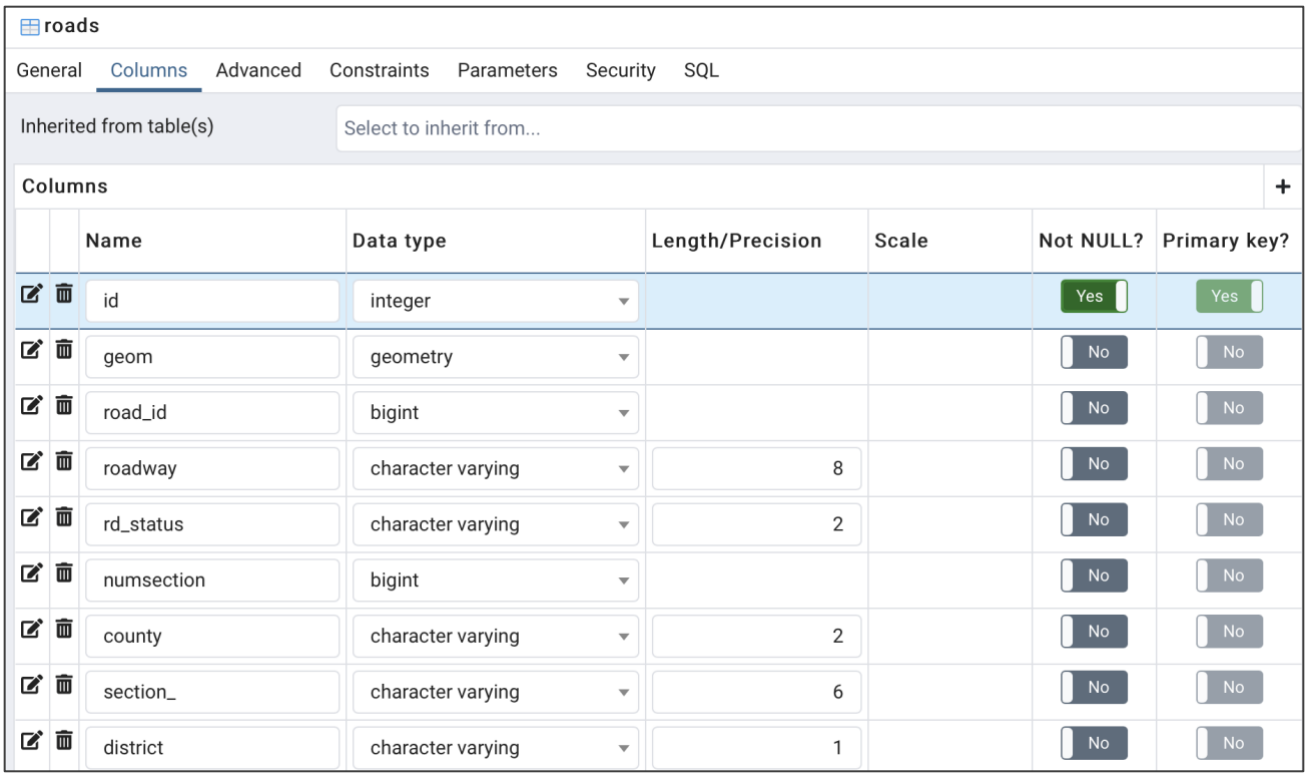


Figure 9: Features of roads table - I

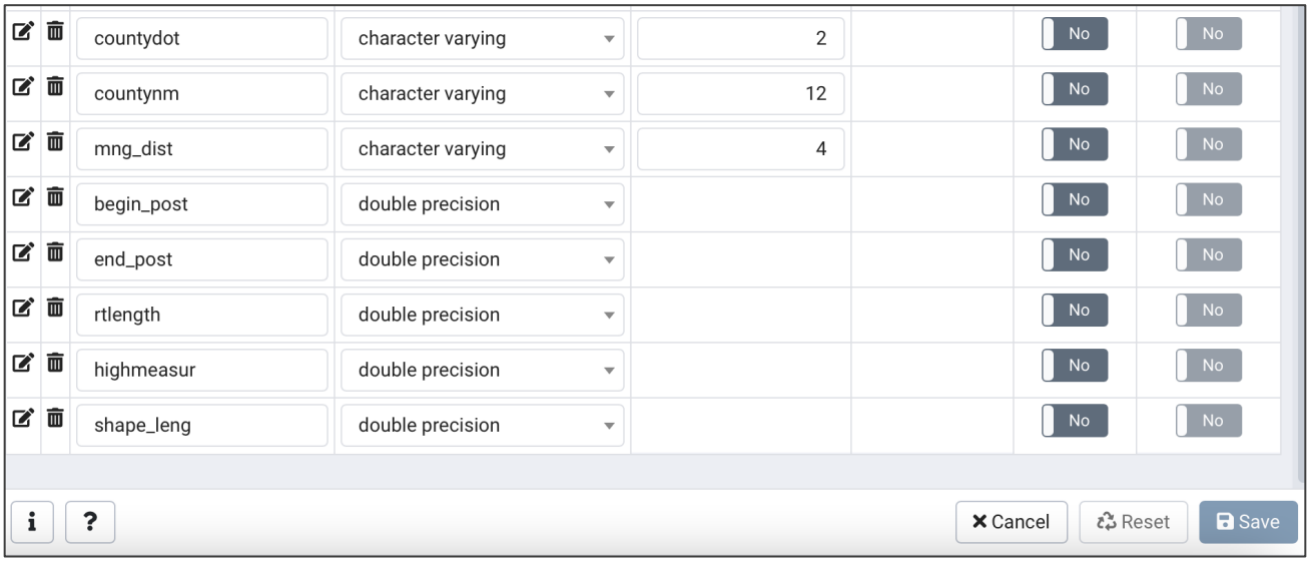


Figure 10: Features of road table - II

POI

POI table stores point geometries of all existing amenities in the Palm Beach county. The **Points of interest** data were collected from **Open Street Map** has been imported into the PostgreSQL, which consists of all necessary information of most of the amenities present inside the Palm beach county such as, **bank, atm, school, hospital, tourist places, parks** etc., which is being specified in the '**fclass'** field in the POI table. Other than this **id, geom, osm_id, code** and **name** are all the other columns present in this table, which is being stored with its respective data types.

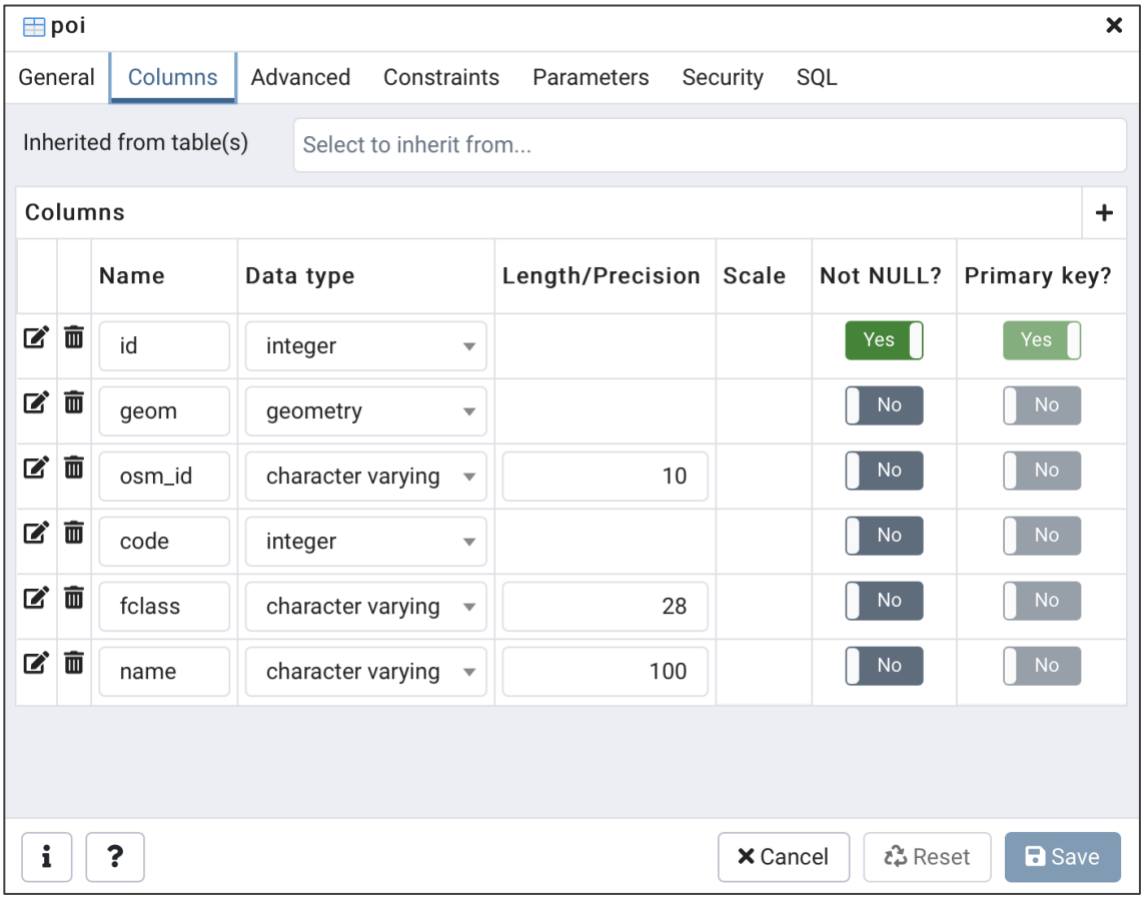


Figure 11: Columns of POI table

Bridges

Bridges table stores line geometries of all existing bridges in the Palm Beach county. The Collected bridge data from **Florida Department of Transportation** has been imported into the PostgreSQL, which consists of all necessary information such as, **id, geom, road_side, roadway, length** etc., Corresponding data types such as integer, geometry, character varying, double precision etc., where set to all the columns in the bridges table.

