Waller SISMID 2025 Reading and Mapping Shapefiles: Alcohol, Drugs, and Crime in Houston

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7/15/2025

What we have

- An ArcGIS shapefile for census tracts in Houston.
- A "shapefile" is actually several separate files with the same file name and different extensions.
- The .dbf file is a dbase database file containing the attribute table
- The .shp file contains information on the outlines of the tracks.
- The .shx, .sbn, and .sbx files have the connective tissue to link it all together (sometimes you can have a .prj paper for the map projection).
- The following attributes are of interest to us: Population(census), violent crimes (police), number of illegal drug arrests(police), total alcohol sales (state alcoholic beverage license data)

What we want

- *Choropleth* maps of the violent crime rate and standardized log drug arrests and standardized log alcohol sales.
- Will need to calculate these variables, choose intervals and colors, and map.

How we get it

- We will use the 'sf' package and the function 'st_read'
- We will use the 'RColorBrewer' library to choose colors and intervals.
- For this example, we will use the basic 'plot' function to make maps.

First, load the libraries. The working directory should automatically be set to the correct one if you opened the R project (`2024-SISMID-Spatial-Epi.Rproj`) through RStudio.

```
##Load libraries
#install.packages("pacman")
pacman::p_load(sf, #replaces "maptools", "rgdal" and other deprecated packages
               tmap, #helps with plotting your map
               RColorBrewer, # creates nice color schemes
               classInt,  # finds class intervals for continuous variables
               spgwr, # Adds the geographically weighted regression functions
               here # For constructing filepaths relative to root directory
               )
```

Now to read in the shapefile. The following five files all constitute what is a "shapefile." If you downloaded the repository from GitHub correctly, they should all be in your `data` folder.

- HoustonENAR2012final.shp
- HoustonENAR2012final.dbf
- HoustonENAR2012final.shx
- HoustonENAR2012final.sbx
- HoustonENAR2012final.sbn

```
## Read in shapefile - Houston Census Tracts
#houston = st_read(dsn = here("data"),layer = "HoustonENAR2012final")

#***HERE***
houston = st_read(dsn = paste(path,"data/",sep=""),layer = "HoustonENAR2012final")
```

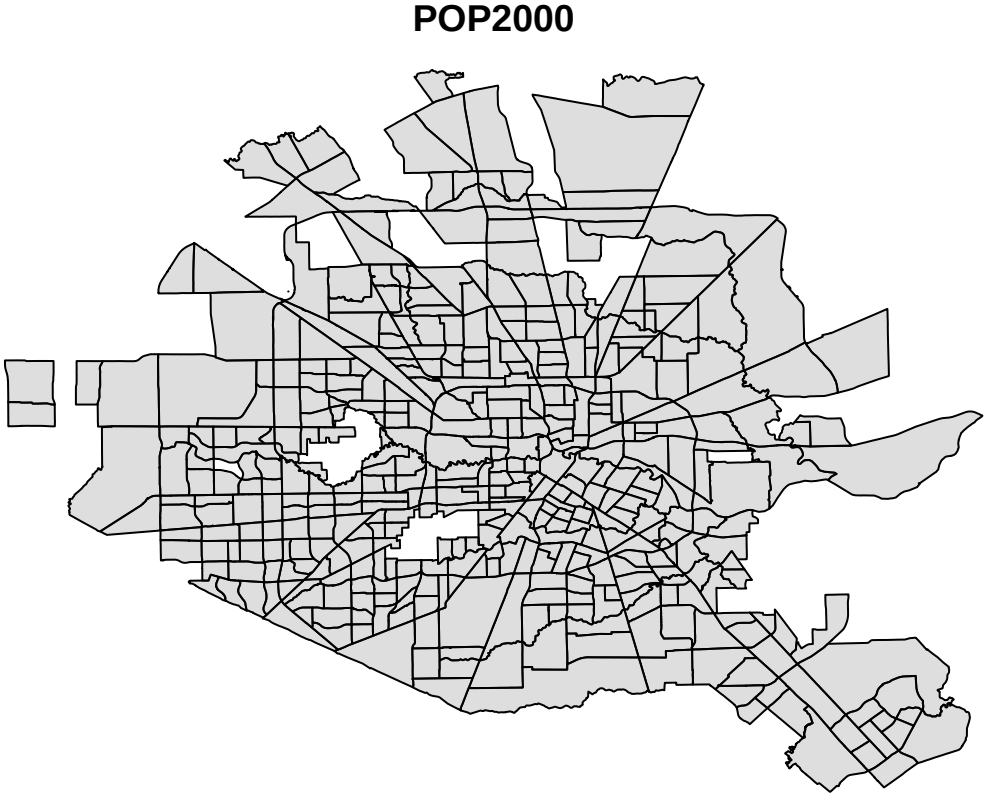
```
## Reading layer `HoustonENAR2012final' from data source
##   `/Users/lwaller/Library/CloudStorage/OneDrive-Emory/meetings/SISMID.2024/SISMID_2024_spatial_statis
##   using driver `ESRI Shapefile'
## Simple feature collection with 439 features and 133 fields
## Geometry type: MULTIPOLYGON
## Dimension:     XY
## Bounding box:  xmin: -95.75434 ymin: 29.52563 xmax: -95.06086 ymax: 30.03774
## CRS:           NA
```

