



Human Mobility in San Diego County

Geography-580

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Data

LODES Census Data

- Origin-Destination (OD) data
- <https://lehd.ces.census.gov/data/lodes/LODES7/ca/od/>

TIGER/Line Census Block Group Shapefiles

- Spatial data corresponding to the LODES data
- <https://www.census.gov/cgi-bin/geo/shapefiles/index.php>

SANDAG Sub-Regional Areas (SRA) Shapefile

- Aggregate to SRA level for analysis/visualization
- https://sandag.org/resources/maps_and_gis/gis_downloads/sandagreportingareas.asp

Data Structure

OD DATA TABLES

ca_od_main/aux_jtXX_20XX

COLUMN	TYPE	DESCRIPTION
<u>w_geocode</u>	text	Workplace Census Block Code
<u>h_geocode</u>	text	Residence Census Block Code
s000	bigint	Num Total number of jobs
sa01	bigint	Number of jobs of workers age 29 or younger
sa02	bigint	Number of jobs for workers age 30 to 54
sa03	bigint	Number of jobs for workers age 55 or older
se01	bigint	Num Number of jobs with earnings \$1250/month or less
se02	bigint	Number of jobs with earnings \$1251/month to \$3333/month
se03	bigint	Number of jobs with earnings greater than \$3333/month
si01	bigint	Number of jobs in Goods Producing industry sectors
si02	bigint	Number of jobs in Trade, Transportation, and Utilities industry sectors
si03	bigint	Number of jobs in All Other Services industry sectors

w_geocode / geoid,
h_geocode / geoid

spatial join using
ST_Within()

SD COUNTY SRA .SHP

sd_sra

COLUMN	TYPE
<u>gid</u> [PK]	integer
objectid	smallint
sra	smallint
name	Char(22)
shapestare	numeric
shapestlen	numeric
geom	Geometry (Multipolygon, 4326)

BLOCK GROUP .SHP

tl_20XX_06_bg

COLUMN	TYPE
<u>gid</u> [PK]	integer
statefp	Char(2)
countyfp	Char(3)
tractce	Char(6)
blkgrpce	Char(1)
geoid	Char(12)
namelsad	Char(13)
mtfcc	Char(5)
funcstat	Char(1)
aland	Double precision
awater	Double precision
intptlon	Char(11)
intptlat	Char(12)
geom	Geometry (Multipolygon, 4326)

Database Implementation

PostgreSQL Access Using Python

- Automation
- Too many tables!
- Too many rows!



Python Libraries & Modules:

- requests (HTTP requests)
- os (OS interface)
- glob (find filenames)
- bs4, BeautifulSoup (parsing)
- gzip (unzip files)
- psycopg2 (access to Postgres database)

Tasks

- Download/Unzip/Save OD Tables (python)
- Create tables and copy CSVs into tables (create table / copy / create index)
- Get San Diego County subset (select statements / substring())
- Aggregate to Block Group level (groupby() / sum())
- Import shapefiles (shp2pgsql)
- Add geometry → Create BG centroids (alter & update tables / add geom() / ST_Centroid())
- Aggregate to SRA level & Add geometry → Create Centroids (ST_Within() / ST_Centroid())
- Create Flowlines (ST_MakeLine)
- Queries for visualization / analysis
- Export shapefiles (pgsql2shp)

Tables in 'lodes' schema: OD Tables

```
covid19=# \d+
```

List of relations					
Schema	Name	Type	Owner	Size	Description
lodes	ca_od_main_jt00_2002_sd_bg	table	embury_admin	48 MB	
lodes	ca_od_main_jt00_2003_sd_bg	table	embury_admin	49 MB	
lodes	ca_od_main_jt00_2004_sd_bg	table	embury_admin	50 MB	
lodes	ca_od_main_jt00_2005_sd_bg	table	embury_admin	50 MB	
lodes	ca_od_main_jt00_2006_sd_bg	table	embury_admin	50 MB	
lodes	ca_od_main_jt00_2007_sd_bg	table	embury_admin	49 MB	
lodes	ca_od_main_jt00_2008_sd_bg	table	embury_admin	52 MB	
lodes	ca_od_main_jt00_2009_sd_bg	table	embury_admin	49 MB	
lodes	ca_od_main_jt00_2010_sd_bg	table	embury_admin	51 MB	
lodes	ca_od_main_jt00_2011_sd_bg	table	embury_admin	50 MB	
lodes	ca_od_main_jt00_2012_sd_bg	table	embury_admin	50 MB	
lodes	ca_od_main_jt00_2013_sd_bg	table	embury_admin	9856 MB	
lodes	ca_od_main_jt00_2013_sd_sra	table	embury_admin	135 MB	
lodes	ca_od_main_jt00_2014_sd_bg	table	embury_admin	6827 MB	
lodes	ca_od_main_jt00_2014_sd_sra	table	embury_admin	135 MB	
lodes	ca_od_main_jt00_2015_sd_bg	table	embury_admin	7345 MB	
lodes	ca_od_main_jt00_2015_sd_sra	table	embury_admin	135 MB	
lodes	ca_od_main_jt00_2016_sd_bg	table	embury_admin	7494 MB	
lodes	ca_od_main_jt00_2016_sd_sra	table	embury_admin	135 MB	
lodes	ca_od_main_jt00_2017_sd_bg	table	embury_admin	8808 MB	
lodes	ca_od_main_jt00_2017_sd_sra	table	embury_admin	134 MB	

LODES tables aggregated to block group then SRA (with added geometry)

```
covid19=# \d ca_od_main_jt00_2017_sd_sra
```

Table "lodes.ca_od_main_jt00_2017_sd_sra"				
Column	Type	Collation	Nullable	Default
home_sra	smallint			
home_sra_name	character varying(22)			
work_sra	smallint			
work_sra_name	character varying(22)			
s000	numeric			
sa01	numeric			
sa02	numeric			
sa03	numeric			
se01	numeric			
se02	numeric			
se03	numeric			
si01	numeric			
si02	numeric			
si03	numeric			
geom_home	geometry(MultiPolygon,4326)			
geom_work	geometry(MultiPolygon,4326)			
geom_pt_home	geometry(Point,4326)			
geom_pt_work	geometry(Point,4326)			
geom_line_flow	geometry(LineString,4326)			

```
Indexes:
    "idx_ca_od_main_jt00_2017_sd_wh_sra" btree (work_sra, home_sra)
```