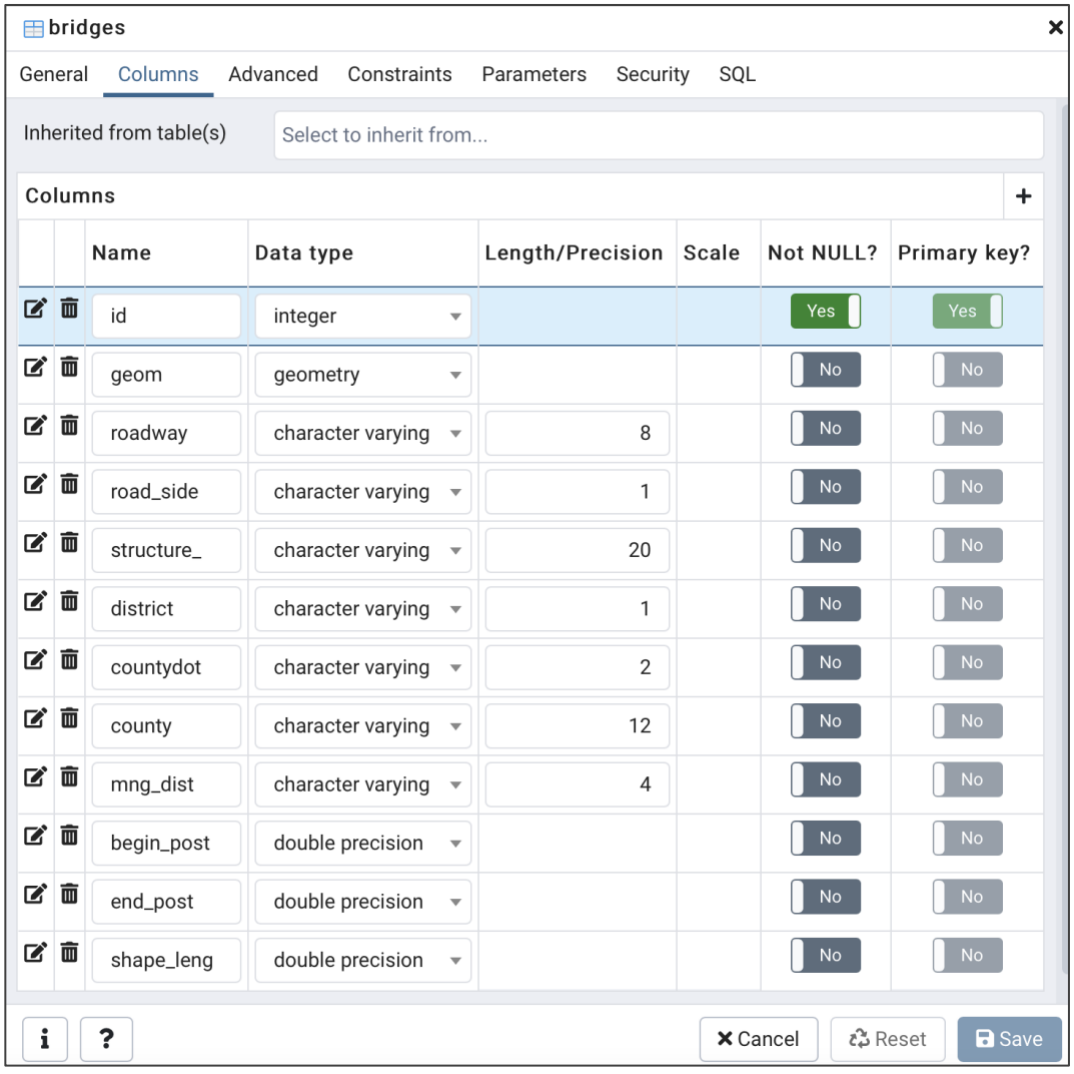


Figure 12: Columns of Bridges table

Bicycle lanes

Bicycle lanes table stores line geometries of all existing lanes in the Palm Beach county, that every bicycle can travel. The data has been collected from **Florida Department of Transportation** and then imported into the PostgreSQL, with all of its information such as, **id, geom, road_side, roadway, length** etc., along with its respective data types including integer, geometry, character varying, double precision etc., The data format is similar to the '**Roads'** and '**Bridges**' table.

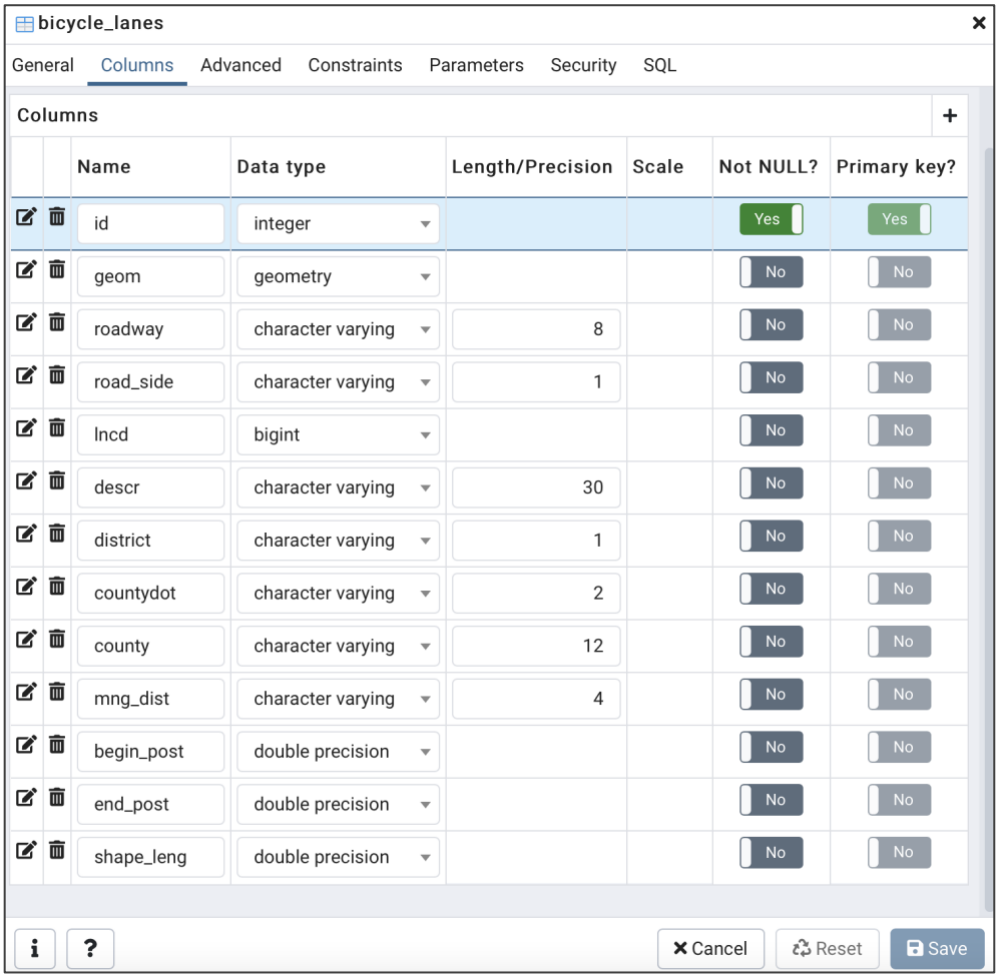


Figure 13: Columns of Bicycle lanes table

The collected data, which are being stored as shapefiles can be imported as a vector layer into the database using the "**Import vector layer**" tool available. During the import process, the target SRID is set as **EPSG:4269 - NAD83** for reprojection.

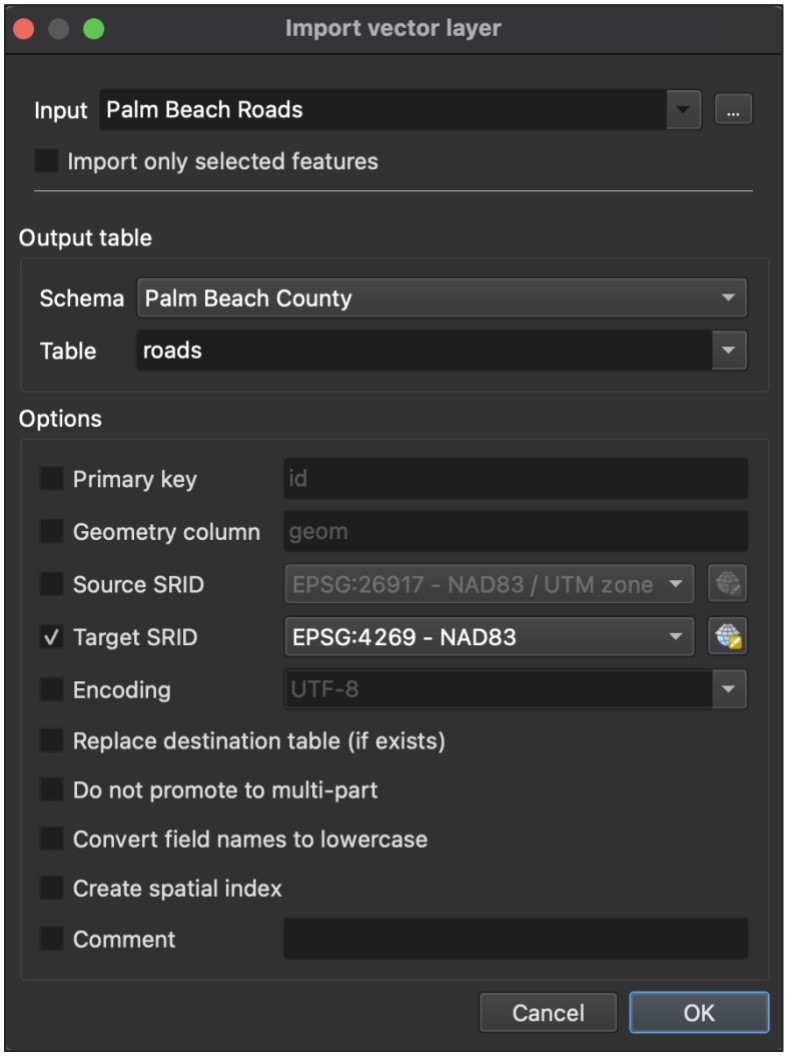


Figure 14: Importing data into the database

Similarly, the other datasets need to be imported into the PostgreSQL database, so that the necessary query can be performed.

All the data such as roads, bridges, bicycle lanes, amenities and the neighborhood crime data has been imported into the PostgreSQL database so that it can be queried using the pgAdmin.

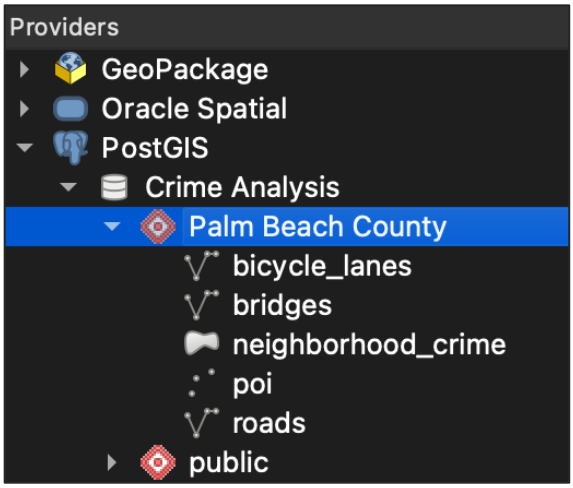


Figure 15: All tables for the Crime Analysis project

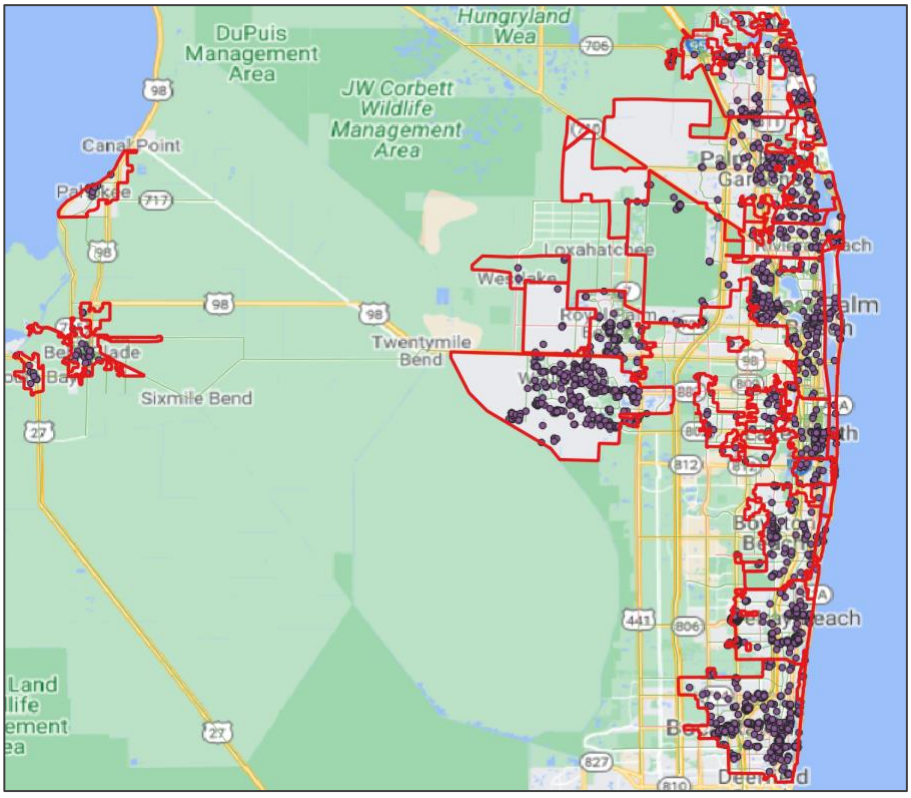


Figure 16: Visualization of all the datasets in Palm Beach county

Raster Data

In addition to all the spatial asset data of Palm Beach neighborhoods, raster data such as **Aspect** was also downloaded from **USGS** and used in this project to come up with better results. Aspect raster was pushed into the Crime Analysis database using **raster2pgsql** tool, in order to perform queries. To make this tool work, **postgis_raster** extension has to be added in the Crime Analysis database. Finally, the output of those queries has been visualized in **QGIS**.