Plotting the map

- If we plot the 'houston' shapefile, the plot command will plot maps of each of the attributes. If we want one houston map, we can do this by plotting, say, POP2000 but assign the same color to every tract with a value (I use grey here, so we can see that there are some tracts with no attribution values. . . these are independent municipalities within Houston).

To get the specific attribute POP2000 from the spatial data object houston, we refer to houston['POP2000']

```
plot(houston['POP2000'],col=adjustcolor("grey", alpha=0.5))
```



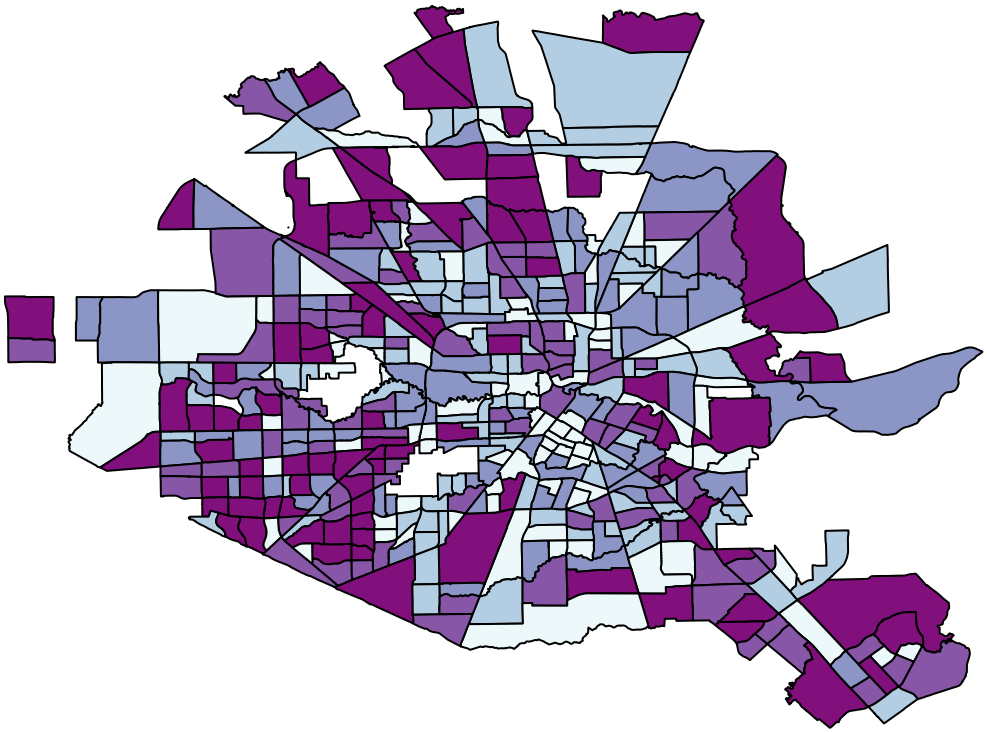
Next, we want to make choropleth maps (shading in each tract based on its associated attribute value).

