Imported Data Exploration–Census Tract-Level

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```
library(here)
```

```
## here() starts at /Users/Alvin/Documents/NCSU_Fall_2021/NIH_SIP/flood-risk-health-effects
```

```
library(usmap)
library(ggplot2)
library(tidyverse)
```

```
## -- Attaching packages --------------------------------------- tidyverse 1.3.0 --
```

```
## v tibble  3.0.5     v dplyr   1.0.3
## v tidyr   1.1.2     v stringr 1.4.0
## v readr   1.4.0     v forcats 0.5.0
## v purrr   0.3.4
```

```
## -- Conflicts ------------------------------------------ tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```

```
library(dplyr)
library(choroplethr)
```

```
## Loading required package: acs
```

```
## Loading required package: XML
```

```
##
## Attaching package: 'acs'
```

```
## The following object is masked from 'package:dplyr':
##
##     combine
```

```
## The following object is masked from 'package:base':
##
##     apply
```

```
library(choroplethrMaps)
```

```
i_am("reports/imported_data_exploration.Rmd")
```

```
## here() starts at /Users/Alvin/Documents/NCSU_Fall_2021/NIH_SIP/flood-risk-health-effects
```

```
select <- dplyr::select
```

Exploration of Flood Risk Dataset

```
flood_risk <- read.csv(here("imported_data", "flood_risk", "Zip_level_risk_FEMA_FSF_v1.3.csv"))
```

```
summary(flood_risk)
```

```
##     zipcode       count_property   count_fema_sfha   pct_fema_sfha
##  Min.   : 1001   Min.   :     1   Min.   :    0.0   Min.   :  0.000
##  1st Qu.:26612   1st Qu.:   783   1st Qu.:   13.0   1st Qu.:  0.800
##  Median :49434   Median :  2206   Median :   66.0   Median :  3.000
##  Mean   :49331   Mean   :  4422   Mean   :  269.5   Mean   :  7.253
##  3rd Qu.:71471   3rd Qu.:  6418   3rd Qu.:  215.0   3rd Qu.:  7.500
##  Max.   :99403   Max.   :107680   Max.   :26478.0   Max.   :100.000
##
##  count_fs_risk_2020_5 pct_fs_risk_2020_5 count_fs_risk_2050_5
##  Min.   :    0.0      Min.   :  0.000    Min.   :    0
##  1st Qu.:   17.0      1st Qu.:  1.000    1st Qu.:   19
##  Median :   62.0      Median :  3.300    Median :   67
##  Mean   :  150.2      Mean   :  5.904    Mean   :  179
##  3rd Qu.:  159.0      3rd Qu.:  6.800    3rd Qu.:  173
##  Max.   :13091.0      Max.   :100.000    Max.   :19264
##
##  pct_fs_risk_2050_5 count_fs_risk_2020_100 pct_fs_risk_2020_100
##  Min.   :  0.000    Min.   :    0.0        Min.   :  0.0
##  1st Qu.:  1.200    1st Qu.:   87.0        1st Qu.:  6.1
##  Median :  3.600    Median :  227.0        Median :  9.9
##  Mean   :  6.473    Mean   :  501.8        Mean   : 13.9
##  3rd Qu.:  7.200    3rd Qu.:  543.0        3rd Qu.: 16.0
##  Max.   :100.000    Max.   :28349.0        Max.   :100.0
##
##  count_fs_risk_2050_100 pct_fs_risk_2050_100 count_fs_risk_2020_500
##  Min.   :    0.0        Min.   :  0.00       Min.   :    0.0
##  1st Qu.:   90.0        1st Qu.:  6.40       1st Qu.:  112.0
##  Median :  236.0        Median : 10.30       Median :  301.5
##  Mean   :  553.9        Mean   : 14.77       Mean   :  737.1
##  3rd Qu.:  570.0        3rd Qu.: 16.70       3rd Qu.:  767.8
##  Max.   :31117.0        Max.   :100.00       Max.   :31302.0
##
##  pct_fs_risk_2020_500 count_fs_risk_2050_500 pct_fs_risk_2050_500
##  Min.   :  0.00       Min.   :    0.0        Min.   :  0.0
##  1st Qu.:  8.40       1st Qu.:  115.0        1st Qu.:  8.7
##  Median : 13.10       Median :  311.0        Median : 13.6
##  Mean   : 18.36       Mean   :  791.4        Mean   : 19.3
##  3rd Qu.: 21.30       3rd Qu.:  805.0        3rd Qu.: 22.2
##  Max.   :100.00       Max.   :35632.0        Max.   :100.0
##
##  count_fs_fema_difference_2020 pct_fs_fema_difference_2020 avg_risk_score_all
##  Min.   :-13247.0              Min.   :-100.000            Min.   : 1.000
##  1st Qu.:    23.0              1st Qu.:   2.300            1st Qu.: 1.460
##  Median :   108.0              Median :   5.500            Median : 1.740
##  Mean   :   232.3              Mean   :   6.649            Mean   : 2.069
##  3rd Qu.:   301.0              3rd Qu.:  10.000            3rd Qu.: 2.220
##  Max.   : 10605.0              Max.   : 100.000            Max.   :10.000
##
```

```
##  avg_risk_score_2_10 avg_risk_fsf_2020_100 avg_risk_fsf_2020_500
##  Min.   : 2.000      Min.   : 3.000        Min.   : 0.500
##  1st Qu.: 5.600      1st Qu.: 6.720        1st Qu.: 5.780
##  Median : 6.520      Median : 7.460        Median : 6.670
##  Mean   : 6.487      Mean   : 7.412        Mean   : 6.628
##  3rd Qu.: 7.410      3rd Qu.: 8.150        3rd Qu.: 7.530
##  Max.   :10.000      Max.   :10.000        Max.   :10.000
##  NA's   :464         NA's   :621           NA's   :489
##  avg_risk_score_sfha avg_risk_score_no_sfha count_floodfactor1
##  Min.   : 1.000      Min.   : 0.020         Min.   :    0
##  1st Qu.: 4.180      1st Qu.: 1.350         1st Qu.:  589
##  Median : 5.570      Median : 1.570         Median : 1732
##  Mean   : 5.576      Mean   : 1.826         Mean   : 3629
##  3rd Qu.: 6.950      3rd Qu.: 1.940         3rd Qu.: 5123
##  Max.   :10.000      Max.   :10.000         Max.   :84159
##  NA's   :3757        NA's   :170
##  count_floodfactor2 count_floodfactor3 count_floodfactor4 count_floodfactor5
##  Min.   :   0.00    Min.   :    0.0    Min.   :    0.0    Min.   :   0.00
##  1st Qu.:   1.00    1st Qu.:    6.0    1st Qu.:    7.0    1st Qu.:   4.00
##  Median :   6.00    Median :   23.0    Median :   28.0    Median :  15.00
##  Mean   :  41.39    Mean   :  102.1    Mean   :  133.4    Mean   :  55.12
##  3rd Qu.:  24.00    3rd Qu.:   77.0    3rd Qu.:   93.0    3rd Qu.:  44.00
##  Max.   :9140.00    Max.   :11340.0    Max.   :23745.0    Max.   :5941.00
##
##  count_floodfactor6 count_floodfactor7 count_floodfactor8 count_floodfactor9
##  Min.   :    0.0    Min.   :   0.00    Min.   :   0.00    Min.   :    0.00
##  1st Qu.:   19.0    1st Qu.:  11.00    1st Qu.:   2.00    1st Qu.:   12.00
##  Median :   61.0    Median :  34.00    Median :   6.00    Median :   36.00
##  Mean   :  198.6    Mean   :  76.02    Mean   :  15.61    Mean   :   85.72
##  3rd Qu.:  192.0    3rd Qu.:  87.00    3rd Qu.:  17.00    3rd Qu.:   88.00
##  Max.   :12742.0    Max.   :7489.00    Max.   :1489.00    Max.   :16013.00
##
##  count_floodfactor10
##  Min.   :    0.00
##  1st Qu.:    5.00
##  Median :   24.00
##  Mean   :   84.46
##  3rd Qu.:   72.00
##  Max.   :10752.00
##
```

