Analysis before fitting the CAR model

Alvin Sheng

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```
library(here)
```

```
## Warning in readLines(f, n): line 1 appears to contain an embedded nul
```

```
## Warning in readLines(f, n): incomplete final line found on '/Volumes/
## ALVINDRIVE2/flood-risk-health-effects/._flood-risk-health-effects.Rproj'
```

```
## here() starts at /Volumes/ALVINDRIVE2/flood-risk-health-effects
```

```
library(ape)
library(GGally)
```

```
## Loading required package: ggplot2
```

```
## Registered S3 method overwritten by 'GGally':
##   method from
##   +.gg   ggplot2
```

```
library(usdm)
```

```
## Loading required package: sp
```

```
## Loading required package: raster
```

```
library(spdep)
```

```
## Loading required package: spData
```

```
## To access larger datasets in this package, install the spDataLarge
## package with: `install.packages('spDataLarge',
## repos='https://nowosad.github.io/drat/', type='source')`
```

```
## Loading required package: sf
```

```
## Linking to GEOS 3.8.1, GDAL 3.2.1, PROJ 7.2.1
```

```
## Registered S3 method overwritten by 'spdep':
##   method   from
##   plot.mst ape
```

```
library(factoextra)
```

```
## Welcome! Want to learn more? See two factoextra-related books at https://goo.gl/ve3WBa
```

```
library(tidyverse)
```

```
## -- Attaching packages --------------------------------------- tidyverse 1.3.1 --
```

```
## v tibble  3.1.6     v dplyr   1.0.7
## v tidyr   1.1.4     v stringr 1.4.0
## v readr   2.1.1     v forcats 0.5.1
```

```
## v purrr   0.3.4
## -- Conflicts ---------------------------------------- tidyverse_conflicts() --
## x tidyr::extract() masks raster::extract()
## x dplyr::filter()  masks stats::filter()
## x dplyr::lag()     masks stats::lag()
## x dplyr::select()  masks raster::select()
```

```
library(performance)
```

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

Summary Statistics for Table 1 of paper

```
first_var <- 19

summ_stats <- round(t(apply(fhs_model_df[, first_var:ncol(fhs_model_df)], 2, function(vec) {
  c(mean(vec, na.rm = T), sd(vec, na.rm = T), range(vec, na.rm = T))
})),2)

colnames(summ_stats) <- c("mean", "sd", "min", "max")

summ_stats
```

```
##                          mean       sd    min       max
## pct_fs_risk_2020_5       0.03     0.08   0.00      1.00
## pct_fs_risk_2050_5       0.04     0.10   0.00      1.00
## pct_fs_risk_2020_100     0.11     0.15   0.00      1.00
## pct_fs_risk_2050_100     0.12     0.18   0.00      1.00
## pct_fs_risk_2020_500     0.17     0.21   0.00      1.00
## pct_fs_risk_2050_500     0.19     0.22   0.00      1.00
## avg_risk_score_all       1.86     1.14   1.00     10.00
## sd_risk_score_all        1.53     0.77   0.00      6.36
## cv_risk_score_all        0.86     0.32   0.00      1.50
## avg_risk_score_2_10      5.64     1.35   2.00     10.00
## avg_risk_fsf_2020_100    6.76     1.11   3.00     10.00
## avg_risk_fsf_2020_500    5.84     1.32   2.00     10.00
## pct_floodfactor1         0.81     0.22   0.00      1.00
## pct_floodfactor2         0.01     0.04   0.00      1.00
## pct_floodfactor3         0.03     0.06   0.00      1.00
## pct_floodfactor4         0.04     0.09   0.00      1.00
## pct_floodfactor5         0.01     0.03   0.00      1.00
## pct_floodfactor6         0.05     0.08   0.00      1.00
## pct_floodfactor7         0.02     0.03   0.00      1.00
## pct_floodfactor8         0.00     0.01   0.00      1.00
## pct_floodfactor9         0.02     0.05   0.00      1.00
## pct_floodfactor10        0.02     0.06   0.00      1.00
## EP_POV                  15.28    11.93   0.00    100.00
## EP_UNEMP                 6.38     4.67   0.00    100.00
## EP_PCI               32258.07 16848.70  42.00 227064.00
## EP_NOHSDP               13.03    10.56   0.00    100.00
## EP_AGE65                15.98     8.02   0.00    100.00
## EP_AGE17                21.97     6.83   0.00     87.60
```