To do this, we need to decide how many intervals (colors) we want. I like odd numbers so there is a 'middle' color, and I usually start with quintiles.

'classInt' will assign each tract to the appropriate quintile for a particular attribute.

'RColorBrewer' will assign a color scheme for the quantiles... lots of fascinating work on color choices by Cynthia Brewer, well worth reading and checking the ColorBrewer webpage (https://colorbrewer2.org/)

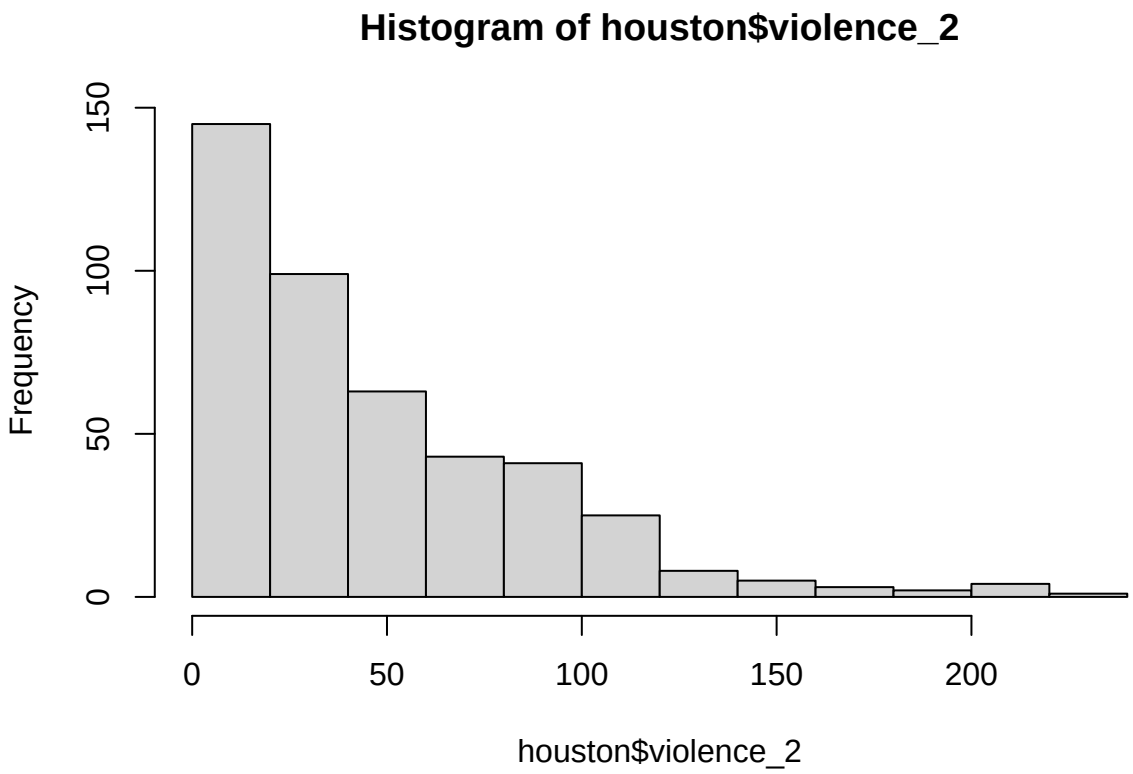
```
# Define the variable (attribute) to shade tracts by
pop2000 <- houston$POP2000

# Define the number of classes
nclr <- 5  # quintiles
# Use RColorBrewer to choose the colors
plotclr <- brewer.pal(nclr,"BuPu")

class <- classInt::classIntervals(pop2000, nclr, style="quantile")
colcode <- classInt::findColours(class, plotclr)

#Fill in the tracts with the colors, 'main' and 'sub' define the titles.
plot(houston['POP2000'],col=colcode,main="Population 2000",
      sub="Quantile (Equal-Frequency) Class Intervals")
```



OK, great, we can map the data. Let's map the main variables for our analysis.