There are some missing values in the flood risk. These columns have missing values: 20, 21, 22, 23, and 24. Below shows how many missing values are in each column.

```
missing_idx <- which(is.na(flood_risk), arr.ind = TRUE)

table(missing_idx[, 2])
```

```
##
##   20   21   22   23   24
##  464  621  489 3757  170
```

Missing variables are all the "avg_risk_" variables except for "avg_risk_score_all".

```
names(flood_risk)[20:24]
```

```
## [1] "avg_risk_score_2_10"    "avg_risk_fsf_2020_100"  "avg_risk_fsf_2020_500"
## [4] "avg_risk_score_sfha"    "avg_risk_score_no_sfha"
```

Exploration of the PLACES data set

This data set contains multiple outcomes of interest, as well as multiple covariates of interest. It's currently in long format; it will be turned into wide format.

```
places_dat <- read.csv(here("imported_data",
                            "PLACES__Local_Data_for_Better_Health__Census_Tract_Data_2020_release.csv"))
```

```
head(places_dat)
```

```
##   Year StateAbbr StateDesc CountyName CountyFIPS LocationName DataSource
## 1 2018        AL   Alabama    Calhoun       1015   1015001600      BRFSS
## 2 2018        AL   Alabama   Cherokee       1019   1019955900      BRFSS
## 3 2018        AL   Alabama       Clay       1027   1027959000      BRFSS
## 4 2018        AL   Alabama       Clay       1027   1027959200      BRFSS
## 5 2018        AL   Alabama   Cleburne       1029   1029959600      BRFSS
## 6 2018        AL   Alabama     Coffee       1031   1031010700      BRFSS
##              Category                                      Measure
## 1     Health Outcomes  All teeth lost among adults aged >=65 years
## 2          Prevention Mammography use among women aged 50-74 years
## 3     Health Outcomes       Arthritis among adults aged >=18 years
## 4     Health Outcomes          Stroke among adults aged >=18 years
## 5     Health Outcomes          Stroke among adults aged >=18 years
## 6 Unhealthy Behaviors         Obesity among adults aged >=18 years
##   Data_Value_Unit  Data_Value_Type Data_Value Data_Value_Footnote_Symbol
## 1               % Crude prevalence       22.1
## 2               % Crude prevalence       74.6
## 3               % Crude prevalence       40.9
## 4               % Crude prevalence        4.8
## 5               % Crude prevalence        5.2
## 6               % Crude prevalence       36.0
##   Data_Value_Footnote Low_Confidence_Limit High_Confidence_Limit
## 1                                    17.7                  27.2
## 2                                    72.1                  77.0
## 3                                    40.0                  41.7
## 4                                     4.5                   5.0
## 5                                     4.7                   5.7
## 6                                    35.3                  36.7
##   TotalPopulation                       Geolocation LocationID CategoryID
## 1            3791  POINT (-85.85970752 33.7049306) 1015001600    HLTHOUT
## 2            4235 POINT (-85.66863815 34.05057636) 1019955900    PREVENT
## 3            3224 POINT (-85.87716485 33.30474877) 1027959000    HLTHOUT
## 4            2480  POINT (-86.02087034 33.1899579) 1027959200    HLTHOUT
## 5            4202 POINT (-85.56228862 33.69258271) 1029959600    HLTHOUT
## 6            2286   POINT (-86.028595 31.25325368) 1031010700     UNHBEH
##   MeasureId DataValueTypeID Short_Question_Text
## 1 TEETHLOST          CrdPrv          Teeth Loss
## 2  MAMMOUSE          CrdPrv         Mammography
## 3 ARTHRITIS          CrdPrv           Arthritis
## 4    STROKE          CrdPrv              Stroke
```

```
## 5    STROKE          CrdPrv              Stroke
## 6   OBESITY          CrdPrv             Obesity
```

Data_Value contains the outcome/covariate values.

There is only one missing value.

```
summary(places_dat)
```

```
##       Year       StateAbbr          StateDesc          CountyName
##  Min.   :2017   Length:2024865     Length:2024865     Length:2024865
##  1st Qu.:2018   Class :character   Class :character   Class :character
##  Median :2018   Mode  :character   Mode  :character   Mode  :character
##  Mean   :2018
##  3rd Qu.:2018
##  Max.   :2018
##
##    CountyFIPS     LocationName        DataSource          Category
##  Min.   : 1001   Min.   :1.001e+09   Length:2024865     Length:2024865
##  1st Qu.:12127   1st Qu.:1.213e+10   Class :character   Class :character
##  Median :27127   Median :2.713e+10   Mode  :character   Mode  :character
##  Mean   :27822   Mean   :2.782e+10
##  3rd Qu.:41035   3rd Qu.:4.104e+10
##  Max.   :56045   Max.   :5.605e+10
##
##    Measure          Data_Value_Unit    Data_Value_Type      Data_Value
##  Length:2024865     Length:2024865     Length:2024865     Min.   : 0.3
##  Class :character   Class :character   Class :character   1st Qu.:10.4
##  Mode  :character   Mode  :character   Mode  :character   Median :23.8
##                                                           Mean   :32.3
##                                                           3rd Qu.:47.1
##                                                           Max.   :95.4
##                                                           NA's   :1
##  Data_Value_Footnote_Symbol Data_Value_Footnote Low_Confidence_Limit
##  Length:2024865             Length:2024865      Min.   : 0.30
##  Class :character           Class :character    1st Qu.: 9.30
##  Mode  :character           Mode  :character    Median :21.40
##                                                 Mean   :30.64
##                                                 3rd Qu.:44.70
##                                                 Max.   :94.70
##                                                 NA's   :1
##  High_Confidence_Limit TotalPopulation Geolocation          LocationID
##  Min.   : 0.30         Min.   :   56   Length:2024865     Min.   :1.001e+09
##  1st Qu.:11.60         1st Qu.: 2910   Class :character   1st Qu.:1.213e+10
##  Median :26.30         Median : 4018   Mode  :character   Median :2.713e+10
##  Mean   :33.98         Mean   : 4269                      Mean   :2.782e+10
##  3rd Qu.:50.10         3rd Qu.: 5335                      3rd Qu.:4.104e+10
##  Max.   :96.00         Max.   :37452                      Max.   :5.605e+10
##  NA's   :1
##   CategoryID         MeasureId         DataValueTypeID    Short_Question_Text
##  Length:2024865     Length:2024865     Length:2024865     Length:2024865
##  Class :character   Class :character   Class :character   Class :character
##  Mode  :character   Mode  :character   Mode  :character   Mode  :character
##
##
##
```

```
##
```