Sample table with column names and types

Tables in 'lodes' schema: Shapefiles

```

lodes | sd_sra | table | embury_admin | 1680 kB |
lodes | sd_sra_gid_seq | sequence | embury_admin | 8192 bytes |
lodes | tl_2013_06_bg | table | embury_admin | 83 MB |
lodes | tl_2013_06_bg_gid_seq | sequence | embury_admin | 8192 bytes |
lodes | tl_2013_06_bg_sd | table | embury_admin | 7608 kB |
lodes | tl_2014_06_bg | table | embury_admin | 83 MB |
lodes | tl_2014_06_bg_gid_seq | sequence | embury_admin | 8192 bytes |
lodes | tl_2014_06_bg_sd | table | embury_admin | 7584 kB |
lodes | tl_2015_06_bg | table | embury_admin | 83 MB |
lodes | tl_2015_06_bg_gid_seq | sequence | embury_admin | 8192 bytes |
lodes | tl_2015_06_bg_sd | table | embury_admin | 7600 kB |
lodes | tl_2016_06_bg | table | embury_admin | 83 MB |
lodes | tl_2016_06_bg_gid_seq | sequence | embury_admin | 8192 bytes |
lodes | tl_2016_06_bg_sd | table | embury_admin | 7600 kB |
lodes | tl_2017_06_bg | table | embury_admin | 84 MB |
lodes | tl_2017_06_bg_gid_seq | sequence | embury_admin | 8192 bytes |
lodes | tl_2017_06_bg_sd | table | embury_admin | 7616 kB |
lodes | tl_2018_06_bg | table | embury_admin | 84 MB |
lodes | tl_2018_06_bg_gid_seq | sequence | embury_admin | 8192 bytes |
lodes | tl_2019_06_bg | table | embury_admin | 84 MB |
lodes | tl_2019_06_bg_gid_seq | sequence | embury_admin | 8192 bytes |
public | geography_columns | view | embury_admin | 0 bytes |
public | geometry_columns | view | embury_admin | 0 bytes |
public | spatial_ref_sys | table | embury_admin | 6968 kB |
(126 rows)

```

Block group / SRA spatial tables from shapefiles
(used for spatial joins, operations)

```

covid19=# \d tl_2017_06_bg_sd
          Table "lodes.tl_2017_06_bg_sd"
  Column |          Type          | Collation | Nullable | Default
-----|-----|-----|-----|-----
gid      | integer                |           |          |
statefp  | character varying(2)  |           |          |
countyfp | character varying(3)  |           |          |
tractce  | character varying(6)  |           |          |
blkgrpce | character varying(1)  |           |          |
geoid    | character varying(12) |           |          |
namelsad | character varying(13) |           |          |
mtfcc    | character varying(5)  |           |          |
funcstat | character varying(1)  |           |          |
aland    | double precision       |           |          |
awater   | double precision       |           |          |
intptlat | character varying(11) |           |          |
intptlon | character varying(12) |           |          |
geom     | geometry(MultiPolygon,4326) |           |          |

covid19=# \d sd_sra
          Table "lodes.sd_sra"
  Column |          Type          | Collation | Nullable | Default
-----|-----|-----|-----|-----
gid      | integer                |           | not null | nextval('sd_sra_gid_seq'::regclass)
objectid | smallint               |           |          |
sra      | smallint               |           |          |
name     | character varying(22) |           |          |
shapestare | numeric                |           |          |
shapestlen | numeric                |           |          |
geom     | geometry(MultiPolygon,4326) |           |          |

Indexes:
  "sd_sra_pkey" PRIMARY KEY, btree (gid)

```

Sample tables with column names and types

Tables in 'lodes' schema: Contents

```
covid19=# select home_sra, home_sra_name, work_sra, work_sra_name, s000, sa01, sa02, sa03, se01, se02, se03, si01, si02, si03
covid19=# from ca_od_main_jt00_2017_sd_sra
covid19=# limit 5;
```

home_sra	home_sra_name	work_sra	work_sra_name	s000	sa01	sa02	sa03	se01	se02	se03	si01	si02	si03
1	CENTRAL SAN DIEGO	1	CENTRAL SAN DIEGO	18822	4332	11054	3436	3787	5858	9177	918	1241	16663
1	CENTRAL SAN DIEGO	2	PENINSULA	3360	799	1925	636	784	1240	1336	137	651	2572
1	CENTRAL SAN DIEGO	3	CORONADO	660	150	395	115	175	265	220	6	37	617
1	CENTRAL SAN DIEGO	4	NATIONAL CITY	917	214	516	187	196	383	338	133	223	561
1	CENTRAL SAN DIEGO	5	SOUTHEASTERN SAN DIEGO	977	195	543	239	218	355	404	186	124	667

(5 rows)

```
covid19=# select gid, statefp, countyfp, tractce, blkgrpce, geoid, namelsad, mtfcc, funcstat, aland, awater, intptlat, intptlon
covid19=# from tl_2017_06_bg_sd
covid19=# limit 5;
```

gid	statefp	countyfp	tractce	blkgrpce	geoid	namelsad	mtfcc	funcstat	aland	awater	intptlat	intptlon
5	06	073	010013	2	060730100132	Block Group 2	G5030	S	404606	0	+32.5564082	-117.0507980
20	06	073	010103	3	060730101033	Block Group 3	G5030	S	393787	0	+32.5798283	-117.1012982
21	06	073	010104	2	060730101042	Block Group 2	G5030	S	657709	0	+32.5728369	-117.0970686
22	06	073	010103	2	060730101032	Block Group 2	G5030	S	461973	0	+32.5804291	-117.0958414
23	06	073	010106	1	060730101061	Block Group 1	G5030	S	736442	0	+32.5724954	-117.0705189