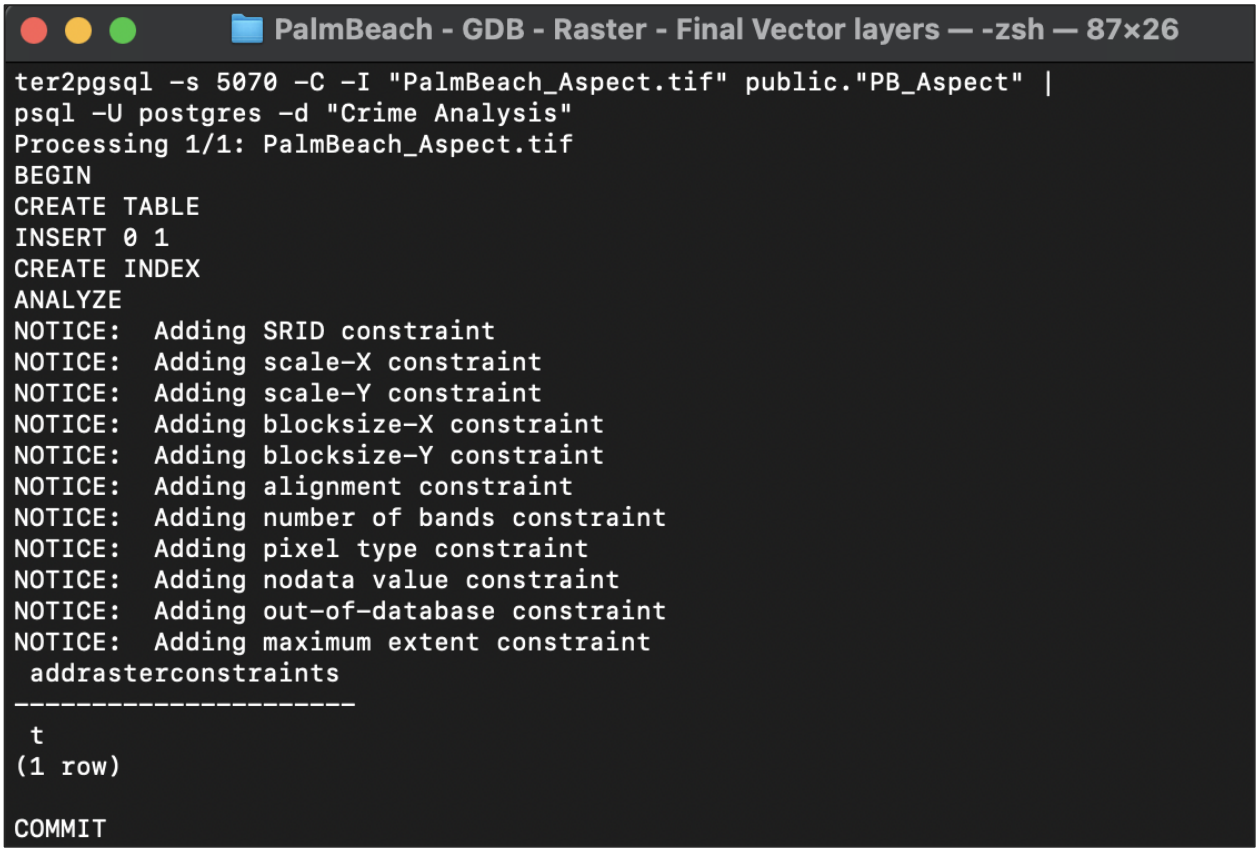


Figure 17: Inserting Aspect raster into database

Performing Queries

The Queries were developed to identify the safe neighborhood, roads, points of interests, bridges and bicycle lanes in the Palm Beach county. It has been divided into two major categories such as **Attribute** Query and **Spatial** Query. Spatial queries are further sub divided as **Vector** and **Raster** based queries. This division has been made for effective generation of output for the Crime Analysis and Mapping.

Before performing queries, **search path** needs to set to public, so that all the tables and functions are accessible. Apart from this **Spatial Reference** also needs to be verified, whether it matches the Palm Beach County dataset.

```
SET search_path TO public;
```

Figure 18: Setting search path

```
12  SELECT Find_SRID('Palm Beach County', 'total_crime', 'geom');
13
```

Data Output | Explain | Messages | Notifications | Geometry Viewer

	find_srid integer
1	4269

Figure 19: Verification of Spatial Reference

In order to speed up the querying process, **spatial index** needs to be created for the roads table, as there are many records present in it. It need not be created for all the other tables such as neighborhood, bridges etc.,

```
CREATE INDEX road_index ON "Palm Beach County".roads
USING GIST (geom);
```

Figure 20: Creation of spatial index - Roads table

Attribute Queries

Seven attribute queries were performed to fulfill the requirement of this project and to come up with an effective solution for Crime analysis.

1. Sorting neighborhoods based on total crime index
2. Crime index for a given neighborhood
3. Neighborhood having lowest rape index
4. Neighborhood easily affected by Property crime index
5. Top 5 neighborhoods with highest burglary and larceny crime index
6. Neighborhoods with personal crime index greater than 150
7. Neighborhood name containing the word ‘Beach’ and with total crime index value greater than 500

Query 1: Sorting neighborhood based on total crime

```
-- 1. Calculate total crime and Sorting the neighborhood by crime (After summing up all crime data).

CREATE OR REPLACE VIEW "Palm Beach County".total_crime AS
    SELECT INITCAP(muniname) as name, geom,
    (personal + murder + rape + robbery + property + burglary + larceny + mvt + assault) as total
    FROM "Palm Beach County".neighborhood_crime;

SELECT * FROM "Palm Beach County".total_crime
ORDER BY total ASC;
```

Data Output | Explain | Messages | Notifications | Geometry Viewer

	name text	geom geometry	total bigint
1	Jupiter Inlet Colony	0106000020AD10000001000000010300000001000000D01000079E839ED190554C0A4...	185
2	South Palm Beach	0106000020AD10000001000000010300000001000005F0000003AD90A685E0254C08C...	275
3	Juno Beach	0106000020AD10000001000000010300000001000005903000030C03FDCA50454C0ED7B	289
4	Golf	0106000020AD10000001000000010300000001000000E2000000F89E57F3780654C0186...	301
5	Highland Beach	0106000020AD10000001000000010300000001000000B6000000703F5972190454C01C...	316
6	Tequesta	0106000020AD10000001000000010300000001000000DF0400000723D6DCA00654C0CBB6	323
7	Palm Beach	0106000020AD10000002000000010300000001000000760200006 2CE0787050254C00E787	326
8	Wellington	0106000020AD10000001000000010300000001000000DB0300009E4E2DFC161354C06DFE	410
9	North Palm Beach	0106000020AD10000001000000010300000001000000170300001D1CD585B50454C093E4	433
10	Jupiter	...	493

Figure 21: Sorting neighborhood based on total crime

Query 2: Visualization of crime indices at a given neighborhood

```
-- 2. Visualization of crime indices at a given neighborhood

SELECT muniname, geom,
        personal, murder, rape, robbery, property, burglary, larceny, mvt, assault
FROM "Palm Beach County".neighborhood_crime
where muniname = 'PALM BEACH'
```

Data Output | Explain | Messages | Notifications | Geometry Viewer

	muniname character varying (80)	geom geometry	personal bigint	murder bigint	rape bigint	robbery bigint	property bigint	burglary bigint	larceny bigint	mvt bigint	assault bigint
1	PALM BEACH	0106000020AD10000	27	5	21	17	56	53	56	58	33

Figure 22: Crime index for a given neighborhood

Query 3: Neighborhood with lowest rape index

```
38  -- 3. Which neighborhood has lowest rape index
39
40  SELECT muniname, geom, rape
41  FROM "Palm Beach County".neighborhood_crime
42  WHERE rape = (SELECT min(rape)
43  FROM "Palm Beach County".neighborhood_crime)
44
```

Data Output | Explain | Messages | Notifications | Geometry Viewer

	muniname character varying (80)	geom geometry	rape bigint
1	JUPITER INLET COLONY	0106000020AD100...	5
2	PALM BEACH SHORES	0106000020AD100...	5

Figure 23: Neighborhood having lowest rape index

Query 4: Neighborhood easily affected by Property crime index

```
45  -- 4. Which neighborhood is easily affected by Property crime index
46
47  SELECT muniname, geom, property
48  FROM "Palm Beach County".neighborhood_crime
49  WHERE property = (SELECT max(property)
50  FROM "Palm Beach County".neighborhood_crime)
51
```

Data Output | Explain | Messages | Notifications | Geometry Viewer

	muniname character varying (80)	geom geometry	property bigint
1	MANGONIA PARK	0106000020AD100...	331

Figure 24: Neighborhood easily affected by Property crime

Query 5: Top 5 neighborhood with higher burglary and larceny index

```
52  -- 5. List top 5 neighborhoods that has highest number of Burglary and Larceny Crime
53
54  SELECT muniname, geom, burglary, larceny
55  FROM "Palm Beach County".neighborhood_crime
56  ORDER BY burglary DESC, larceny DESC LIMIT 5
57
```

Data Output | Explain | Messages | Notifications | Geometry Viewer

	muniname character varying (80)	geom geometry	burglary bigint	larceny bigint
1	PALM BEACH SHORES	0106000020AD100...	277	99
2	MANGONIA PARK	0106000020AD100...	240	357
3	BELLE GLADE	...	217	148
4	LAKE WORTH BEACH	0106000020AD10000	210	156
5	LAKE PARK	0106000020AD10000	181	371

Figure 25: Top 5 neighborhood with highest burglary and larceny crime index

Query 6: Neighborhoods with personal crime index greater than 150

```
58  -- 6. Personal crime index value greater than x  value
59
60  SELECT muniname, geom, personal
61  FROM "Palm Beach County".neighborhood_crime
62  WHERE personal >= 150
63  ORDER BY personal DESC
64
```

Data Output | Explain | Messages | Notifications | Geometry Viewer

	muniname character varying (80)	geom geometry	personal bigint
1	MANGONIA PARK	0106000020AD100...	522
2	BELLE GLADE	...	309
3	RIVIERA BEACH	0106000020AD10000	304
4	SOUTH BAY	0106000020AD100...	294
5	LAKE WORTH BEACH	0106000020AD10000	278
6	PAHOKEE	0106000020AD10000	262
7	LAKE PARK	0106000020AD10000	251
8	WEST PALM BEACH	0106000020AD10000	215
9	LANTANA	0106000020AD10000	159

Figure 26: Neighborhoods with personal crime index greater than 150

Query 7: Neighborhood's name containing 'Beach' and having total crime index greater than 500

```
65  -- 7. Neighborhood names contains x word and total crime index greater than y value
66
67  SELECT name, geom, total
68  FROM  "Palm Beach County".total_crime
69  WHERE name LIKE '%Beach%' AND total >= 500
70  ORDER BY total DESC
71
```

Data Output | Explain | Messages | Notifications | Geometry Viewer

	name text	geom geometry	total bigint
1	Riviera Beach	0106000020AD10000001000	2256
2	Lake Worth Beach	0106000020AD10000001000	2135
3	West Palm Beach	0106000020AD10000001000	1916
4	Delray Beach	0106000020AD10000001000	1238
5	Boynton Beach	...	1178
6	Palm Beach Shores	0106000020AD100000010...	948
7	Palm Beach Gardens	...	581

Figure 27: Neighborhood name with 'Beach' and total crime index greater than 500

Spatial Queries

Spatial queries help in fetching information from a map layer by querying a spatial database. Queries can be performed both in Vector and Raster datasets.