There are 28 measures in the data set.

```
unique(places_dat$Measure)
```

```
##  [1] "All teeth lost among adults aged >=65 years"
##  [2] "Mammography use among women aged 50-74 years"
##  [3] "Arthritis among adults aged >=18 years"
##  [4] "Stroke among adults aged >=18 years"
##  [5] "Obesity among adults aged >=18 years"
##  [6] "Current asthma among adults aged >=18 years"
##  [7] "Diagnosed diabetes among adults aged >=18 years"
##  [8] "Binge drinking among adults aged >=18 years"
##  [9] "Current smoking among adults aged >=18 years"
## [10] "Sleeping less than 7 hours among adults aged >=18 years"
## [11] "Fecal occult blood test, sigmoidoscopy, or colonoscopy among adults aged 50-75 years"
## [12] "Cancer (excluding skin cancer) among adults aged >=18 years"
## [13] "Physical health not good for >=14 days among adults aged >=18 years"
## [14] "Older adult men aged >=65 years who are up to date on a core set of clinical preventive service
## [15] "Older adult women aged >=65 years who are up to date on a core set of clinical preventive servi
## [16] "Visits to doctor for routine checkup within the past year among adults aged >=18 years"
## [17] "High blood pressure among adults aged >=18 years"
## [18] "Visits to dentist or dental clinic among adults aged >=18 years"
## [19] "Mental health not good for >=14 days among adults aged >=18 years"
## [20] "No leisure-time physical activity among adults aged >=18 years"
## [21] "Current lack of health insurance among adults aged 18-64 years"
## [22] "Chronic obstructive pulmonary disease among adults aged >=18 years"
## [23] "Cholesterol screening among adults aged >=18 years"
## [24] "Chronic kidney disease among adults aged >=18 years"
## [25] "High cholesterol among adults aged >=18 years who have been screened in the past 5 years"
## [26] "Taking medicine for high blood pressure control among adults aged >=18 years with high blood pr
## [27] "Coronary heart disease among adults aged >=18 years"
## [28] "Cervical cancer screening among adult women aged 21-65 years"
```

The data source for all measures is the Behavioral Risk Factor Surveillance System.

```
table(places_dat$DataSource)
```

```
##
##   BRFSS
## 2024865
```

3 kinds of outcomes.

```
table(places_dat$Category)
```

```
##
##     Health Outcomes          Prevention Unhealthy Behaviors
##              940282              722898              361685
```

All measures are in the form of crude prevalence (%).

```
table(places_dat$Data_Value_Type)
```

```
##
## Crude prevalence
##          2024865
```

MeasureId is a shorter indicator for each of the 28 measures

```
table(places_dat$MeasureId)
```

```
##
##      ACCESS2    ARTHRITIS        BINGE       BPHIGH        BPMED       CANCER
##        72337        72337        72337        72337        72337        72337
##      CASTHMA     CERVICAL          CHD      CHECKUP   CHOLSCREEN COLON_SCREEN
##        72337        72320        72337        72337        72337        72305
##         COPD        COREM        COREW     CSMOKING       DENTAL     DIABETES
##        72337        72193        72142        72337        72337        72337
##     HIGHCHOL       KIDNEY          LPA     MAMMOUSE        MHLTH      OBESITY
##        72337        72337        72337        72253        72337        72337
##        PHLTH        SLEEP       STROKE    TEETHLOST
##        72337        72337        72337        72238
```

The data has 72337 out of 73057 census tracts in the U.S. But census tracts can split and merge over time, so the data may actually have all census tracts at that moment in time.

```
n_distinct(places_dat$LocationName)
```

```
## [1] 72337
```

All but 2 of the census tracts in the PLACES data set are in the CDC SVI data set. Census tracts 6037930401, 15009000320 are not in the CDC SVI data set.

LocationName refers to the census tract FIPS. Below is the frequency table of the number of measures associated with a census tract. 99.66 % of census tracts have all 28 measures.

```
table(as.numeric(table(places_dat$LocationName)))
```

```
##
##    22    23    24    25    26    27    28
##     1    32    13    66    24   107 72094
```