(5 rows)

```
covid19=# select gid, objectid, sra, name, shapestare, shapestlen
covid19=# from sd_sra
covid19=# limit 5;
```

gid	objectid	sra	name	shapestare	shapestlen
1	1	1	CENTRAL SAN DIEGO	726889492.73828125000000	314903.940618921944406
2	2	2	PENINSULA	365681201.25683593750000	172677.604937830154086
3	3	3	CORONADO	410804735.10937500000000	139799.825372824445367
4	4	4	NATIONAL CITY	254546528.11718750000000	129491.764697081118356
5	5	5	SOUTHEASTERN SAN DIEGO	528901639.63378906250000	136008.710808895295486

(5 rows)

Analysis

Create table for basic mobility analysis

- Residents leaving SRA
- Commuters entering SRA
- Residents working within SRA

```
--*****  
--get summarized mobility numbers for each sra and export shapefile  
--Total numbers of residents leaving for work, commuters entering for jobs,  
--and people that live and work within the SRA  
  
create table lodes.ca_od_main_jt00_2017_sd_sra_summary as select home_sra as sra,  
home_sra_name as sra_name, h.s000-b.s000 as residents_leaving,  
w.s000-b.s000 as commuters_entering, b.s000 as both_live_work, geom_home as geom  
from (  
select home_sra, home_sra_name, sum(s000) as s000, geom_home  
from ca_od_main_jt00_2017_sd_sra  
group by home_sra, home_sra_name, geom_home  
order by home_sra  
) as h join (  
select work_sra, work_sra_name, sum(s000) as s000  
from ca_od_main_jt00_2017_sd_sra  
group by work_sra, work_sra_name  
order by work_sra  
) as w on h.home_sra = w.work_sra join (  
select home_sra as both_sra, home_sra_name as both_sra_name, s000  
from ca_od_main_jt00_2017_sd_sra  
group by home_sra, home_sra_name, s000, work_sra  
having home_sra = work_sra  
order by home_sra  
) as b on h.home_sra = b.both_sra  
group by home_sra, home_sra_name, h.s000, w.s000, b.s000, geom_home  
order by home_sra_name;
```

Analysis

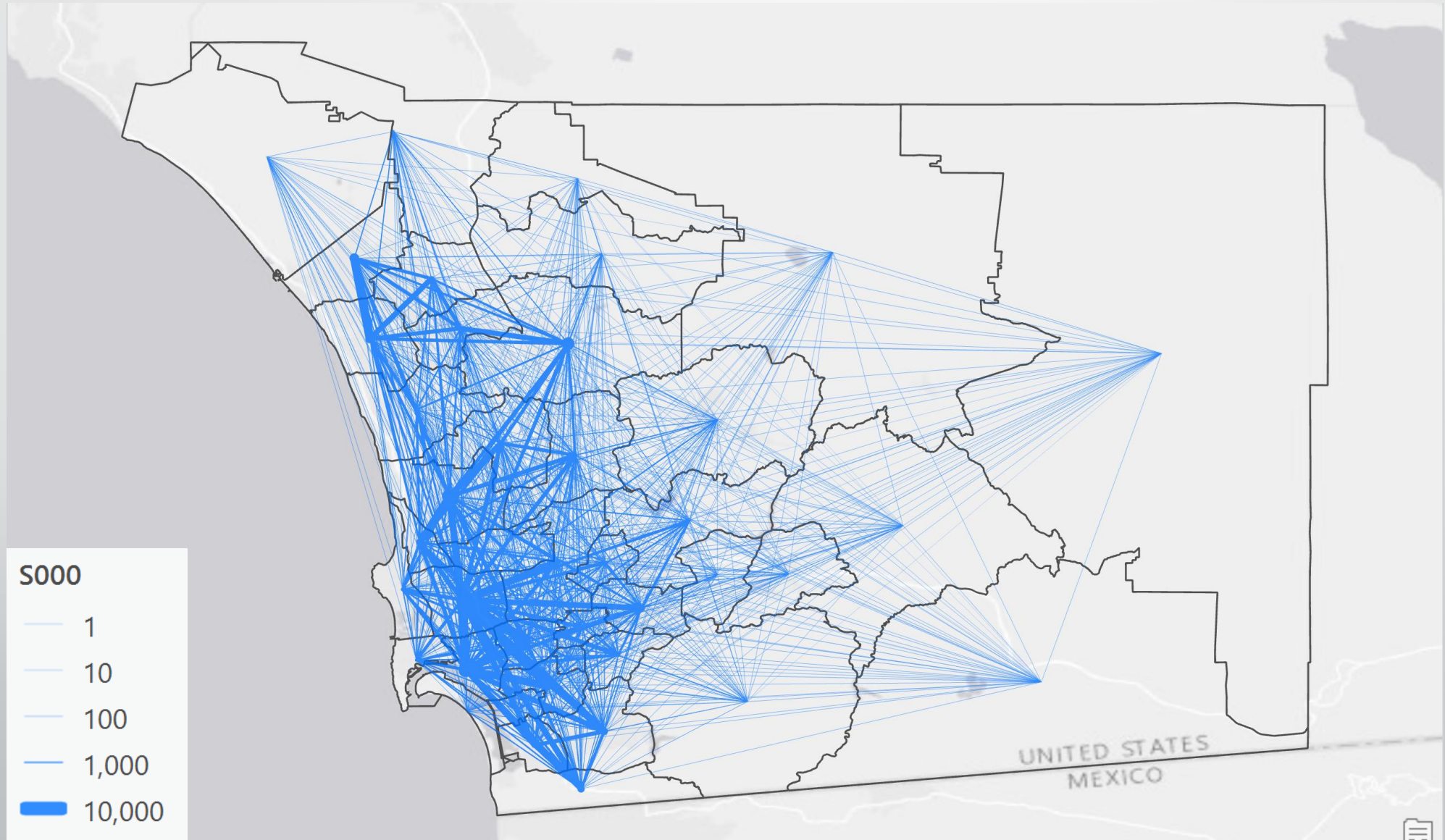
- Records from the mobility summary table.
- Exported as a shapefile using pgsql2shp

```
covid19=# select sra, sra_name, residents_leaving, commuters_entering, both_live_work
covid19=# from lodes.ca_od_main_jt00_2017_sd_sra_summary;
```