Vector based

Views has been created to store vector queries in the PostgreSQL. To visualize the output, these views are then loaded in **QGIS**. A Map depicting the spread of crime has been generated as an output of all vector queries.

Query 1: Safest Neighborhood with more tourist places

```
90  -- 1. Which safest neighborhood has more number of tourist_info
91
92  CREATE OR REPLACE VIEW "Palm Beach County".vq1 AS
93      SELECT tc.name, tc.total as total_crime, count(poi.geom) as tourist_poi, tc.geom
94      FROM "Palm Beach County".poi as poi, "Palm Beach County".total_crime AS tc
95      WHERE ST_Within(poi.geom, tc.geom) AND poi.fclass = 'tourist_info'
96      GROUP BY tc.name, tc.total, tc.geom
97      ORDER BY tc.total ASC, tourist_poi DESC
98      LIMIT 1;
99
100 SELECT * from "Palm Beach County".vq1;
```

Data Output | Explain | Messages | Notifications | Geometry Viewer

	name text	total_crime bigint	tourist_poi bigint	geom geometry
1	Wellington	410	66	0106000020AD10000001000000010300000001000000DB0300009

Figure 28: SQL Code for safest neighborhood with more tourist places

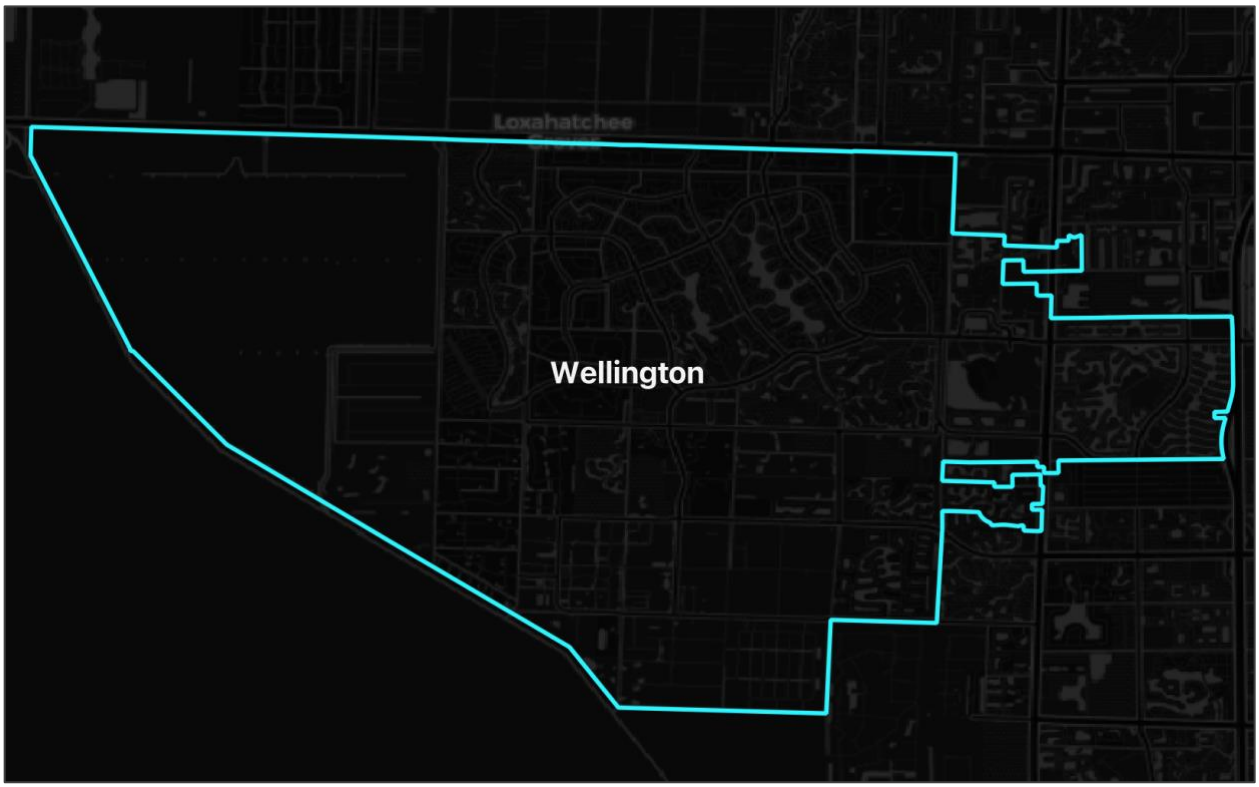


Figure 29: Visualization of safest neighborhood with more tourist places

Query 2: Shops in red zones with respect to robbery

```sql
-- 2. Which 5 shops are all at red zone with respect to robbery

CREATE OR REPLACE VIEW "Palm Beach County".vq2 AS
    SELECT nc.robbery, poi.fclass, poi.geom
    FROM "Palm Beach County".poi as poi, "Palm Beach County".neighborhood_crime AS nc
    WHERE ST_Within(poi.geom, nc.geom) AND poi.fclass LIKE '%shop%'
    GROUP BY nc.robbery, poi.fclass, poi.geom
    ORDER BY nc.robbery DESC
    LIMIT 5;

SELECT * from "Palm Beach County".vq2;
```

Data Output | Explain | Messages | Notifications | Geometry Viewer

	robbery bigint	fclass character varying (28)	geom geometry
1	344	bicycle_shop	0101000020AD100...
2	287	beauty_shop	0101000020AD100...
3	287	beauty_shop	0101000020AD100...
4	287	beauty_shop	0101000020AD100...
5	287	beauty_shop	0101000020AD100...

Figure 30: SQL Query to fetch shops at red zone with respect to robbery

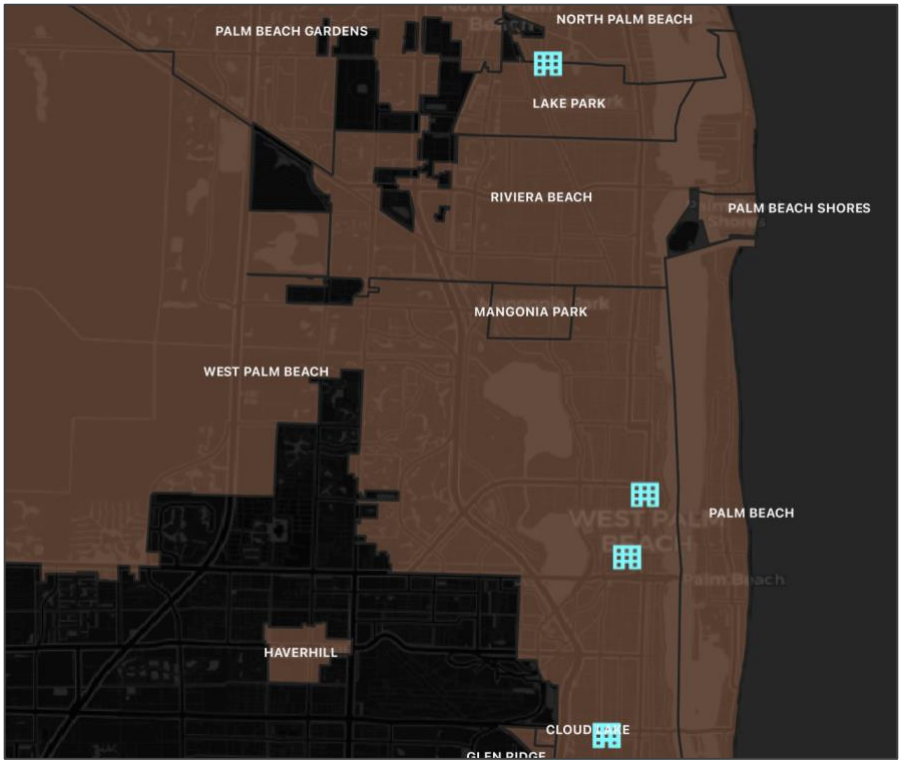


Figure 31: Visualizing the shops at red zone with respect to robbery

Query 3: Bike lanes with more motor vehicle theft

```
114  -- 3. Which bike lanes are not safe - using Motor vehicle theft
115
116  DROP TABLE IF EXISTS tempTable;
117
118  SELECT * INTO tempTable
119  FROM (SELECT nc.muniname, bl.geom, nc.mvt
120      FROM "Palm Beach County".neighborhood_crime as nc
121      LEFT JOIN "Palm Beach County".bicycle_lanes as bl
122      ON ST_Crosses(bl.geom, nc.geom)
123      WHERE bl.geom IS NOT NULL ORDER BY nc.mvt DESC) as output;
124
125  CREATE OR REPLACE VIEW "Palm Beach County".vq3 AS
126      SELECT * FROM tempTable
127      WHERE mvt = (SELECT MAX(mvt) FROM tempTable);
128
129  SELECT * from "Palm Beach County".vq3;
```

Data Output | Explain | Messages | Notifications | Geometry Viewer

	muniname character varying (80)	geom geometry	mvt bigint
1	RIVIERA BEACH	0105000020AD100...	194
2	RIVIERA BEACH	0105000020AD100...	194
3	RIVIERA BEACH	0105000020AD100...	194
4	RIVIERA BEACH	0105000020AD100...	194
5	RIVIERA BEACH	0105000020AD100...	194
6	RIVIERA BEACH	0105000020AD100...	194

Figure 32: SQL for fetching bike lanes with higher motor vehicle theft index

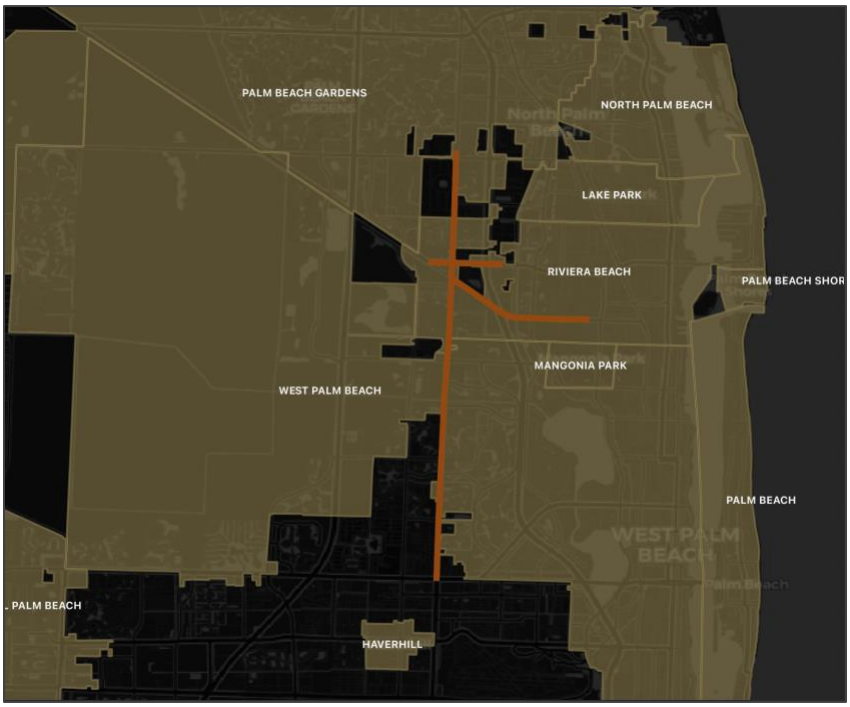


Figure 33: Visualizing the bike lane with high motor vehicle theft

Query 4: Roads connecting top 2 safest neighborhood

```sql
-- 4. Roads connecting top 2 safest neighborhood

CREATE OR REPLACE VIEW "Palm Beach County".vq4 AS
    SELECT tc.total as total_crime, rd.geom
    FROM "Palm Beach County".roads as rd, "Palm Beach County".total_crime AS tc
    WHERE ST_NumGeometries(ST_Intersection(tc.geom, rd.geom)) = 2
    GROUP BY rd.road_id, tc.total, rd.geom
    ORDER BY tc.total ASC LIMIT 2;

SELECT * from "Palm Beach County".vq4;
```

Data Output | Explain | Messages | Notifications | Geometry Viewer

	total_crime bigint	geom geometry
1	323	0105000060AD100...
2	323	0105000060AD100...