Exploration of CDC SVI data

```
# reading in the CDC SVI data
cdc_svi <- read.csv(here("imported_data", "CDC_SVI", "SVI2018_US.csv"))
```

```
summary(cdc_svi)
```

```
##        ST           STATE              ST_ABBR             STCNTY
##  Min.   : 1.00   Length:72837       Length:72837       Min.   : 1001
##  1st Qu.:12.00   Class :character   Class :character   1st Qu.:12127
##  Median :27.00   Mode  :character   Mode  :character   Median :27131
##  Mean   :27.74                                         Mean   :27831
##  3rd Qu.:41.00                                         3rd Qu.:41039
##  Max.   :56.00                                         Max.   :56045
##     COUNTY               FIPS             LOCATION           AREA_SQMI
##  Length:72837       Min.   :1.001e+09   Length:72837       Min.   :    0.00
##  Class :character   1st Qu.:1.213e+10   Class :character   1st Qu.:    0.69
##  Mode  :character   Median :2.713e+10   Mode  :character   Median :    1.88
##                     Mean   :2.783e+10                      Mean   :   48.50
##                     3rd Qu.:4.104e+10                      3rd Qu.:   13.26
##                     Max.   :5.605e+10                      Max.   :85554.34
```

```
##     E_TOTPOP        M_TOTPOP           E_HU            M_HU
##  Min.   :    0   Min.   :   0.0   Min.   :    0   Min.   :  3.00
##  1st Qu.: 2923   1st Qu.: 237.0   1st Qu.: 1274   1st Qu.: 48.00
##  Median : 4128   Median : 336.0   Median : 1752   Median : 72.00
##  Mean   : 4433   Mean   : 368.5   Mean   : 1872   Mean   : 82.88
##  3rd Qu.: 5543   3rd Qu.: 467.0   3rd Qu.: 2332   3rd Qu.:106.00
##  Max.   :70271   Max.   :4094.0   Max.   :26436   Max.   :700.00
##       E_HH            M_HH           E_POV           M_POV
##  Min.   :    0   Min.   :  3.0   Min.   :-999.0   Min.   :-999.0
##  1st Qu.: 1104   1st Qu.: 74.0   1st Qu.: 241.0   1st Qu.: 124.0
##  Median : 1543   Median :102.0   Median : 462.0   Median : 211.0
##  Mean   : 1644   Mean   :111.3   Mean   : 607.4   Mean   : 248.1
##  3rd Qu.: 2063   3rd Qu.:139.0   3rd Qu.: 813.0   3rd Qu.: 332.0
##  Max.   :21337   Max.   :764.0   Max.   :9373.0   Max.   :2051.0
##     E_UNEMP          M_UNEMP           E_PCI           M_PCI
##  Min.   :-999.0   Min.   :-999.00   Min.   : -999   Min.   : -999
##  1st Qu.:  62.0   1st Qu.:  43.00   1st Qu.: 21571   1st Qu.:  2632
##  Median : 107.0   Median :  66.00   Median : 28460   Median :  3592
##  Mean   : 130.4   Mean   :  76.09   Mean   : 32060   Mean   :  4472
##  3rd Qu.: 172.0   3rd Qu.:  99.00   3rd Qu.: 38120   3rd Qu.:  5246
##  Max.   :1734.0   Max.   : 726.00   Max.   :227064   Max.   :126980
##     E_NOHSDP        M_NOHSDP         E_AGE65         M_AGE65
##  Min.   :   0   Min.   :   2.0   Min.   :    0   Min.   :   0.0
##  1st Qu.: 139   1st Qu.:  67.0   1st Qu.:  394   1st Qu.:  73.0
##  Median : 268   Median : 109.0   Median :  606   Median : 104.0
##  Mean   : 370   Mean   : 127.6   Mean   :  676   Mean   : 115.7
##  3rd Qu.: 483   3rd Qu.: 168.0   3rd Qu.:  872   3rd Qu.: 145.0
##  Max.   :5114   Max.   :1340.0   Max.   :31071   Max.   :1142.0
##     E_AGE17         M_AGE17          E_DISABL         M_DISABL
##  Min.   :    0   Min.   :   0.0   Min.   :   0.0   Min.   :   2.0
##  1st Qu.:  573   1st Qu.: 116.0   1st Qu.: 332.0   1st Qu.:  98.0
##  Median :  886   Median : 172.0   Median : 496.0   Median : 139.0
##  Mean   : 1010   Mean   : 195.1   Mean   : 550.2   Mean   : 152.3
##  3rd Qu.: 1288   3rd Qu.: 249.0   3rd Qu.: 709.0   3rd Qu.: 191.0
##  Max.   :25420   Max.   :1467.0   Max.   :7419.0   Max.   :1270.0
##     E_SNGPNT         M_SNGPNT        E_MINRTY        M_MINRTY
##  Min.   :   0.0   Min.   :  2.2   Min.   :    0   Min.   :   3.0
##  1st Qu.:  65.0   1st Qu.: 42.7   1st Qu.:  455   1st Qu.: 323.7
##  Median : 120.0   Median : 67.2   Median : 1162   Median : 444.9
##  Mean   : 146.8   Mean   : 74.9   Mean   : 1726   Mean   : 480.8
##  3rd Qu.: 199.0   3rd Qu.: 98.2   3rd Qu.: 2453   3rd Qu.: 596.0
##  Max.   :2039.0   Max.   :592.4   Max.   :39057   Max.   :4207.6
##     E_LIMENG         M_LIMENG         E_MUNIT          M_MUNIT
##  Min.   :   0.0   Min.   :  31.7   Min.   :    0.0   Min.   :  2.80
##  1st Qu.:   9.0   1st Qu.:  48.8   1st Qu.:    7.0   1st Qu.: 20.20
##  Median :  50.0   Median :  70.6   Median :   75.0   Median : 49.40
##  Mean   : 182.9   Mean   : 104.3   Mean   :  251.8   Mean   : 70.66
##  3rd Qu.: 190.0   3rd Qu.: 125.5   3rd Qu.:  288.0   3rd Qu.:100.80
##  Max.   :5040.0   Max.   :1023.8   Max.   :12554.0   Max.   :806.30
##     E_MOBILE         M_MOBILE         E_CROWD          M_CROWD
##  Min.   :   0.0   Min.   :  2.00   Min.   :   0.00   Min.   :  2.80
##  1st Qu.:   0.0   1st Qu.: 12.00   1st Qu.:   8.00   1st Qu.: 18.40
##  Median :  11.0   Median : 19.00   Median :  28.00   Median : 30.90
##  Mean   : 116.9   Mean   : 44.52   Mean   :  55.06   Mean   : 42.66
```

```
##  3rd Qu.: 133.0   3rd Qu.: 63.00   3rd Qu.:  69.00   3rd Qu.: 56.30
##  Max.   :3181.0   Max.   :508.00   Max.   :1315.00   Max.   :471.50
##     E_NOVEH          M_NOVEH          E_GROUPQ          M_GROUPQ
##  Min.   :   0.0   Min.   :  2.00   Min.   :    0.0   Min.   :   2.00
##  1st Qu.:  35.0   1st Qu.: 29.00   1st Qu.:    0.0   1st Qu.:  11.00
##  Median :  82.0   Median : 53.00   Median :   10.0   Median :  15.00
##  Mean   : 143.1   Mean   : 61.51   Mean   :  111.1   Mean   :  42.85
##  3rd Qu.: 168.0   3rd Qu.: 83.00   3rd Qu.:   63.0   3rd Qu.:  43.00
##  Max.   :6059.0   Max.   :761.00   Max.   :16694.0   Max.   :4101.00
##      EP_POV           MP_POV           EP_UNEMP          MP_UNEMP
##  Min.   :-999.000   Min.   :-999.000   Min.   :-999.000   Min.   :-999.000
##  1st Qu.:   6.400   1st Qu.:   3.300   1st Qu.:   3.300   1st Qu.:   2.200
##  Median :  11.900   Median :   5.400   Median :   5.200   Median :   3.100
##  Mean   :   7.142   Mean   :  -2.138   Mean   :  -1.162   Mean   :  -3.723
##  3rd Qu.:  20.600   3rd Qu.:   7.700   3rd Qu.:   8.000   3rd Qu.:   4.500
##  Max.   : 100.000   Max.   : 100.000   Max.   : 100.000   Max.   : 100.000
##      EP_PCI           MP_PCI         EP_NOHSDP          MP_NOHSDP
##  Min.   :  -999   Min.   :  -999   Min.   :-999.000   Min.   :-999.000
##  1st Qu.: 21571   1st Qu.:  2632   1st Qu.:   5.300   1st Qu.:   2.600
##  Median : 28460   Median :  3592   Median :  10.000   Median :   3.900
##  Mean   : 32060   Mean   :  4472   Mean   :   6.924   Mean   :  -1.628
##  3rd Qu.: 38120   3rd Qu.:  5246   3rd Qu.:  17.600   3rd Qu.:   5.600
##  Max.   :227064   Max.   :126980   Max.   : 100.000   Max.   : 100.000
##     EP_AGE65         MP_AGE65          EP_AGE17        MP_AGE17
##  Min.   :-999.00   Min.   :-999.000   Min.   : 0.00   Min.   :-999.000
##  1st Qu.:  10.90   1st Qu.:   2.000   1st Qu.:18.50   1st Qu.:   2.800
##  Median :  15.20   Median :   2.600   Median :22.20   Median :   3.800
##  Mean   :  10.04   Mean   :  -2.891   Mean   :21.96   Mean   :  -1.587
##  3rd Qu.:  19.50   3rd Qu.:   3.500   3rd Qu.:26.00   3rd Qu.:   5.100
##  Max.   : 100.00   Max.   : 100.000   Max.   :87.60   Max.   : 600.000
##    EP_DISABL         MP_DISABL          EP_SNGPNT        MP_SNGPNT
##  Min.   :-999.000   Min.   :-999.000   Min.   :  0.00   Min.   :-999.000
##  1st Qu.:   9.100   1st Qu.:   2.700   1st Qu.:  4.70   1st Qu.:   3.100
##  Median :  12.500   Median :   3.400   Median :  7.80   Median :   4.400
##  Mean   :   5.934   Mean   :  -3.596   Mean   :  9.17   Mean   :  -3.117
##  3rd Qu.:  16.600   3rd Qu.:   4.300   3rd Qu.: 12.20   3rd Qu.:   6.000
##  Max.   : 100.000   Max.   : 100.000   Max.   :100.00   Max.   :1700.000
##    EP_MINRTY        MP_MINRTY          EP_LIMENG         MP_LIMENG
##  Min.   :  0.00   Min.   :-999.000   Min.   :  0.000   Min.   :-999.00
##  1st Qu.: 12.30   1st Qu.:   7.500   1st Qu.:  0.300   1st Qu.:   1.40
##  Median : 29.40   Median :   9.900   Median :  1.300   Median :   2.10
##  Mean   : 38.12   Mean   :   4.404   Mean   :  4.129   Mean   :  -2.67
##  3rd Qu.: 60.50   3rd Qu.:  12.400   3rd Qu.:  4.700   3rd Qu.:   3.30
##  Max.   :100.00   Max.   : 400.300   Max.   :100.000   Max.   :2400.00
##     EP_MUNIT         MP_MUNIT          EP_MOBILE          MP_MOBILE
##  Min.   :  0.00   Min.   :-999.000   Min.   :-999.000   Min.   :-999.000
##  1st Qu.:  0.50   1st Qu.:   1.400   1st Qu.:   0.000   1st Qu.:   1.400
##  Median :  4.50   Median :   3.100   Median :   0.700   Median :   2.300
##  Mean   : 12.27   Mean   :  -3.829   Mean   :  -2.054   Mean   :  -4.922
##  3rd Qu.: 15.90   3rd Qu.:   5.500   3rd Qu.:   7.500   3rd Qu.:   3.900
##  Max.   :100.00   Max.   :1700.000   Max.   : 100.000   Max.   : 100.000
##     EP_CROWD          MP_CROWD           EP_NOVEH           MP_NOVEH
##  Min.   :  0.000   Min.   :-999.000   Min.   :-999.0000   Min.   :-999.000
##  1st Qu.:  0.600   1st Qu.:   1.300   1st Qu.:   2.4000   1st Qu.:   2.000
```