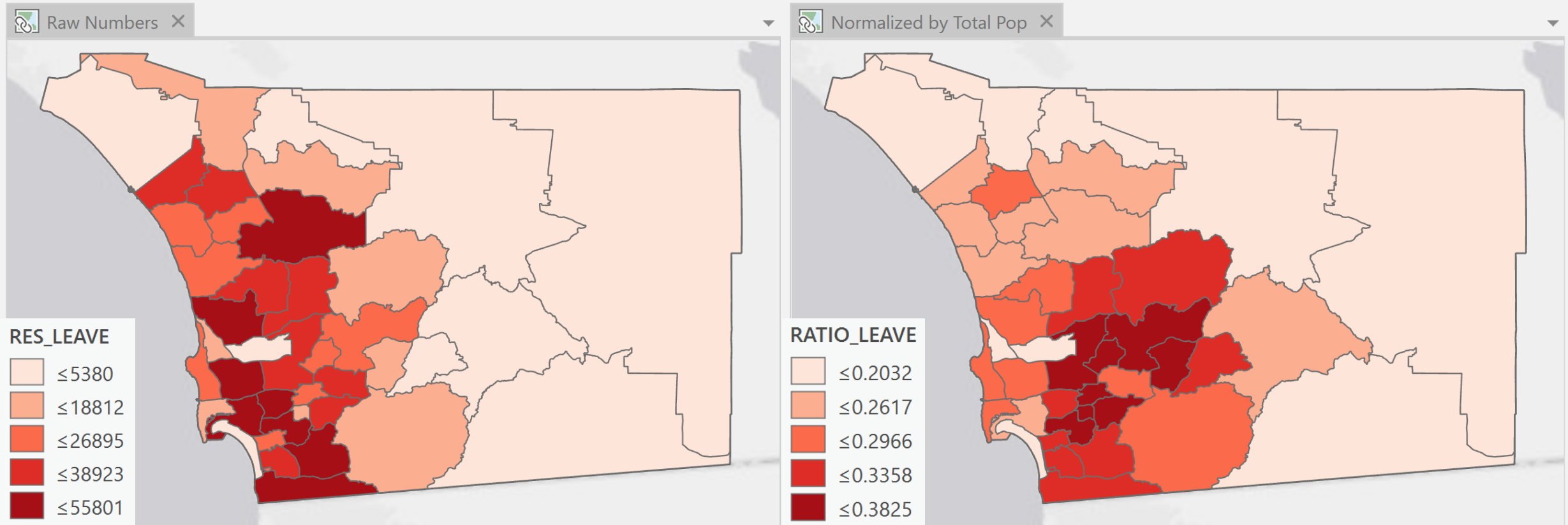
sra	sra_name	residents_leaving	commuters_entering	both_live_work
38	ALPINE	5380	1778	571
63	ANZA-BORREGO SPRINGS	320	293	492
41	CARLSBAD	26895	46597	11867
1	CENTRAL SAN DIEGO	49813	101840	18822
21	CHULA VISTA	38447	26322	7362
11	COASTAL	22395	29858	5126
3	CORONADO	3915	6879	949
13	DEL MAR-MIRA MESA	46747	82650	18397
34	EL CAJON	38923	29591	9470
17	ELLIOTT-NAVAJO	31940	15379	1927
50	ESCONDIDO	42430	28157	16069
55	FALLBROOK	9259	3236	4031
37	HARBISON CREST	5478	3712	424
30	JAMUL	5783	2631	380
10	KEARNY MESA	44636	147716	16660
33	LA MESA	22243	21931	2533
61	LAGUNA-PINE VALLEY	1278	2129	216
36	LAKESIDE	20903	9278	2513
32	LEMON GROVE	11621	4717	540
6	MID-CITY	54609	23919	5611
16	MIRAMAR	339	742	1
62	MOUNTAIN EMPIRE	1620	476	395
4	NATIONAL CITY	19110	16485	2552
14	NORTH SAN DIEGO	33950	35790	7735
42	OCEANSIDE	37911	18778	12377
60	PALOMAR-JULIAN	935	613	459
54	PAUMA	1656	1423	306
43	PENDLETON	2522	910	82
2	PENINSULA	18812	29061	3558
15	POWAY	28849	31214	4656
39	RAMONA	11033	2091	2876
40	SAN DIEGUITO	22866	24929	7171
51	SAN MARCOS	24860	29528	6789
35	SANTEE	19961	13014	2096
22	SOUTH BAY	44882	18168	9278
5	SOUTHEASTERN SAN DIEGO	55801	11642	3217
31	SPRING VALLEY	29646	9725	2299
20	SWEETWATER	44448	19365	6303
12	UNIVERSITY	12915	60886	4596
53	VALLEY CENTER	6015	3560	1531
52	VISTA	29511	13644	5585

(41 rows)