The data table has a lot of census data and various transformations of the violent crime, alcohol sales, and drug arrest data. The next section pulls the values we want.

```
# Outcome:  Number of violent crimes by tract
hist(houston$violence_2)
```




```
# Divide by the 2000 population to get the rate
houston$violence.rate = houston$violence_2/houston$tot_pop

#Summarize key variables
summary(houston$violence.rate)
```

```
##      Min.   1st Qu.    Median      Mean   3rd Qu.      Max.
##  0.000000  0.003351  0.008368  0.052432  0.014706 13.333333
```

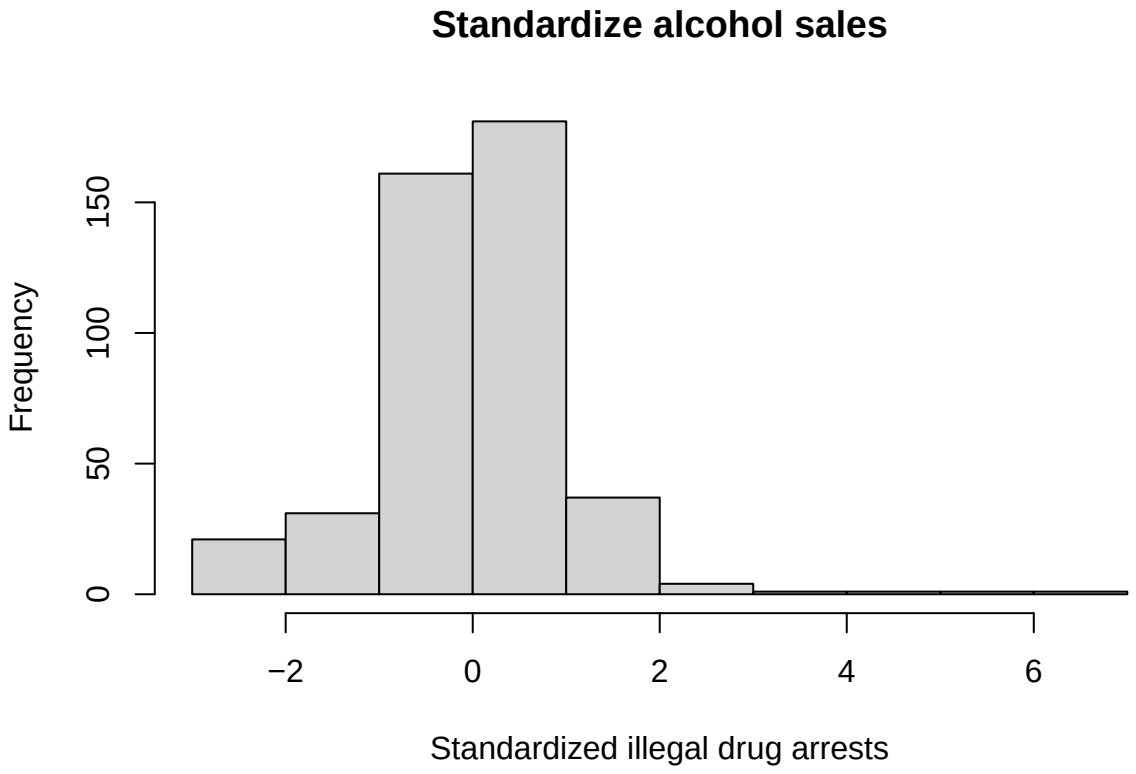
```
summary(houston$violence_2)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    0.00   14.50   36.00   46.97   69.00  234.00
```