Figure 34: SQL for finding roads that connect top 2 safest neighborhood

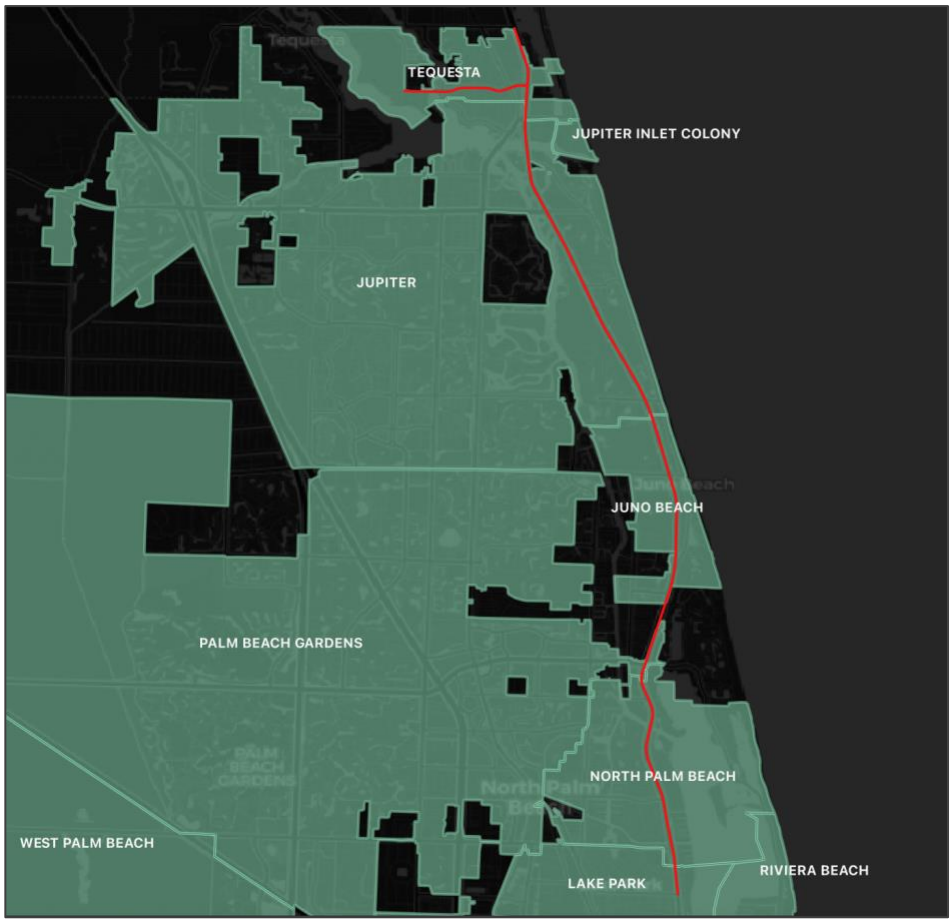


Figure 35: Visualization of roads that connect top 2 safest neighborhood

Query 5: Calculating crime indices for all roads

```
142  -- 5. Calculate crime index for all roads (view)
143
144  CREATE OR REPLACE VIEW "Palm Beach County".vq5 AS
145      SELECT rd.road_id, sum(tc.total) as total_crime, rd.geom
146      FROM "Palm Beach County".roads as rd
147      LEFT JOIN "Palm Beach County".total_crime AS tc
148      ON ST_Intersects(tc.geom, rd.geom)
149      GROUP BY rd.road_id, rd.geom
150      ORDER BY total_crime ASC;
151
152  SELECT * from "Palm Beach County".vq5;
153
```

Data Output | Explain | Messages | Notifications | Geometry Viewer

	road_id bigint	total_crime numeric	geom geometry
1	93040001	289	0105000060AD100...
2	93000179	289	0105000060AD100...
3	93000114	323	0105000060AD100...
4	93940000	323	0105000060AD100...
5	93000007	323	0105000060AD100...
6	93941000	323	0105000060AD100...

Figure 36: SQL for calculating crime index for all roads

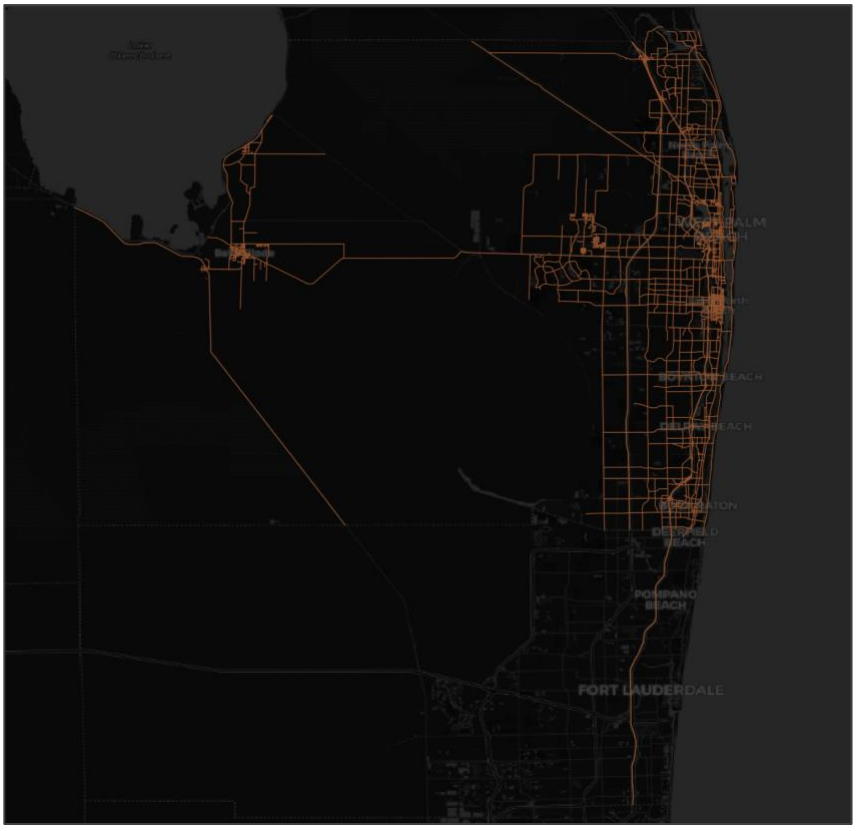


Figure 37: Visualizing all roads in Palm Beach

Query 6: Sorting banks, atm on safest road

```
154  -- 6. Sorting banks, atms on safest road (from view 5)
155
156  CREATE OR REPLACE VIEW "Palm Beach County".vq6 AS
157      SELECT poi.fclass, poi.geom FROM "Palm Beach County".poi AS poi
158      JOIN "Palm Beach County".vq5 as safe_rd
159      ON  ST_DWithin(poi.geom, safe_rd.geom, 0.0005) -- 50 m
160      WHERE poi.fclass = 'bank' OR poi.fclass = 'atm'
161      GROUP BY poi.geom, poi.fclass;
162
163  SELECT * from "Palm Beach County".vq6;
164
```

Data Output | Explain | Messages | Notifications | Geometry Viewer

	fclass character varying (28)	geom geometry
1	bank	0101000020AD100...
2	bank	0101000020AD100...
3	bank	0101000020AD100...
4	bank	0101000020AD100...
5	bank	0101000020AD100...
6	bank	0101000020AD100...
7	bank	0101000020AD100...

Figure 38: SQL for sorting bank, atm on safest road

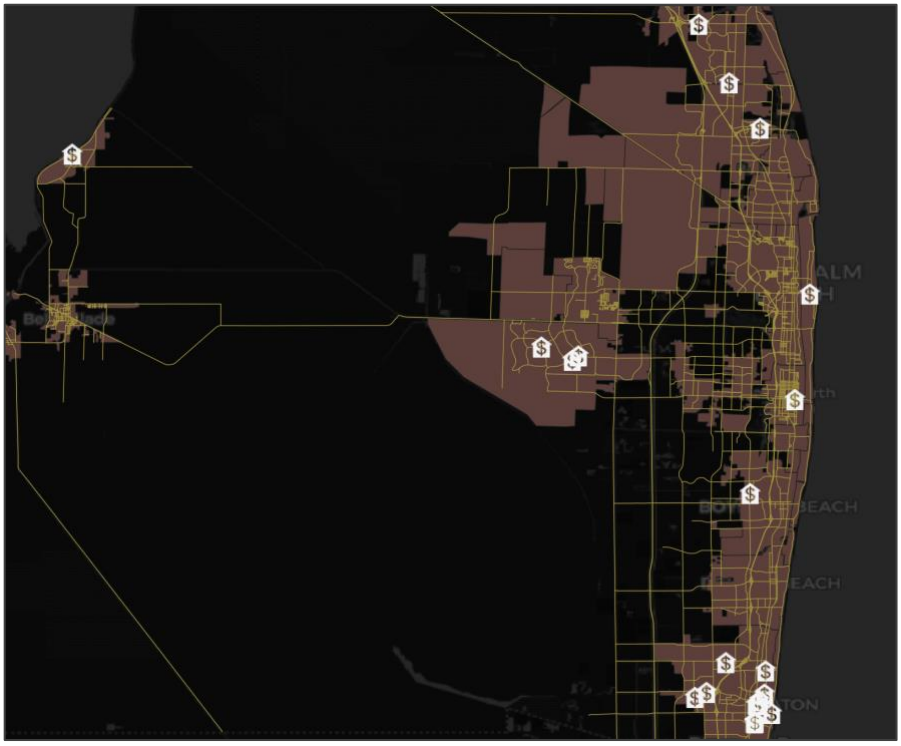


Figure 39: Visualizing bank/atm on safest road

Query 7: Crime statistics based on a 5 mile buffer at any given point

```
-- 7. Crime Statistics based on a 5 mile buffer of any given point

CREATE OR REPLACE VIEW "Palm Beach County".vq7 AS
    SELECT muniname, geom,
        personal, murder, rape, robbery, property, burglary, larceny, mvt, assault
    FROM "Palm Beach County".neighborhood_crime as nc
    WHERE ST_Intersects(ST_Multi(ST_Buffer(ST_GeomFromText('POINT (-80.254788 26.682384)', 4269), 0.08)), -- approx 5 miles
                        nc.geom);

SELECT * from "Palm Beach County".vq7;
```

Data Output | Explain | Messages | Notifications | Geometry Viewer

	muniname character varying (80)	geom geometry	personal bigint	murder bigint	rape bigint	robbery bigint	property bigint	burglary bigint	larceny bigint	mvt bigint	assault bigint
1	ROYAL PALM BEACH	0106000020AD10000	53	27	61	37	82	39	98	44	58
2	LOXAHATCHEE GROVES	0106000020AD10000	54	12	16	22	90	89	91	80	73
3	WELLINGTON	0106000020AD10000	37	21	51	30	65	40	73	55	38
4	WEST PALM BEACH	0106000020AD10000	215	350	155	287	183	155	189	188	194
5	WESTLAKE	0106000020AD100...	54	14	25	17	82	86	81	79	74