Maps: Flowlines Example



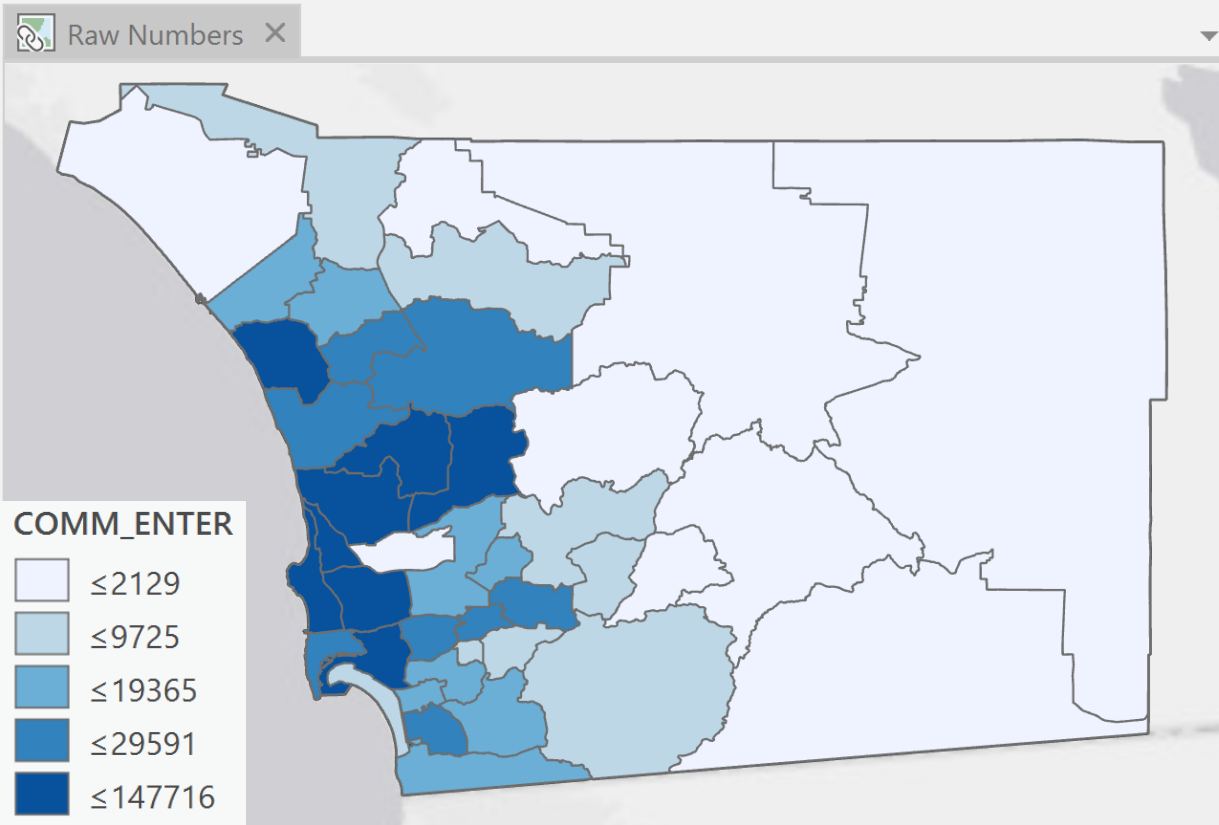
Maps: Residents Leaving SRA



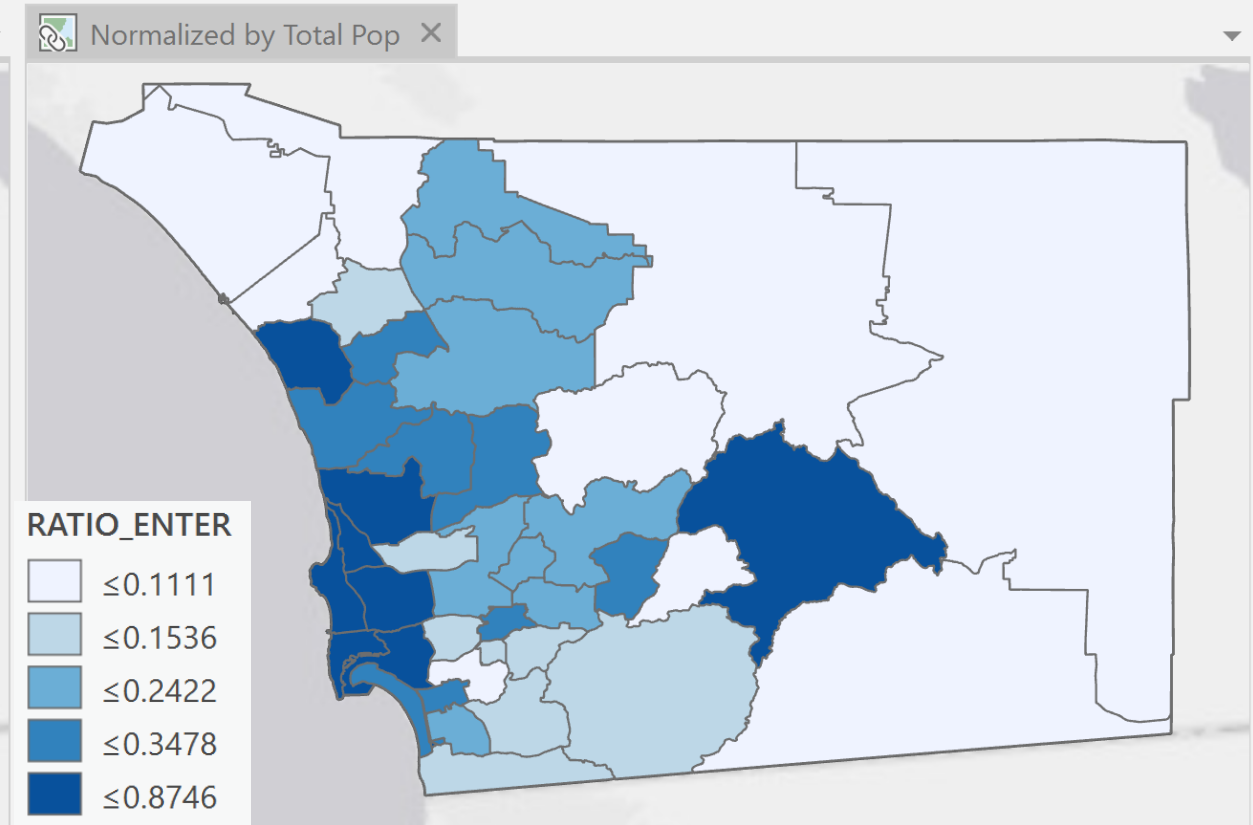
Total number of residents leaving each SRA for work

Ratio of residents leaving each SRA for work (normalized by total population)