```
##  Median :  1.800   Median :   2.200   Median :   5.2000   Median :   3.500
##  Mean   :  3.551   Mean   :  -5.026   Mean   :   0.9595   Mean   :  -4.223
##  3rd Qu.:  4.300   3rd Qu.:   3.700   3rd Qu.:  10.9000   3rd Qu.:   5.300
##  Max.   :100.000   Max.   :1700.000   Max.   : 100.0000   Max.   : 100.000
##    EP_GROUPQ         MP_GROUPQ           EPL_POV            EPL_UNEMP
##  Min.   :  0.000   Min.   :-999.000   Min.   :-999.0000   Min.   :-999.0000
##  1st Qu.:  0.000   1st Qu.:   0.300   1st Qu.:   0.2397   1st Qu.:   0.2320
##  Median :  0.200   Median :   0.400   Median :   0.4938   Median :   0.4859
##  Mean   :  2.674   Mean   :  -4.712   Mean   :  -7.4881   Mean   :  -6.9968
##  3rd Qu.:  1.500   3rd Qu.:   1.100   3rd Qu.:   0.7479   3rd Qu.:   0.7466
##  Max.   :100.000   Max.   : 600.000   Max.   :   0.9997   Max.   :   0.9999
##     EPL_PCI           EPL_NOHSDP          SPL_THEME1         RPL_THEME1
##  Min.   :-999.0000   Min.   :-999.0000   Min.   :-999.000   Min.   :-999.0000
##  1st Qu.:   0.2450   1st Qu.:   0.2422   1st Qu.:   1.154   1st Qu.:   0.2434
##  Median :   0.4967   Median :   0.4942   Median :   1.935   Median :   0.4956
##  Mean   :  -6.1005   Mean   :  -5.4986   Mean   :  -6.749   Mean   :  -8.2275
##  3rd Qu.:   0.7483   3rd Qu.:   0.7480   3rd Qu.:   2.785   3rd Qu.:   0.7478
##  Max.   :   1.0000   Max.   :   1.0000   Max.   :   3.986   Max.   :   1.0000
##    EPL_AGE65           EPL_AGE17           EPL_DISABL
##  Min.   :-999.0000   Min.   :-999.0000   Min.   :-999.0000
##  1st Qu.:   0.2451   1st Qu.:   0.2454   1st Qu.:   0.2405
##  Median :   0.4948   Median :   0.4945   Median :   0.4933
##  Mean   :  -5.3479   Mean   :  -5.3481   Mean   :  -6.8304
##  3rd Qu.:   0.7445   3rd Qu.:   0.7458   3rd Qu.:   0.7456
##  Max.   :   0.9999   Max.   :   1.0000   Max.   :   0.9999
##    EPL_SNGPNT          SPL_THEME2         RPL_THEME2          EPL_MINRTY
##  Min.   :-999.0000   Min.   :-999.000   Min.   :-999.0000   Min.   :-999.0000
##  1st Qu.:   0.2415   1st Qu.:   1.614   1st Qu.:   0.2444   1st Qu.:   0.2456
##  Median :   0.4921   Median :   2.013   Median :   0.4963   Median :   0.4964
##  Mean   :  -5.3486   Mean   :  -5.347   Mean   :  -6.8278   Mean   :  -5.3464
##  3rd Qu.:   0.7471   3rd Qu.:   2.400   3rd Qu.:   0.7481   3rd Qu.:   0.7479
##  Max.   :   0.9999   Max.   :   3.813   Max.   :   1.0000   Max.   :   0.9967
##    EPL_LIMENG          SPL_THEME3          RPL_THEME3
##  Min.   :-999.0000   Min.   :-999.0000   Min.   :-999.0000
##  1st Qu.:   0.2381   1st Qu.:   0.5262   1st Qu.:   0.2455
##  Median :   0.4857   Median :   0.9668   Median :   0.4971
##  Mean   :  -5.3671   Mean   :  -4.8706   Mean   :  -5.3458
##  3rd Qu.:   0.7480   3rd Qu.:   1.4232   3rd Qu.:   0.7485
##  Max.   :   1.0000   Max.   :   1.9967   Max.   :   1.0000
##    EPL_MUNIT           EPL_MOBILE          EPL_CROWD
##  Min.   :-999.0000   Min.   :-999.0000   Min.   :-999.0000
##  1st Qu.:   0.2430   1st Qu.:   0.0000   1st Qu.:   0.2418
##  Median :   0.4949   Median :   0.4938   Median :   0.4815
##  Mean   :  -5.3694   Mean   :  -7.8099   Mean   :  -5.3661
##  3rd Qu.:   0.7474   3rd Qu.:   0.7465   3rd Qu.:   0.7430
##  Max.   :   0.9997   Max.   :   1.0000   Max.   :   0.9999
##    EPL_NOVEH           EPL_GROUPQ          SPL_THEME4         RPL_THEME4
##  Min.   :-999.0000   Min.   :-999.0000   Min.   :-999.000   Min.   :-999.0000
##  1st Qu.:   0.2383   1st Qu.:   0.0000   1st Qu.:   1.694   1st Qu.:   0.2437
##  Median :   0.4915   Median :   0.4400   Median :   2.314   Median :   0.4958
##  Mean   :  -7.8604   Mean   :  -5.4245   Mean   :  -6.089   Mean   :  -7.8570
##  3rd Qu.:   0.7474   3rd Qu.:   0.7409   3rd Qu.:   2.890   3rd Qu.:   0.7479
##  Max.   :   0.9999   Max.   :   0.9975   Max.   :   4.611   Max.   :   1.0000
##    SPL_THEMES         RPL_THEMES            F_POV              F_UNEMP
```

```
##  Min.   :-999.000   Min.   :-999.0000   Min.   :-999.000   Min.   :-999.000
##  1st Qu.:   5.541   1st Qu.:   0.2431   1st Qu.:   0.000   1st Qu.:   0.000
##  Median :   7.170   Median :   0.4954   Median :   0.000   Median :   0.000
##  Mean   :  -1.926   Mean   :  -8.6117   Mean   :  -7.883   Mean   :  -7.391
##  3rd Qu.:   8.888   3rd Qu.:   0.7477   3rd Qu.:   0.000   3rd Qu.:   0.000
##  Max.   :  13.294   Max.   :   1.0000   Max.   :   1.000   Max.   :   1.000
##      F_PCI              F_NOHSDP           F_THEME1           F_AGE65
##  Min.   :-999.000   Min.   :-999.000   Min.   :-999.000   Min.   :-999.000
##  1st Qu.:   0.000   1st Qu.:   0.000   1st Qu.:   0.000   1st Qu.:   0.000
##  Median :   0.000   Median :   0.000   Median :   0.000   Median :   0.000
##  Mean   :  -6.498   Mean   :  -5.895   Mean   :  -8.332   Mean   :  -5.743
##  3rd Qu.:   0.000   3rd Qu.:   0.000   3rd Qu.:   0.000   3rd Qu.:   0.000
##  Max.   :   1.000   Max.   :   1.000   Max.   :   4.000   Max.   :   1.000
##     F_AGE17            F_DISABL           F_SNGPNT           F_THEME2
##  Min.   :-999.000   Min.   :-999.000   Min.   :-999.000   Min.   :-999.000
##  1st Qu.:   0.000   1st Qu.:   0.000   1st Qu.:   0.000   1st Qu.:   0.000
##  Median :   0.000   Median :   0.000   Median :   0.000   Median :   0.000
##  Mean   :  -5.744   Mean   :  -7.226   Mean   :  -5.744   Mean   :  -6.928
##  3rd Qu.:   0.000   3rd Qu.:   0.000   3rd Qu.:   0.000   3rd Qu.:   1.000
##  Max.   :   1.000   Max.   :   1.000   Max.   :   1.000   Max.   :   4.000
##     F_MINRTY           F_LIMENG           F_THEME3           F_MUNIT
##  Min.   :-999.000   Min.   :-999.000   Min.   :-999.000   Min.   :-999.000
##  1st Qu.:   0.000   1st Qu.:   0.000   1st Qu.:   0.000   1st Qu.:   0.000
##  Median :   0.000   Median :   0.000   Median :   0.000   Median :   0.000
##  Mean   :  -5.743   Mean   :  -5.744   Mean   :  -5.644   Mean   :  -5.744
##  3rd Qu.:   0.000   3rd Qu.:   0.000   3rd Qu.:   0.000   3rd Qu.:   0.000
##  Max.   :   1.000   Max.   :   1.000   Max.   :   2.000   Max.   :   1.000
##     F_MOBILE           F_CROWD            F_NOVEH            F_GROUPQ
##  Min.   :-999.000   Min.   :-999.000   Min.   :-999.000   Min.   :-999.000
##  1st Qu.:   0.000   1st Qu.:   0.000   1st Qu.:   0.000   1st Qu.:   0.000
##  Median :   0.000   Median :   0.000   Median :   0.000   Median :   0.000
##  Mean   :  -8.117   Mean   :  -5.743   Mean   :  -8.254   Mean   :  -5.744
##  3rd Qu.:   0.000   3rd Qu.:   0.000   3rd Qu.:   0.000   3rd Qu.:   0.000
##  Max.   :   1.000   Max.   :   1.000   Max.   :   1.000   Max.   :   1.000
##     F_THEME4           F_TOTAL            E_UNINSUR         M_UNINSUR
##  Min.   :-999.00    Min.   :-999.000   Min.   :   0.0    Min.   :   2.0
##  1st Qu.:   0.00    1st Qu.:   0.000   1st Qu.: 148.0    1st Qu.:  83.0
##  Median :   0.00    Median :   1.000   Median : 286.0    Median : 140.0
##  Mean   :  -7.86    Mean   :  -7.632   Mean   : 408.5    Mean   : 170.8
##  3rd Qu.:   1.00    3rd Qu.:   2.000   3rd Qu.: 533.0    3rd Qu.: 225.0
##  Max.   :   4.00    Max.   :  12.000   Max.   :6700.0    Max.   :1664.0
##    EP_UNINSUR         MP_UNINSUR          E_DAYPOP
##  Min.   :-999.000   Min.   :-999.000   Min.   :  -999
##  1st Qu.:   4.200   1st Qu.:   2.300   1st Qu.:  1866
##  Median :   7.500   Median :   3.600   Median :  2993
##  Mean   :   1.973   Mean   :  -3.403   Mean   :  3998
##  3rd Qu.:  12.600   3rd Qu.:   5.000   3rd Qu.:  4869
##  Max.   : 100.000   Max.   : 100.000   Max.   :115199
```