Figure 40: SQL for calculating crime statistics

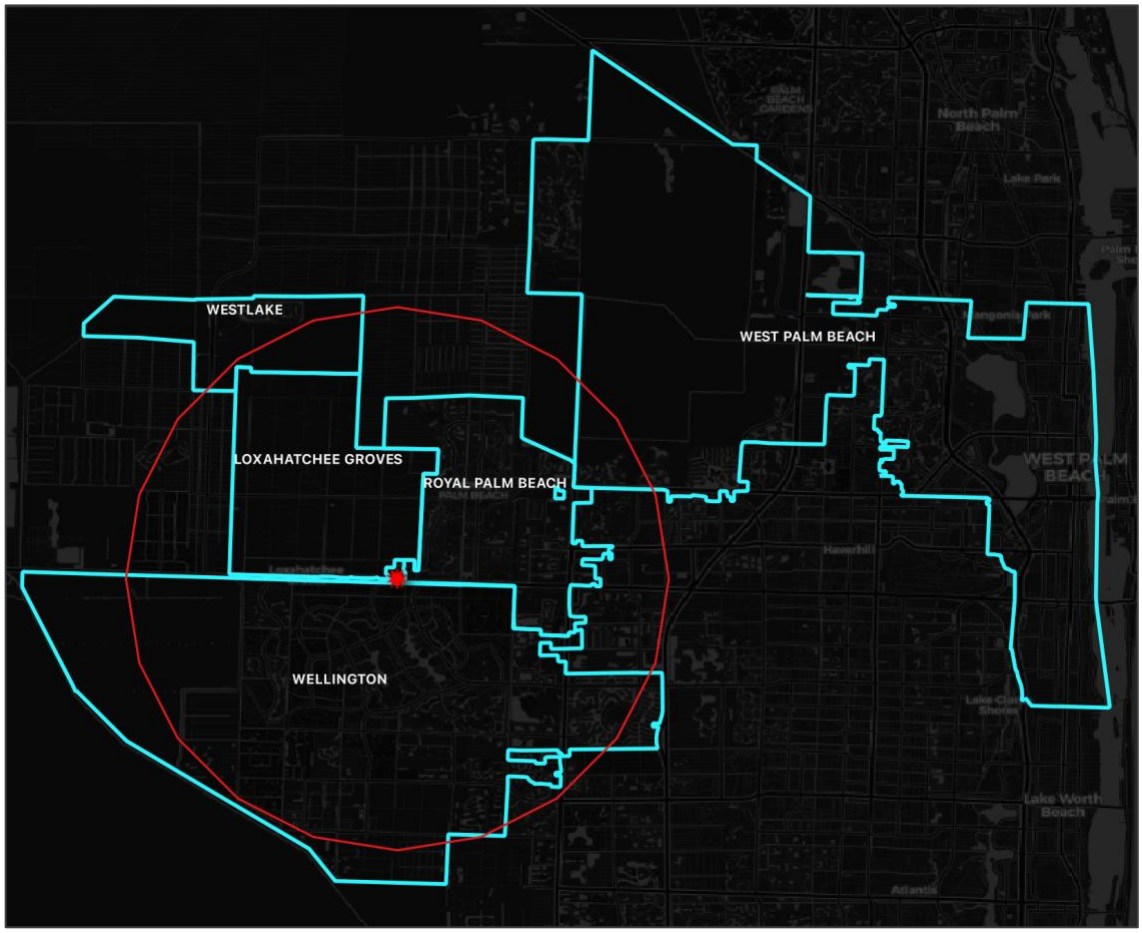


Figure 41: Visualization of neighborhoods within 5 mile of given point

Query 8: Safest 20 bike lanes and its corresponding neighborhood based on total crime

```sql
-- 8. Safe 20 Bike lanes and its neighborhood based on Total Crime

CREATE OR REPLACE VIEW "Palm Beach County".vq8 AS
    SELECT tc.name, bl.geom, tc.total
    FROM "Palm Beach County".total_crime as tc
    LEFT JOIN "Palm Beach County".bicycle_lanes as bl
    ON ST_Intersects(bl.geom, tc.geom)
    WHERE bl.geom IS NOT NULL
    ORDER BY tc.total ASC LIMIT 20;

SELECT * from "Palm Beach County".vq8;
```

Data Output | Explain | Messages | Notifications | Geometry Viewer

	muniname character varying (80)	geom geometry	personal bigint	murder bigint	rape bigint	robbery bigint	property bigint	burglary bigint	larceny bigint	mvt bigint	assault bigint
1	ROYAL PALM BEACH	0106000020AD10000	53	27	61	37	82	39	98	44	58
2	LOXAHATCHEE GROVES	0106000020AD10000	54	12	16	22	90	89	91	80	73
3	WELLINGTON	0106000020AD10000	37	21	51	30	65	40	73	55	38
4	WEST PALM BEACH	0106000020AD10000	215	350	155	287	183	155	189	188	194
5	WESTLAKE	0106000020AD100...	54	14	25	17	82	86	81	79	74

Figure 42: SQL to fetch safest bike lanes based on total crime

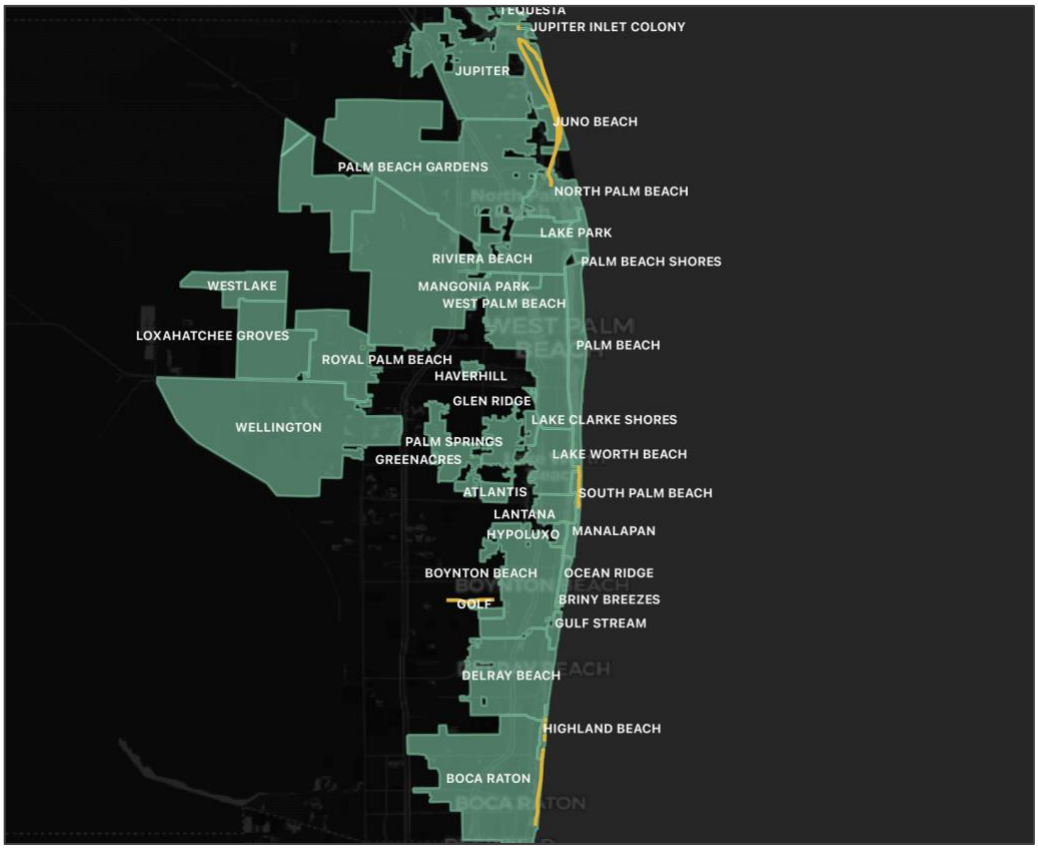


Figure 43: Visualization of safest bike lanes based on total crime

Query 9: Top 10 bridges with highest crime index

```
188  -- 9. Top 10 Bridges present in higher crime index neighborhood
189
190  CREATE OR REPLACE VIEW "Palm Beach County".vq9 AS
191      SELECT tc.name, bridges.structure_, bridges.geom, tc.total
192      FROM "Palm Beach County".total_crime as tc
193      LEFT JOIN "Palm Beach County".bridges as bridges
194      ON ST_Crosses(bridges.geom, tc.geom)
195      WHERE bridges.geom IS NOT NULL
196      ORDER BY tc.total DESC LIMIT 10;
197
198  SELECT * from "Palm Beach County".vq9
199
```

Data Output | Explain | Messages | Notifications | Geometry Viewer

	name text	structure_ character varying (20)	geom geometry	total bigint
1	Lake P...	934164	0105000020AD100...	2432
2	Riviera ...	934171	0105000020AD100...	2256
3	Lake W...	930373	0105000020AD100...	2135
4	Lake W...	930367	0105000020AD100...	2135
5	West P...	930367	0105000020AD100...	1916
6	West P...	930506	0105000020AD100...	1916
7	West P...	930479	0105000020AD100...	1916

Figure 44: SQL to get top 10 bridges with high crime index

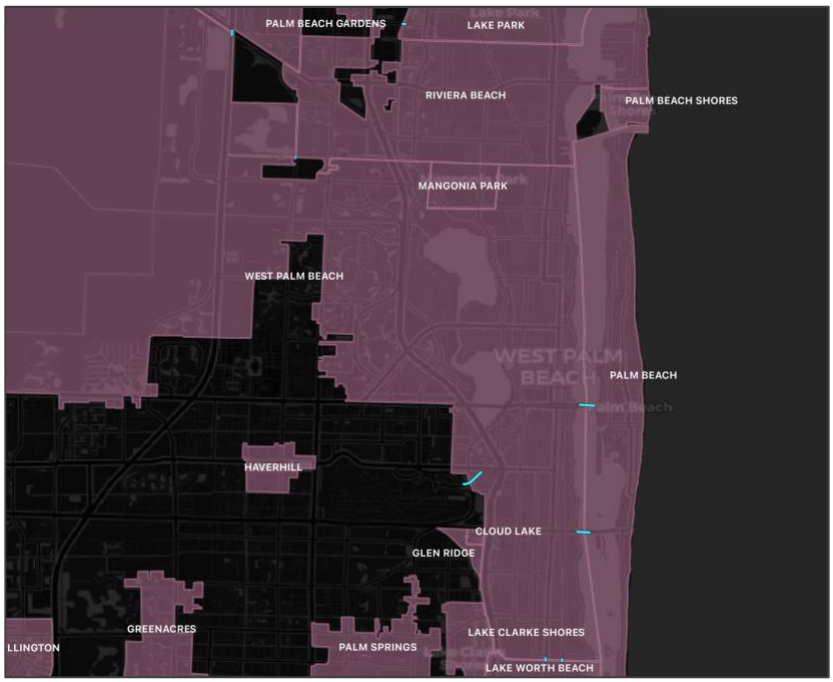


Figure 45: Visualization of top 10 bridges with high crime index value

Raster based

The Aspect data downloaded from USGS has been used to perform query and create maps out of it. Two queries have been done in order to learn about the crime analytics in detail. One is to clip a particular portion or a neighborhood from the Palm Beach county and export that as a separate tiff file. Another one is to determine the summary statistics for any given neighborhood. Similar kind of queries can be applied to any crime related raster layers based on the necessity.