Maps: Commuters Entering SRA

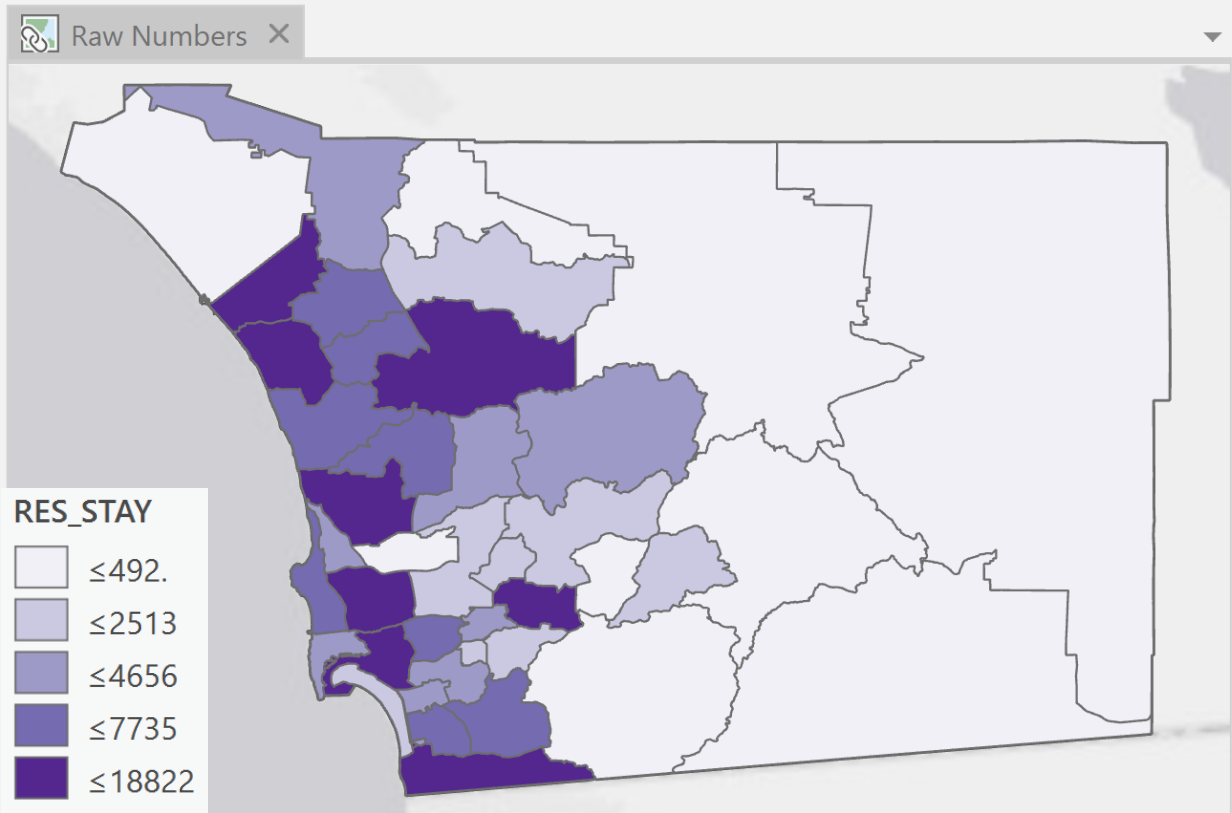


Total number of commuters entering each SRA for work

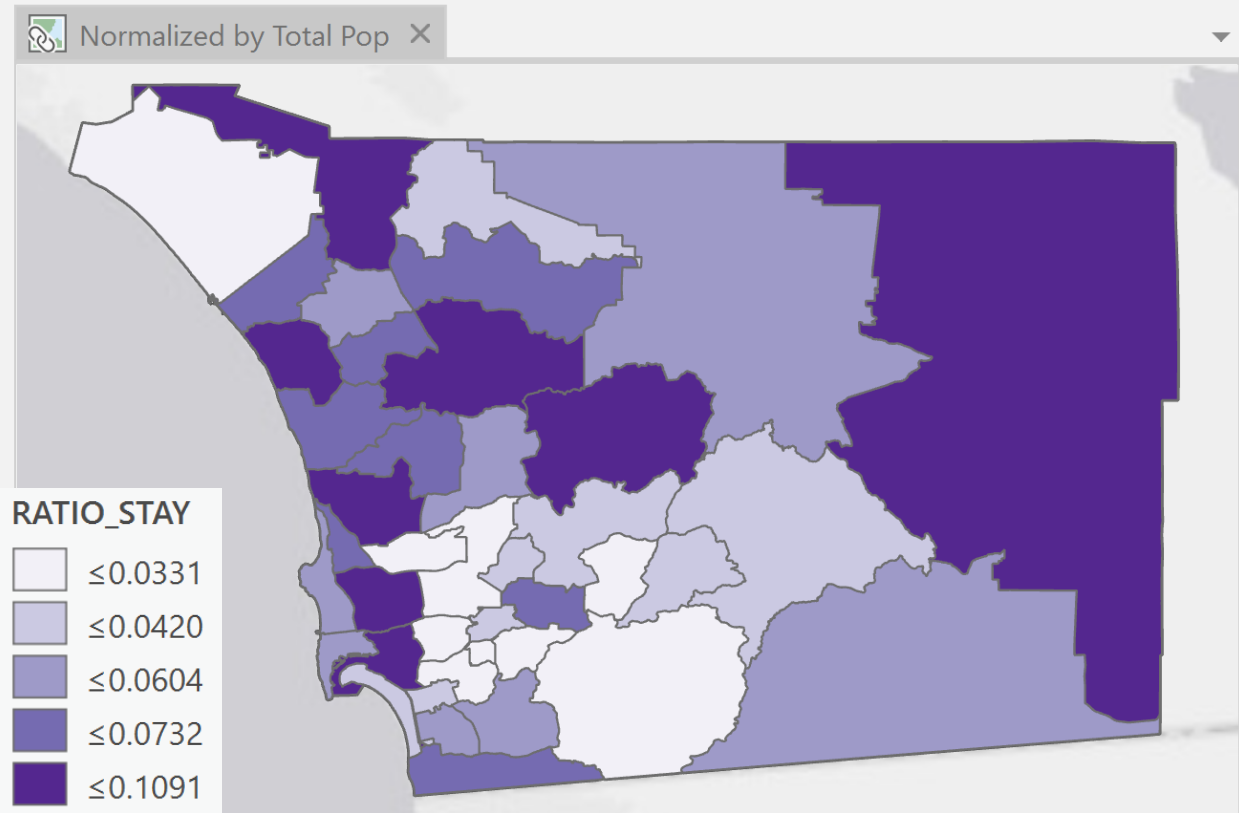


Ratio of commuters entering each SRA for work (normalized by total population)