Exploration of CACES LUR air pollution data

```
caces_lur_wide <- readRDS(here("intermediary_data/caces_lur_wide_census_tract.rds"))
```

There is information for 72043 census tracts in the modeling dataset.

```
n_distinct(caces_lur_wide$fips)
```

```
## [1] 72043
```

```
summary(caces_lur_wide)
```

```
##       fips                 co               no2               o3
##  Min.   :1.001e+09   Min.   :0.07771   Min.   : 0.4068   Min.   :27.13
##  1st Qu.:1.213e+10   1st Qu.:0.22727   1st Qu.: 3.8755   1st Qu.:42.04
##  Median :2.717e+10   Median :0.25747   Median : 6.0835   Median :45.01
##  Mean   :2.794e+10   Mean   :0.26459   Mean   : 7.1848   Mean   :44.83
##  3rd Qu.:4.105e+10   3rd Qu.:0.29429   3rd Qu.: 9.3586   3rd Qu.:47.72
##  Max.   :5.605e+10   Max.   :0.47878   Max.   :25.4443   Max.   :58.21
##       pm10             pm25             so2
##  Min.   : 4.18   Min.   : 2.165   Min.   :0.03413
##  1st Qu.:15.29   1st Qu.: 6.916   1st Qu.:0.68218
##  Median :18.34   Median : 8.125   Median :0.88071
##  Mean   :18.54   Mean   : 8.055   Mean   :0.90740
##  3rd Qu.:21.45   3rd Qu.: 9.188   3rd Qu.:1.08757
##  Max.   :43.66   Max.   :15.927   Max.   :6.69922
```