Query 1: Clip and save aspect for a given neighborhood

```
-- 1. Clip and save elevation raster to any of the palm beach neighborhood

CREATE TABLE tmp_out AS
    SELECT lo_from_bytea(0, ST_AsGDALRaster(
        (SELECT ST_Clip(rast, ST_Transform(polygon.geom, 5070))
        FROM pb_aspect, (SELECT * from "Palm Beach County".neighborhood_crime
        WHERE muniname = 'BOCA RATON') as polygon), 'GTIff')
    ) AS rast_out
FROM pb_aspect;

SELECT lo_export(rast_out, 'BocaRaton_Aspect.tif') FROM tmp_out;
SELECT lo_unlink(rast_out) FROM tmp_out;
```

Figure 46: SQL for clipping a raster and exporting as tif file

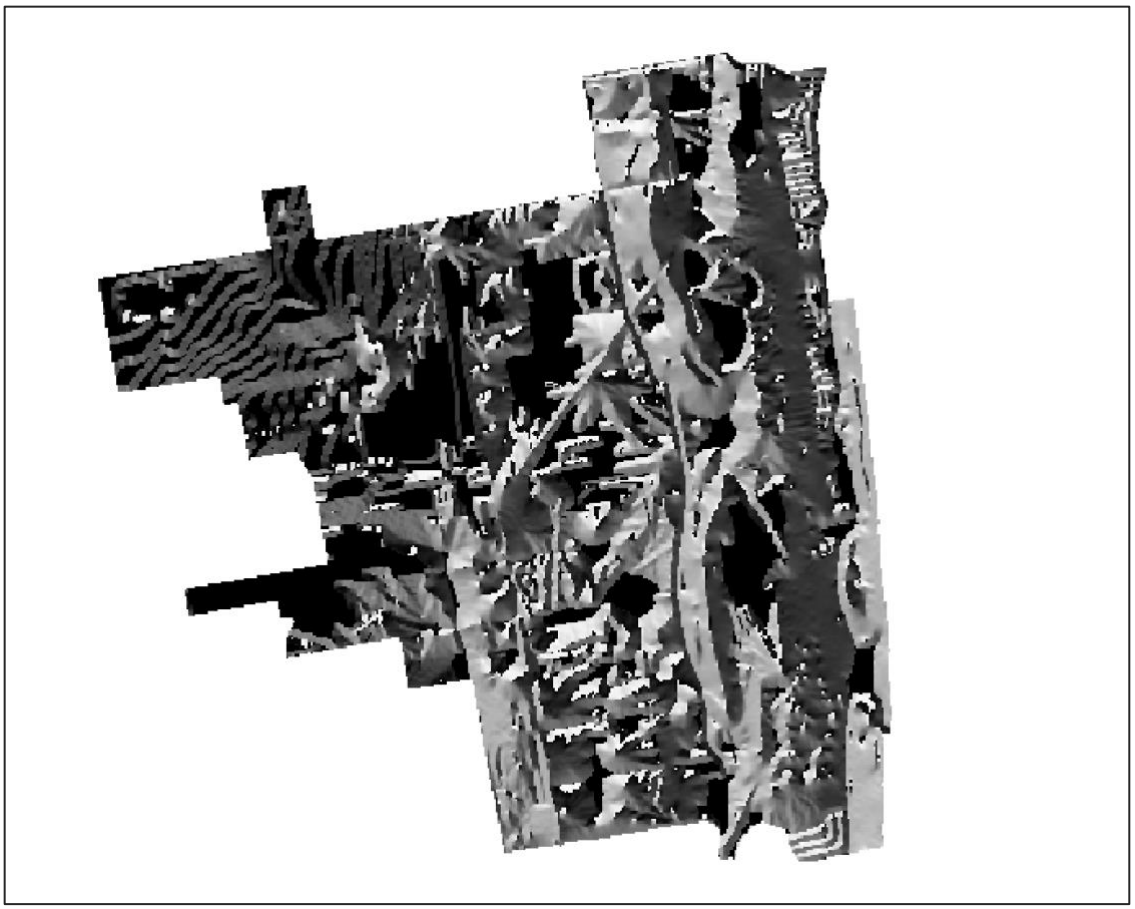


Figure 47: Output of the clipped aspect raster

Query 2: Summary Statistics of raster

Query Editor | Query History

```
1  SELECT (ST_SummaryStats(ST_Clip(rast, ST_Transform(polygon.geom, 5070)))).*
2  FROM pb_aspect, (SELECT * from "Palm Beach County".neighborhood_crime
3  WHERE muniname = 'ATLANTIS') as polygon;
```

Data Output | Explain | Messages | Notifications

	count bigint	sum double precision	mean double precision	stddev double precision	min double precisio	max double precision
1	4103	371596.4315023422	90.56700743415604	108.39852792217498	-1	359.8611145019531

Figure 48: SQL for fetching statistics of aspect raster

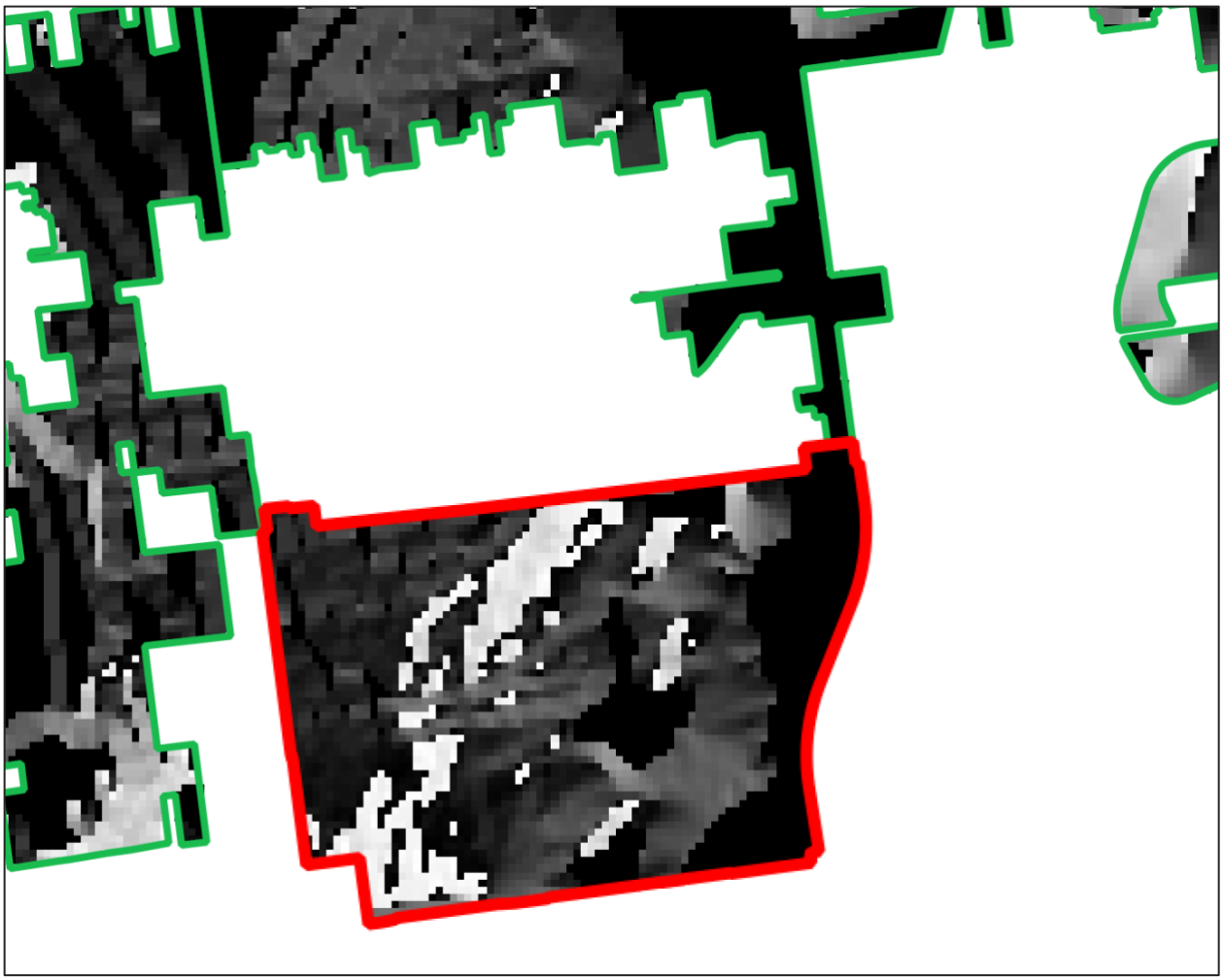


Figure 49: Highlighted the raster polygon whose summary statistics is computed

Mapping

After querying all required features from the spatial database, the output needs to be compiled and added to QGIS for Visualization and Map Creation. The Essential Elements of Map are Title, Legend, North Arrows, Scale, Labels, Grids with Index and Citation.

Symbology

Symbology needs to be effectively chosen, so that all the necessary output can be clearly visualized. Choosing lighter or darker colors should be based on the visually appealing factor.

Labelling

Labelling the data for all neighborhoods is required. All the other datasets need not to be labelled as there are lots of information present. Properties of the text such as formatting, alignment, background, placement, rendering can also be set for the layer.

Legend

Legend needs to be placed on the map at the required position. **Auto update** needs to be enabled so that, whenever there is a change in layer, legend also gets updated automatically. Properties such as fonts, text formatting, title etc., can be changed as per requirement.

Title

A Well-defined title related to the map must be present. Font style and text position of title can be made so that the map appearance is visually appealing.

Scale Bar

Adding a scale bar to the map represents the scale of the created map. Style, units and properties of text such as don't, color etc., can be modified as needed for the map.

North Arrow

North arrow is an important factor for every map, which indicates the direction of the map that one creates. Properties of the symbol such as resize, placement etc., can also be updated based on the requirement of map.

Basemap

Basemap is an optional one, which gives an additional beauty to the created map layout and various other information can be also fetched from the basemap when it is added on to a map layout.

Citation

Any map that is being prepared must contain the author's name as well the date when the map was created. Also, if there is any citation to be specified for the layers that are used in map, it must also be given.

Visualization of safe assets in Palm Beach

This map represents the safest bike lanes that are present in the Palm Beach county. Along with that, safer bank and atm is also shown in the map. This will be useful for the people who needs to withdraw cash from bank or atm and return back to his desired place by bicycle. A person can choose the safest bike lane and an atm or bank based on their necessity.