Maps: Residents Working in SRA



Total number of residents working within each SRA

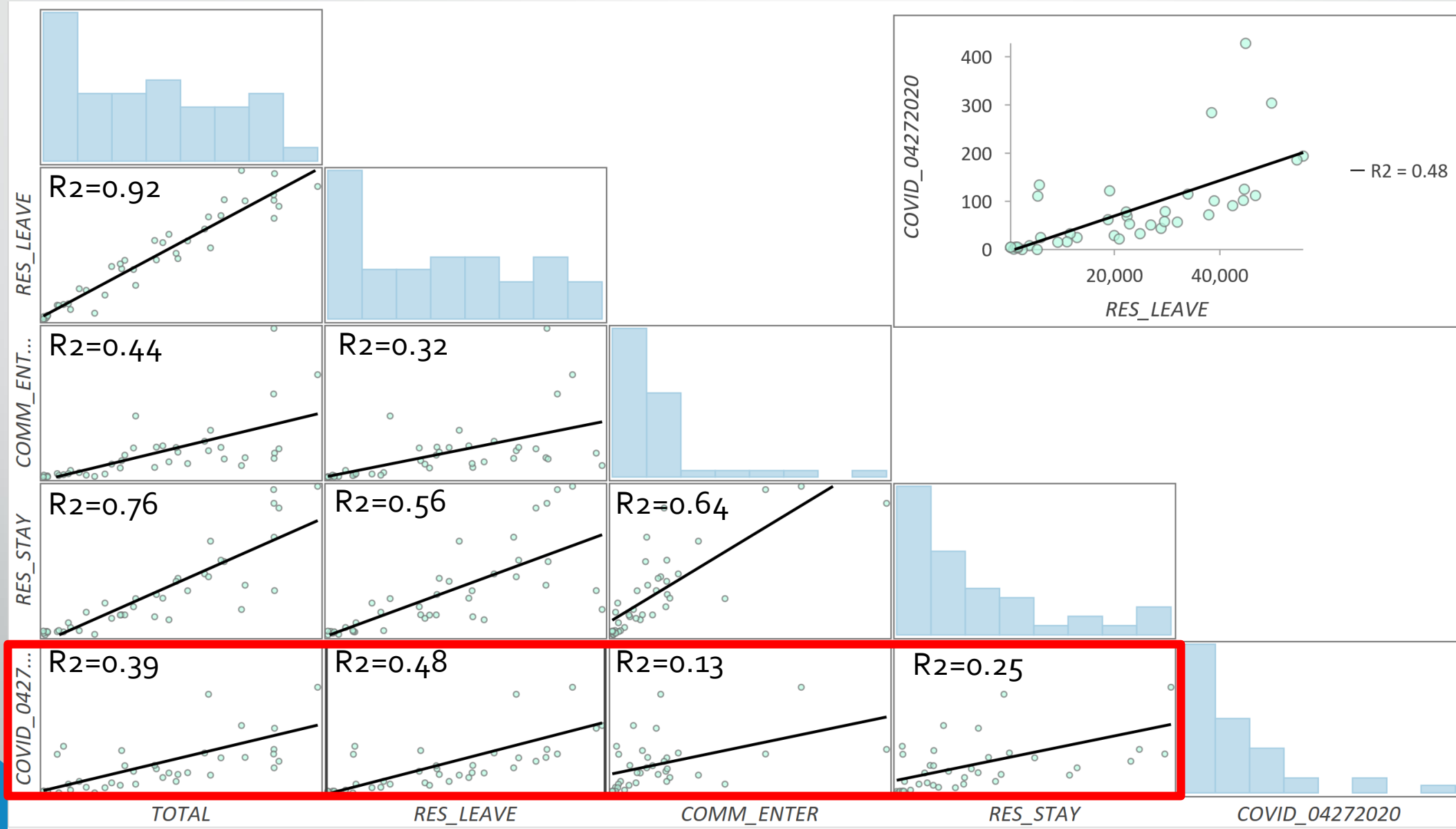


Ratio of residents working within each SRA (normalized by total population)

Back to
Analysis

Scatter Plot Matrix

Variables: COVID-19 Cases
(04/27/2020), Total Population,
Residents Leaving, Commuters
Entering, Residents Staying