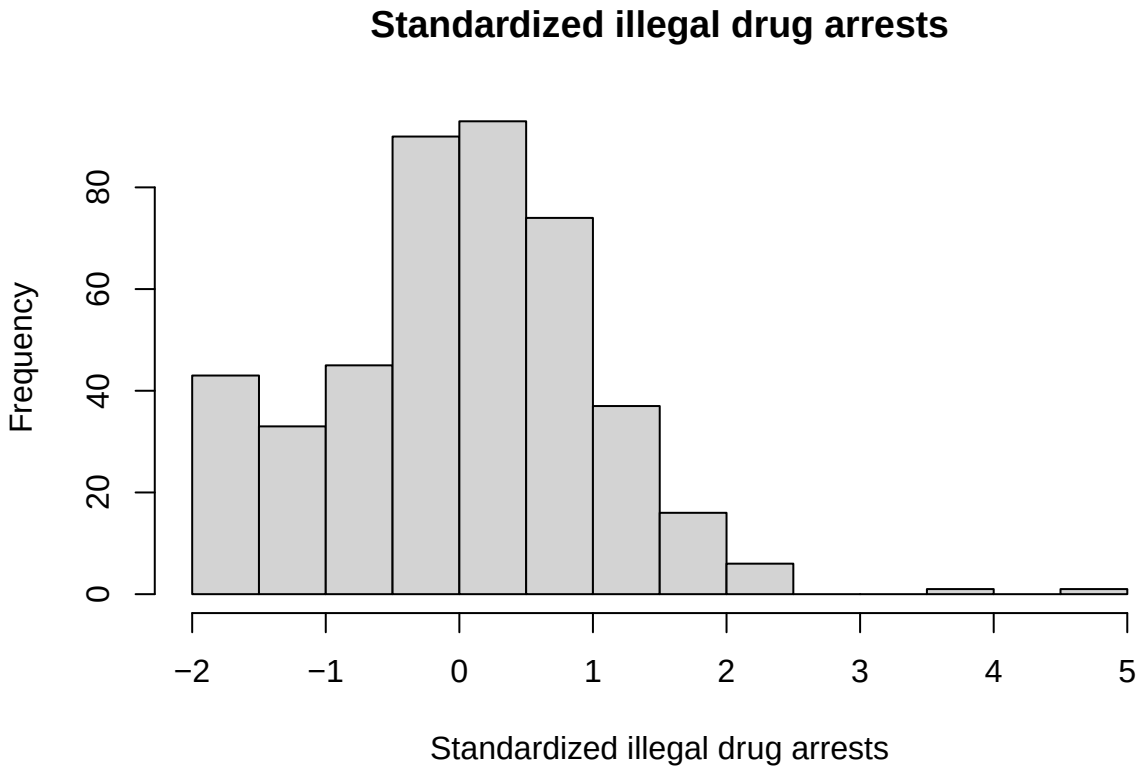
```
summary(houston$tot_pop)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##       1    2946    4475    5038    6566   15411
```

```
# Covariate 1 (log standardized total alcohol sales)
hist(houston$Zl_total, main="Standardize alcohol sales",
     xlab="Standardized illegal drug arrests")
```