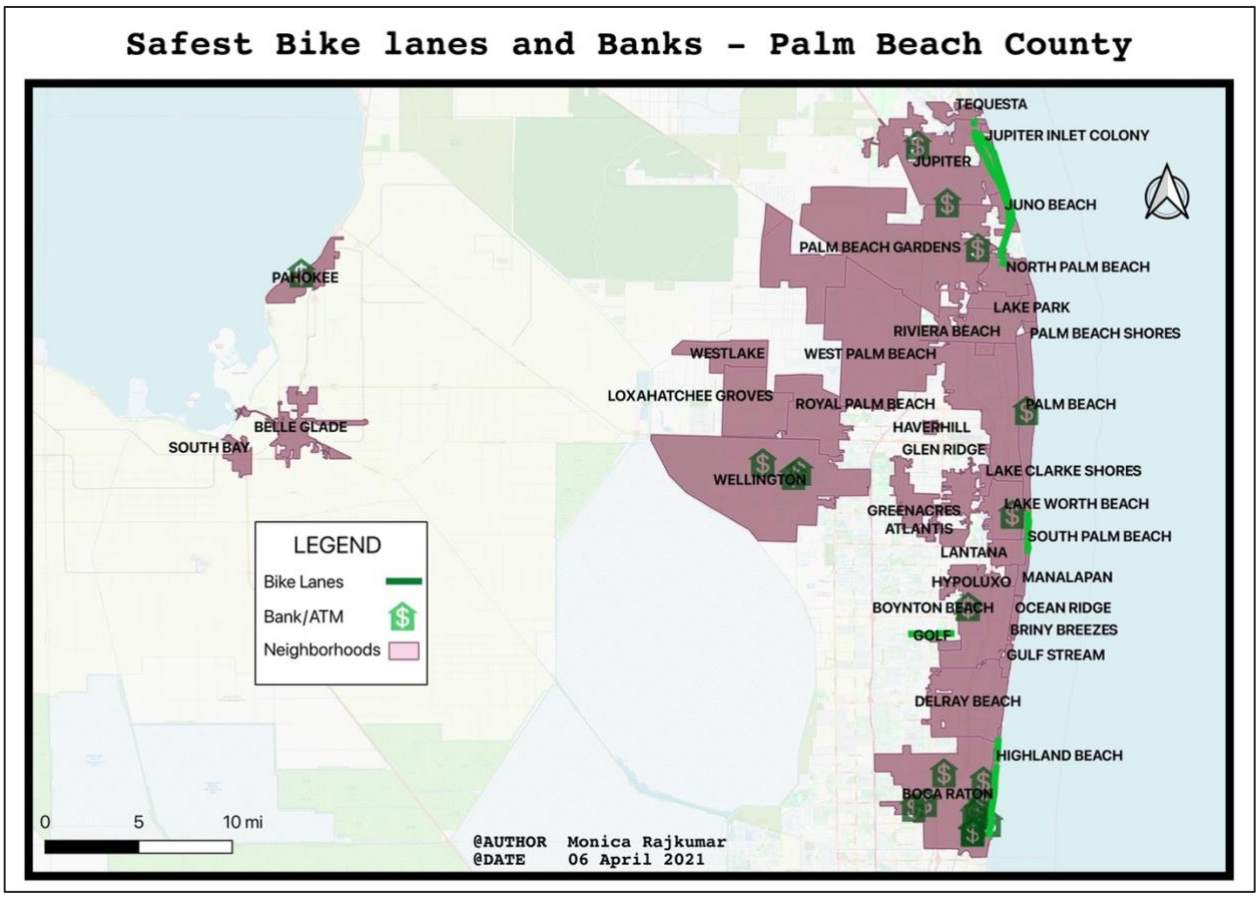


Figure 50: Map depicting the safest bike lanes and bank/atm

Visualization of red zoned assets in Palm Beach neighborhoods

This map clearly shows the bridges, bicycle lanes and shops that are present in red zone with respect to crime index of the Palm Beach neighborhood. Shops that are displayed, is based on the **robber** crime index, whereas bicycle lanes are based on the **motor vehicle theft** index. Apart from that, bridges is based on the total crime index value of the neighborhood crime data.

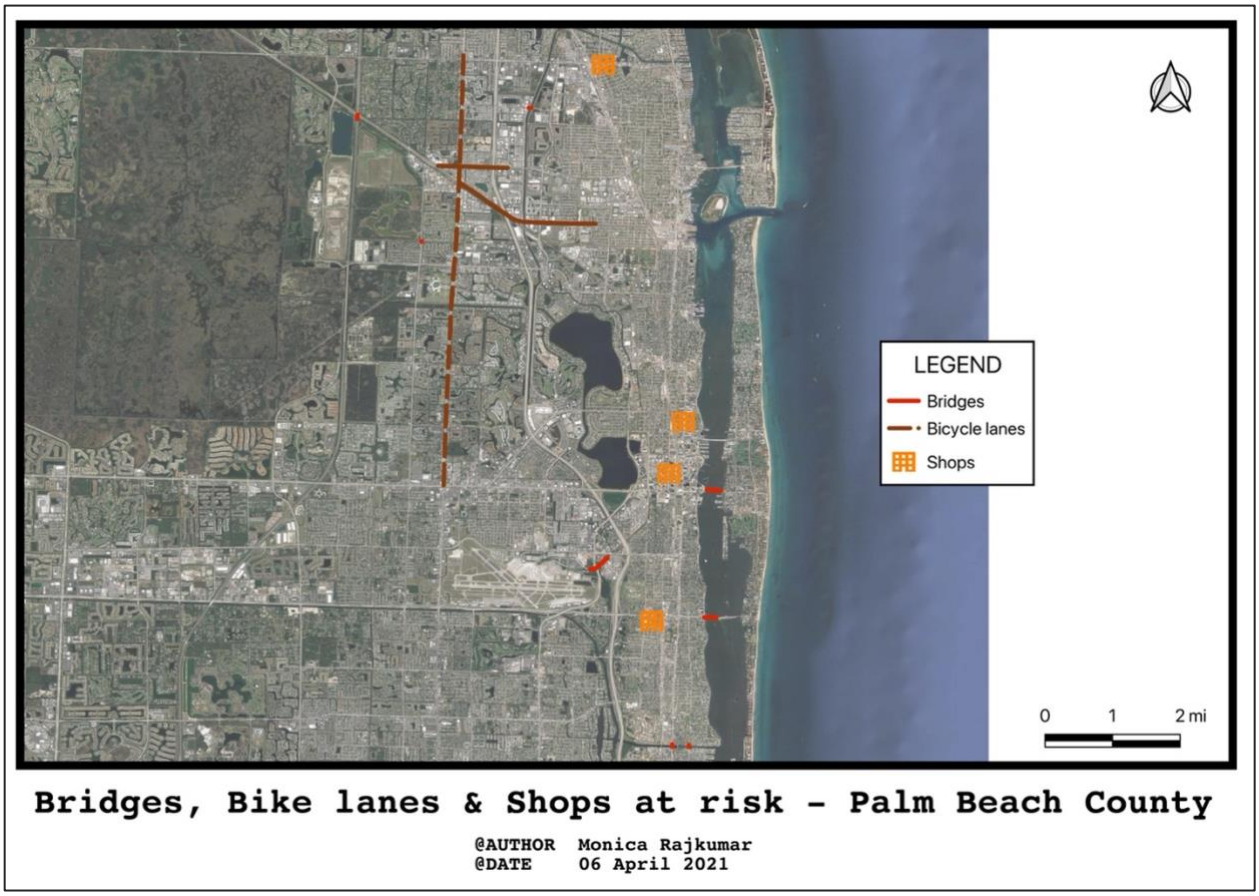


Figure 51: Map depicting the shops, bridges and bike lanes in red zone

Colorized map based on crime data

The colorized map is based on the total crime data which includes robbery, murder, rape, assault, burglary, larceny, property, personal etc., Green color indicates that the neighborhood is safe whereas red color indicates that the neighborhood is at risk. This map is generated in the green to red color ramp, so that it will visually be appealing to determine the safest neighborhoods in the Palm Beach county very easily.

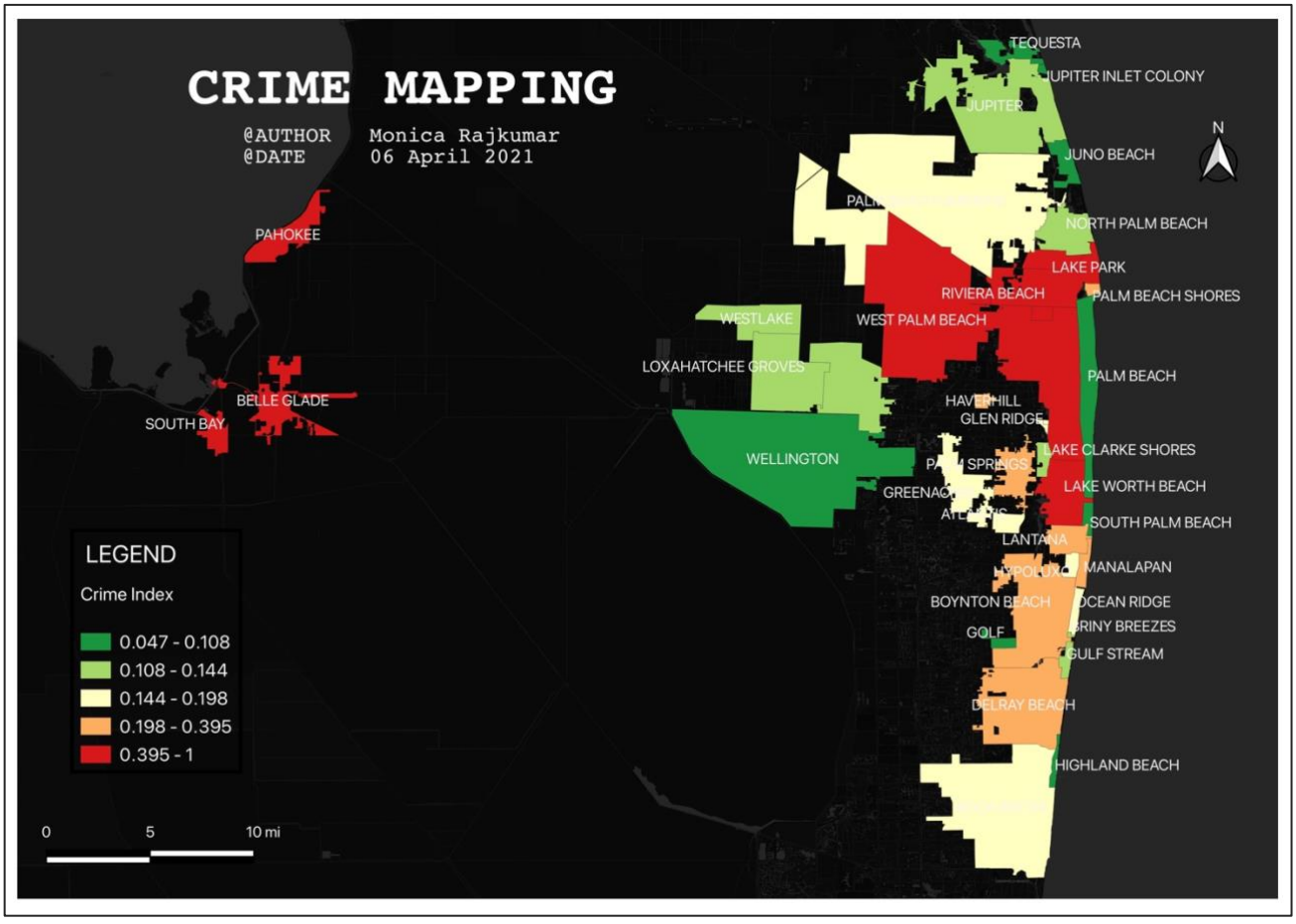


Figure 52: Crime mapping based on index

Conclusion

To conclude, I have performed spatial analysis of various types of crime including rape, murder, robbery, burglary, larceny, assault, etc., and mapped the results accordingly to better visualize it. The results appear to be desirable, and I believe it would help in reducing crime by giving a most optimal and accurate solution for decision makers to allocate respective assets which in turn will improvise police operations. The outcome of this project can be used to formulate better strategies pertaining to security across the neighborhoods of Palm Beach county.

Future Scope

This project can be further extended to various other states of the United States of America. In addition to that, population and area-based crime mapping can also be achieved. A web mapping application can be built, so that all the queries can be user specified and be executed in run time. With the help of this web application, various maps can be generated on the fly based on the user's preference.

References

https://opendata2-pbcgov.opendata.arcgis.com/

https://ftp.fdot.gov/file/d/FTP/FDOT/

https://dds.cr.usgs.gov/

https://www.openstreetmap.org/about

https://postgis.net/docs/

https://www.mssqltips.com/

Class Presentations - 1 to 12

https://www.esri.com/en-us/arcgis/

https://docs.qgis.org/3.16/en/docs/index.html

Appendix A

Crime Index Data of Palm Beach