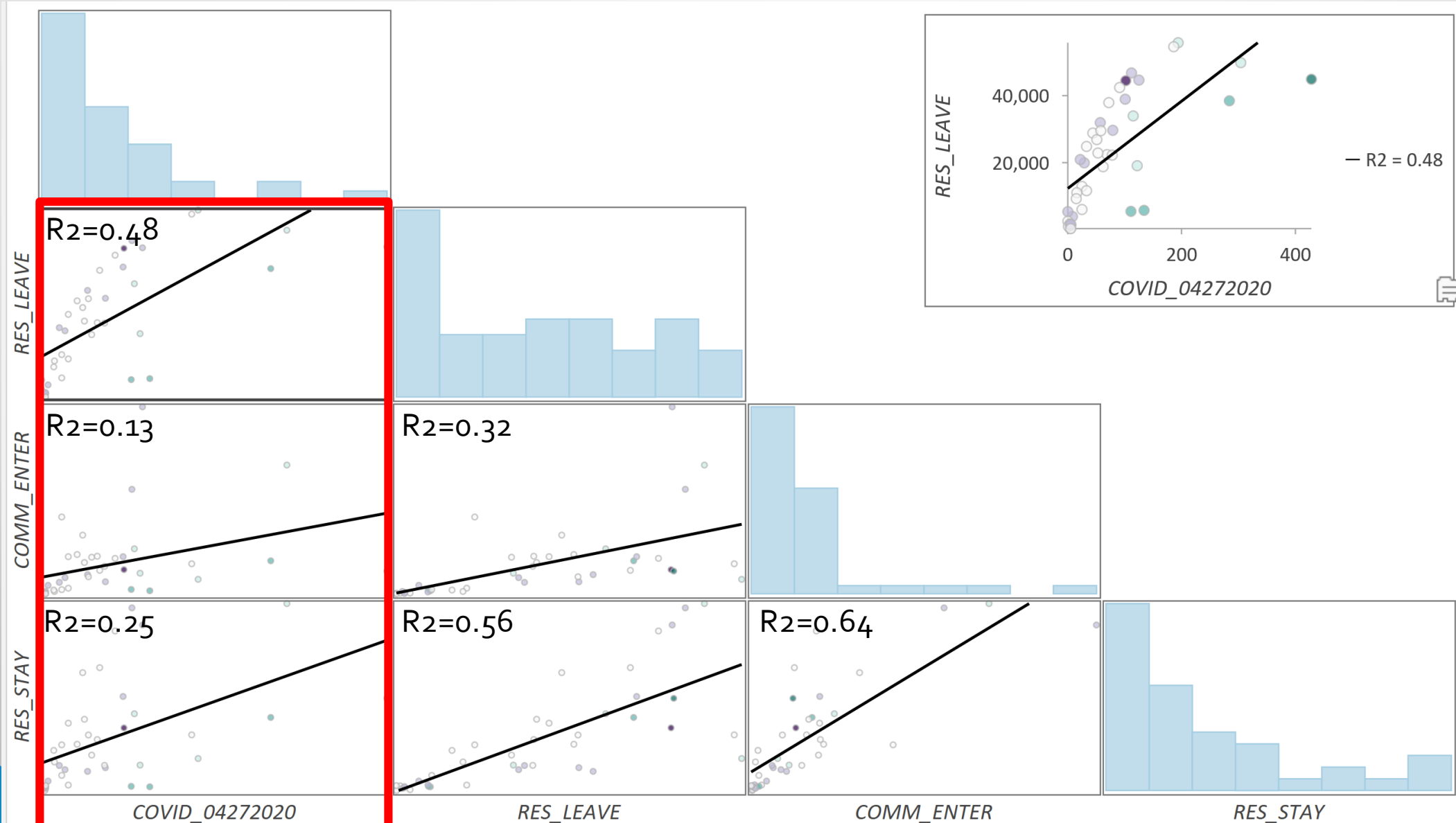


Back to
Analysis

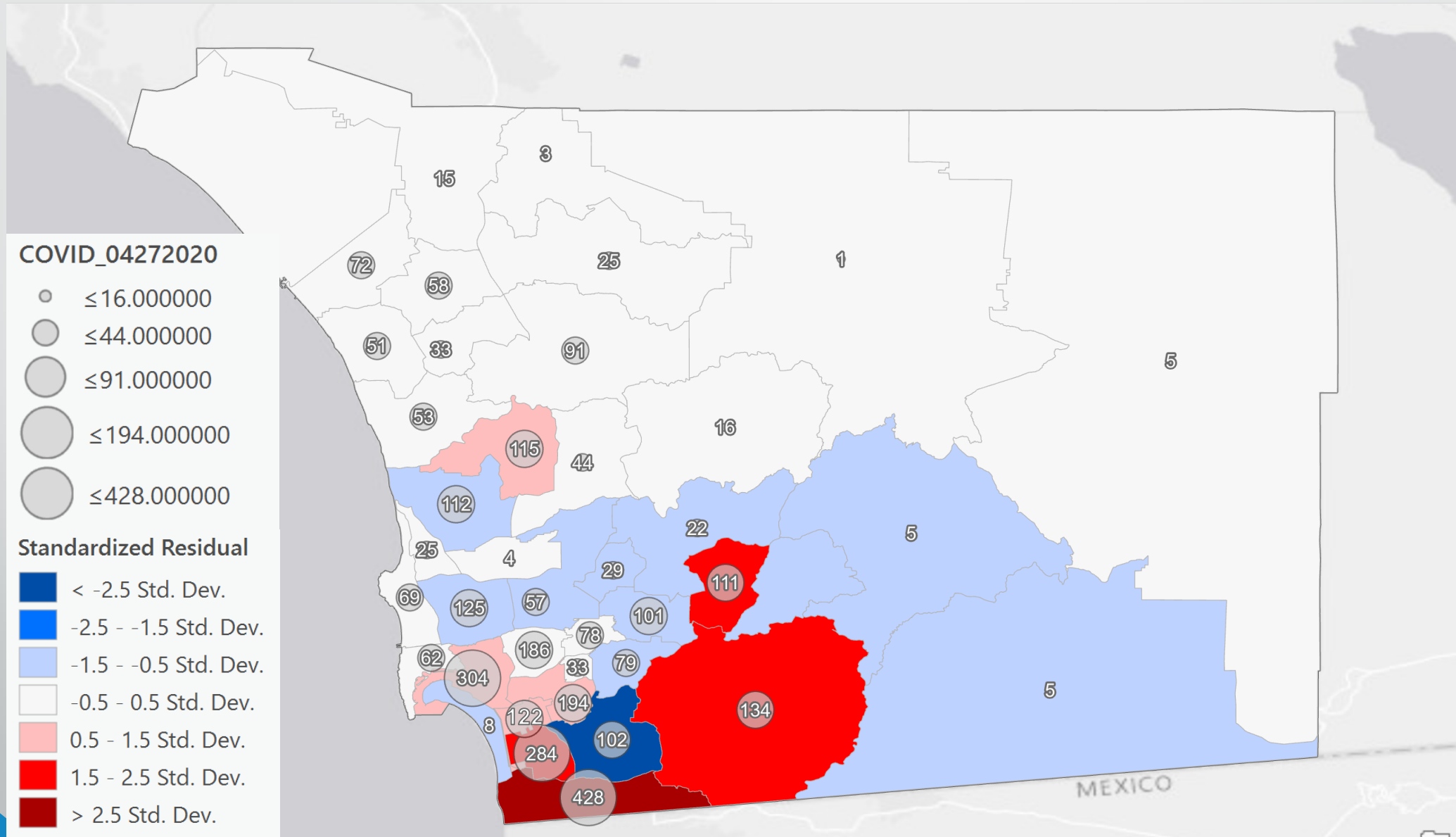
GWR

Dependent Variable: COVID-19 Cases (04/27/2020)

Explanatory Variables: Residents Leaving, Commuters Entering, Residents Staying



GWR: Standardized Residuals





Thank you!
Questions?