Maps

```
library(choroplethr)
```

Census Tracts

```
# plot_usmap(regions = "counties") +
#   labs(title = "US Counties",
#        subtitle = "This is a blank map of the counties of the United States.") +
#   theme(panel.background = element_rect(color = "black", fill = "lightblue"))
```

North Carolina, specifically

```
get_tract_map("north carolina")
```

```
##   |                                                                              |
```

```
## 3       37      067  002701 1400000US37067002701 37067002701  27.01   CT
## 4       37      183  053409 1400000US37183053409 37183053409 534.09   CT
## 5       37      111  970100 1400000US37111970100 37111970100   9701   CT
## 6       37      119  005518 1400000US37119005518 37119005518  55.18   CT
## 7       37      051  003309 1400000US37051003309 37051003309  33.09   CT
## 8       37      081  013700 1400000US37081013700 37081013700    137   CT
## 9       37      135  010703 1400000US37135010703 37135010703 107.03   CT
## 10      37      097  060100 1400000US37097060100 37097060100    601   CT
##        ALAND  AWATER                       geometry      region
## 1    5900440    4314 MULTIPOLYGON (((-78.98735 3... 37063001706
## 2    1040114       0 MULTIPOLYGON (((-78.65288 3... 37183050300
## 3    5596725   17656 MULTIPOLYGON (((-80.33408 3... 37067002701
## 4    5645509    8795 MULTIPOLYGON (((-78.87566 3... 37183053409
## 5  318591648 6555386 MULTIPOLYGON (((-82.1679 35... 37111970100
## 6    8010972   40900 MULTIPOLYGON (((-80.78739 3... 37119005518
## 7    4189684  348815 MULTIPOLYGON (((-79.01839 3... 37051003309
## 8    4385571   10009 MULTIPOLYGON (((-80.03377 3... 37081013700
## 9    2368196    1390 MULTIPOLYGON (((-79.09926 3... 37135010703
## 10   7079116   22273 MULTIPOLYGON (((-80.89071 3... 37097060100
##    county.fips.numeric
## 1                37063
## 2                37183
## 3                37067
## 4                37183
## 5                37111
## 6                37119
## 7                37051
## 8                37081
## 9                37135
## 10               37097
```

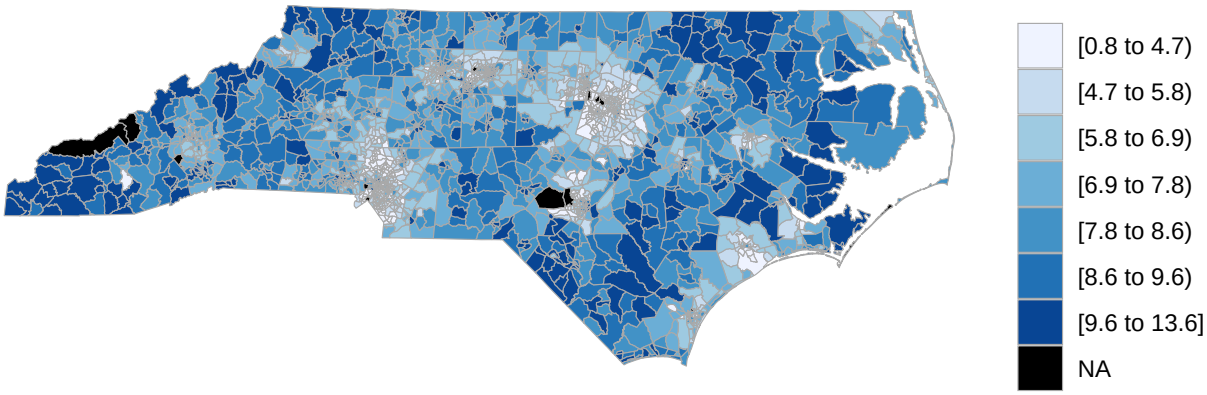
Outcome

```
fhs_model_df <- readRDS(here("intermediary_data/fhs_model_df_NC_census_tract.rds"))
```

```
outcome_df <- data.frame(region = fhs_model_df$fips, value = fhs_model_df$Data_Value_CHD)
```

```
tract_choropleth(outcome_df, state_name = "north carolina")
```

```
## Warning in self$bind(): The following regions were missing and are being
## set to NA: 37031980100, 37141990100, 37119980300, 37133990100, 37095990100,
## 37129990100, 37019990100, 37173980200, 37053990100, 37031990100, 37093980100,
## 37087980100, 37183980100, 37055990200, 37183980200, 37063980100, 37119980200,
## 37129980100, 37051980100, 37055990100, 37119980100, 37089980100, 37081980100
```