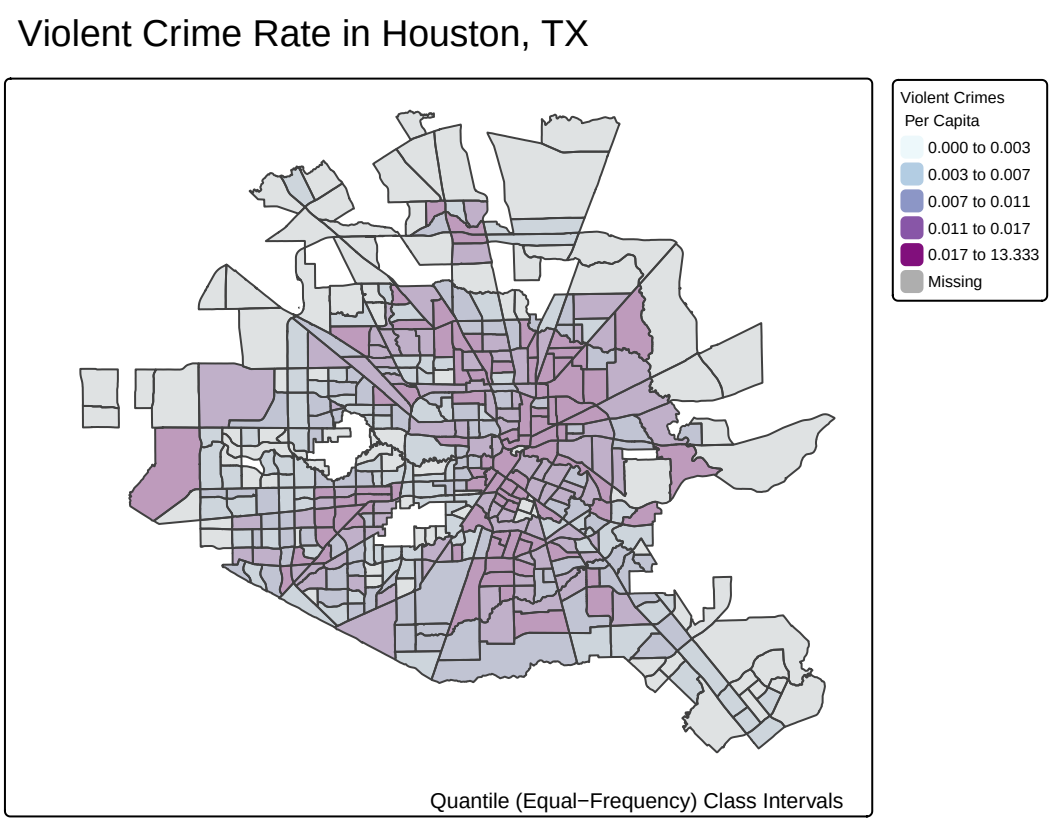



```
# Covariate 2 (log standardized illegal drug arrests)
hist(houston$Zl_drug, main="Standardized illegal drug arrests",
     xlab="Standardized illegal drug arrests")
```



Now to map the outcome, using the mapping package tmap's routines tm_shape and tm_fill. tmap builds the maps as objects making it easier to customize parts of the map (legends, credits, and the layout) and to build multi-map figures (see below).