This function helpfully points out the missing census tract fips in the data set:

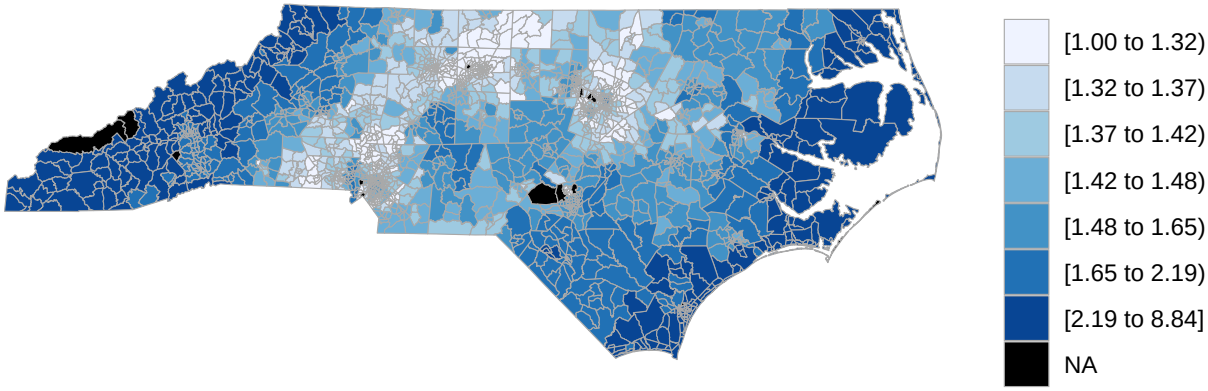
The following regions were missing and are being set to NA: 37031980100, 37141990100, 37119980300, 37133990100, 37095990100, 37129990100, 37019990100, 37173980200, 37053990100, 37031990100, 37093980100, 37087980100, 37183980100, 37055990200, 37183980200, 37063980100, 37119980200, 37129980100, 37051980100, 37055990100, 37119980100, 37089980100, 37081980100.

Flood Risk Variables

```
fl_df <- data.frame(region = fhs_model_df$fips, value = fhs_model_df$avg_risk_score_all)
```

```
tract_choropleth(fl_df, state_name = "north carolina")
```

```
## Warning in self$bind(): The following regions were missing and are being
## set to NA: 37031980100, 37141990100, 37119980300, 37133990100, 37095990100,
## 37129990100, 37019990100, 37173980200, 37053990100, 37031990100, 37093980100,
## 37087980100, 37183980100, 37055990200, 37183980200, 37063980100, 37119980200,
## 37051980200, 37051003404, 37129980100, 37051980100, 37055990100, 37119980100,
## 37089980100, 37051003402, 37081980100
```



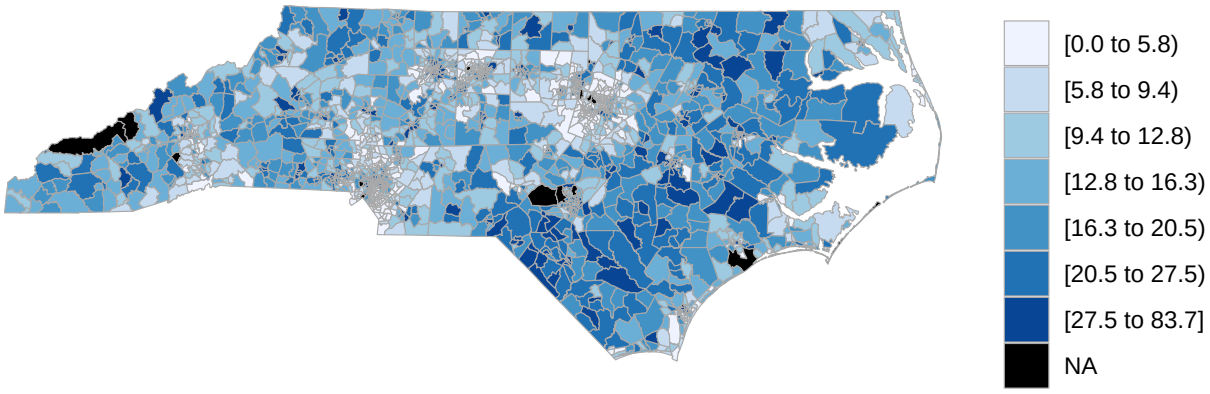
CDC SVI

```
svi_df <- data.frame(region = fhs_model_df$fips, value = fhs_model_df$EP_POV)
```

```
tract_choropleth(svi_df, state_name = "north carolina")
```

```
## Warning in self$bind(): The following regions were missing and are being
```

```
## set to NA: 37031980100, 37141990100, 37119980300, 37133990100, 37135011601,
## 37095990100, 37129990100, 37019990100, 37173980200, 37053990100, 37031990100,
## 37093980100, 37087980100, 37183980100, 37055990200, 37183980200, 37133000500,
## 37063980100, 37063001503, 37119980200, 37051980200, 37051003404, 37129980100,
## 37051980100, 37055990100, 37119980100, 37089980100, 37077970704, 37051003402,
## 37081980100
```



Air Pollution

```
air_df <- data.frame(region = fhs_model_df$fips, value = fhs_model_df$pm25)
```

```
tract_choropleth(air_df, state_name = "north carolina")
```

```
## Warning in self$bind(): The following regions were missing and are being
## set to NA: 37031980100, 37141990100, 37119980300, 37133990100, 37095990100,
## 37129990100, 37019990100, 37173980200, 37053990100, 37031990100, 37093980100,
## 37087980100, 37183980100, 37055990200, 37183980200, 37063980100, 37119980200,
## 37129980100, 37051980100, 37055990100, 37119980100, 37089980100, 37081980100
```