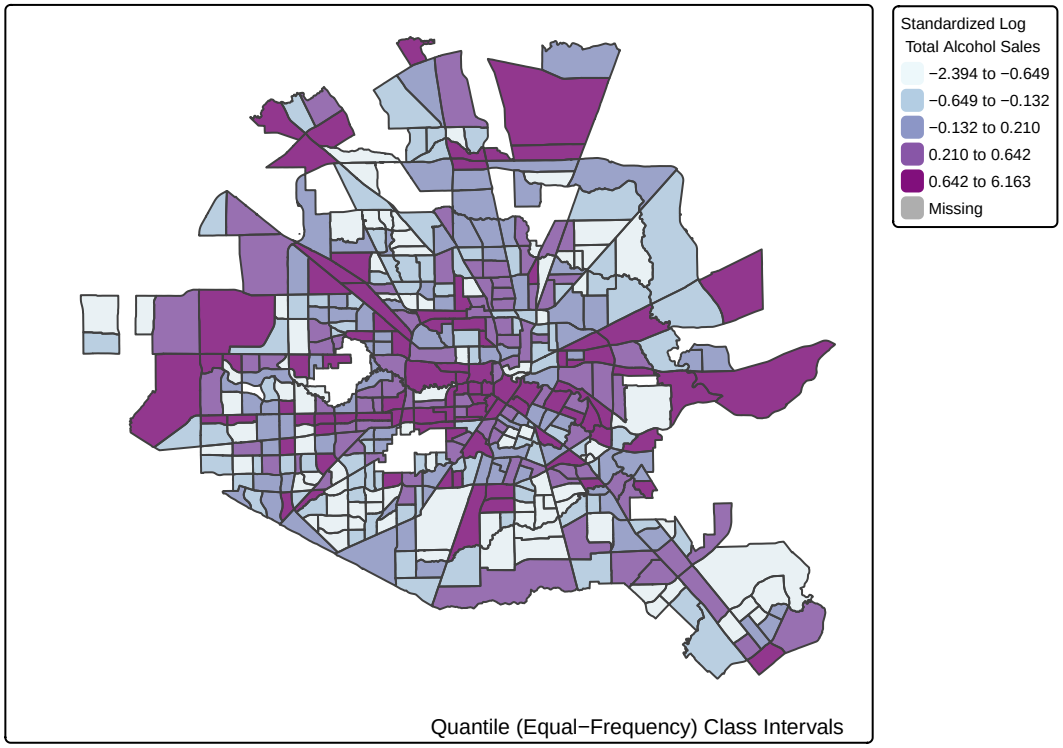
```
violence_map <- tm_shape(houston) +
  tm_fill('violence.rate',
style='quantile',
palette='BuPu',
title='Violent Crimes \n Per Capita') +
  tm_borders(alpha=0.7) +
  tm_credits('Quantile (Equal-Frequency) Class Intervals',
             position=c('RIGHT', 'BOTTOM')) +
  tm_layout(main.title="Violent Crime Rate in Houston, TX",
            inner.margins = c(0.1, 0.1, 0.05, 0.05),
            main.title.size=1.2, legend.title.size=0.5,
            legend.text.size=0.5)
violence_map
```



Next, map standardized log total alcohol sales.

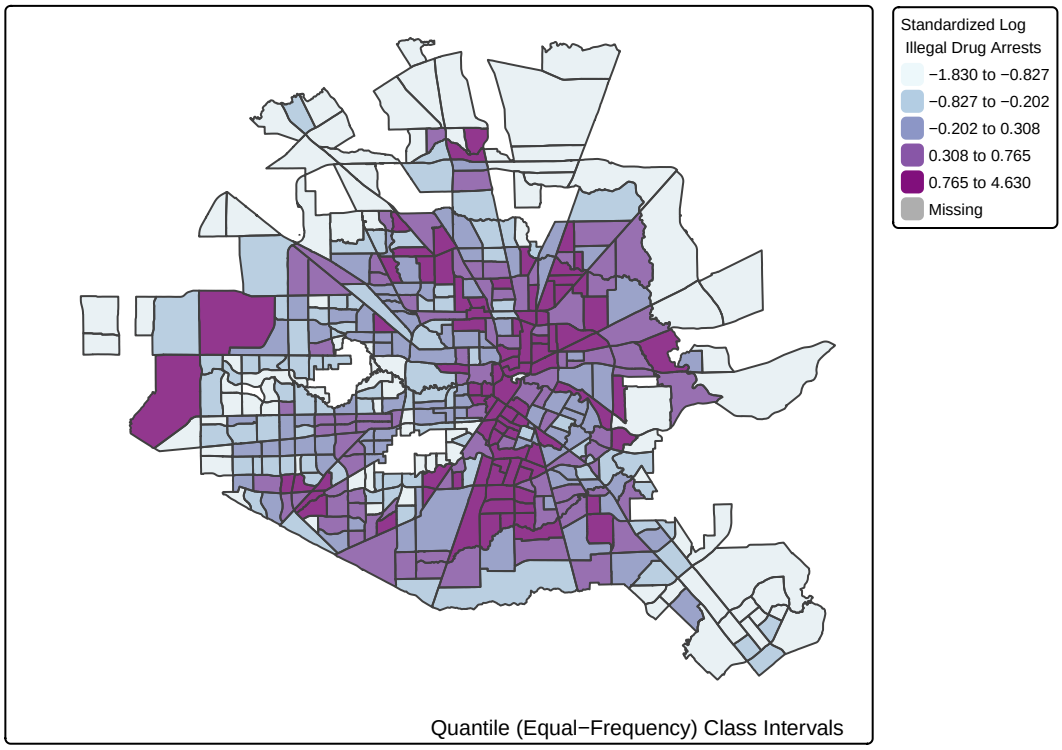
```
alc_map <- tm_shape(houston) +
  tm_fill('Zl_total',
style='quantile',
palette='BuPu',
title='Standardized Log \n Total Alcohol Sales') + # "\n" moves text to the next line
  tm_borders(alpha=0.2) +
  tm_credits('Quantile (Equal-Frequency) Class Intervals',
             position=c('RIGHT', 'BOTTOM')) +
```

```
  tm_layout(main.title="Alcohol Sales in Houston, TX",
            inner.margins = c(0.1, 0.1, 0.05, 0.05),
            main.title.size=1.2, legend.title.size=0.5,
            legend.text.size=0.5)
alc_map
```



Finally, plot standardized log illegal drug arrests.

```
drug_map <- tm_shape(houston) +
  tm_fill('Zl_drug',
style='quantile',
palette='BuPu',
title='Standardized Log \n Illegal Drug Arrests') +
  tm_borders(alpha=0.2) +
  tm_credits('Quantile (Equal-Frequency) Class Intervals',
             position=c('RIGHT', 'BOTTOM')) +
  tm_layout(main.title="Illegal Drug Arrests in Houston, TX",
            inner.margins = c(0.1, 0.1, 0.05, 0.05),
            main.title.size=1.2, legend.title.size=0.5,
            legend.text.size=0.5)
drug_map
```



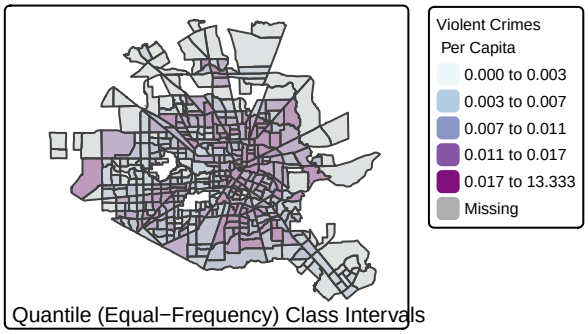
These three figures will match the maps in Figure 1 of:

Waller LA, Zhu L, Gotway CA, Gorman DM, and Gruenewald PJ (2007) "Quantifying geographic variations in associations between alcohol distribution and violence: A comparison of geographically weighted regression and spatially varying coefficient models". Stochastic Environmental Research and Risk Assessment.21, 573-588.

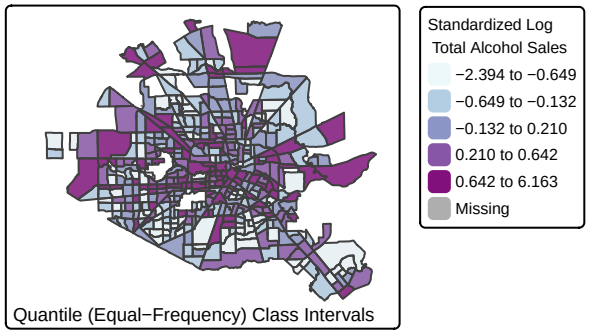
Let's use tmap to make a multiple-map single figure.

```
tmap_arrange(violence_map, alc_map, drug_map)
```

Violent Crime Rate in Houston, TX



Alcohol Sales in Houston, TX



Illegal Drug Arrests in Houston, TX