```
## EP_DISABL                13.37     5.88   0.00    100.00
## EP_SNGPNT                 9.18     6.44   0.00    100.00
## EP_MINRTY                37.96    30.03   0.00    100.00
## EP_LIMENG                 4.13     6.81   0.00    100.00
## EP_MUNIT                 12.25    18.45   0.00    100.00
## EP_MOBILE                 6.06    10.76   0.00    100.00
## EP_CROWD                  3.52     5.18   0.00    100.00
## EP_NOVEH                  9.39    12.24   0.00    100.00
## EP_GROUPQ                 2.66     9.53   0.00    100.00
## EP_UNINSUR                9.37     7.09   0.00    100.00
## co                        0.36     0.09   0.21      1.93
## no2                      10.20     5.66   1.09     33.08
## o3                       47.32     5.17  29.37     60.51
## pm10                     20.25     5.42   3.88     49.35
## pm25                     10.46     2.32   2.43     18.69
## so2                       2.19     0.98   0.58      9.01
## summer_tmmx             303.09     3.36 289.37    316.04
## winter_tmmx             283.48     7.17 265.42    299.36
## summer_rmax              86.38    11.60  27.90     99.77
## winter_rmax              82.51     7.57  48.82     98.03
## Data_Value_CSMOKING      18.28     5.87   3.20     51.70
## Data_Value_CHD            6.67     2.21   0.50     36.00
## Data_Value_CASTHMA        9.90     1.58   5.40     20.60
## Data_Value_BPHIGH        32.35     7.30   4.90     70.30
## Data_Value_MHLTH         14.26     3.41   5.20     35.50
```

Checking for multicollinearity among the covariates

`S.CARleroux()` automatically puts a fixed ridge penalty on the beta coefficients. Therefore, the large number of covariates and multicollinearity would be accounted for.

Actually no, because the penalty is negligible.

Flood risk variables

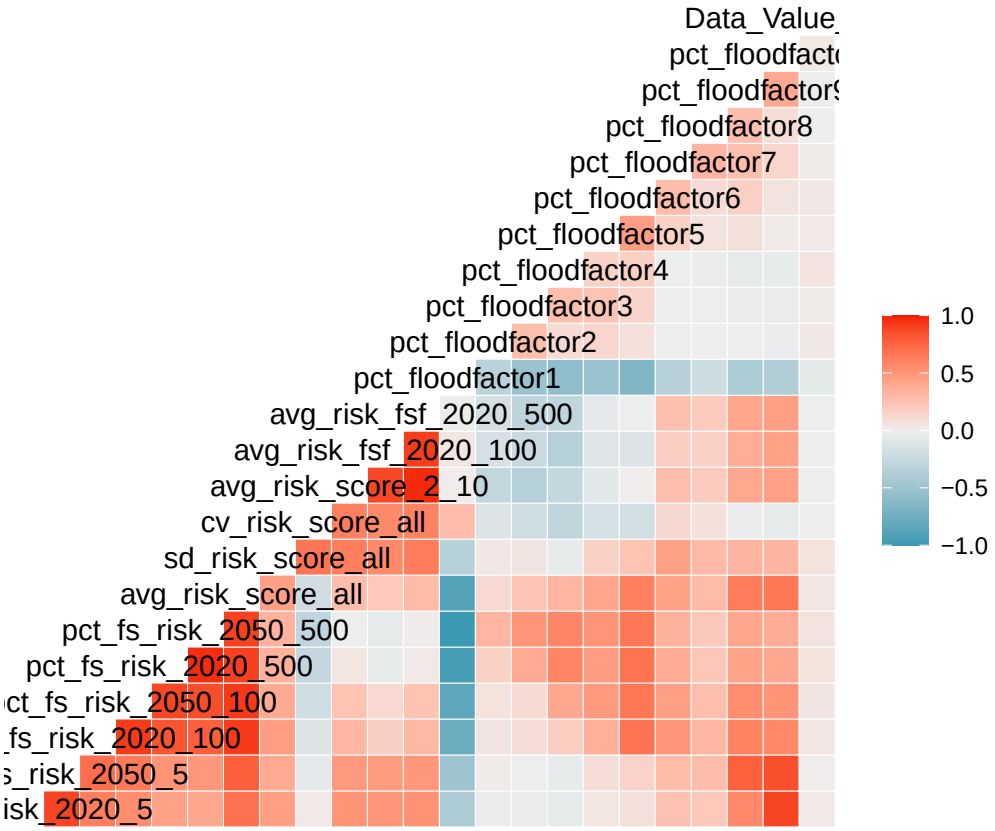
```
fr_index <- 19:40
```

```
apply(fhs_model_df[fr_index], 2, function(vec) sd(vec, na.rm = T))
```

```
##    pct_fs_risk_2020_5    pct_fs_risk_2050_5  pct_fs_risk_2020_100
##             0.07588759            0.09713802            0.15288601
##  pct_fs_risk_2050_100  pct_fs_risk_2020_500  pct_fs_risk_2050_500
##             0.17630796            0.20712713            0.22417139
##    avg_risk_score_all     sd_risk_score_all     cv_risk_score_all
##             1.13805698            0.76598522            0.31550045
##   avg_risk_score_2_10 avg_risk_fsf_2020_100 avg_risk_fsf_2020_500
##             1.35167833            1.10638589            1.32059843
##      pct_floodfactor1      pct_floodfactor2      pct_floodfactor3
##             0.22422161            0.03629972            0.06143963
##      pct_floodfactor4      pct_floodfactor5      pct_floodfactor6
##             0.09444138            0.03121215            0.08487768
##      pct_floodfactor7      pct_floodfactor8      pct_floodfactor9
```

```
##            0.02575375            0.01092882            0.04667818
##    pct_floodfactor10
##            0.06209557
```

```
ggcorr(data = fhs_model_df[, c(fr_index, ncol(fhs_model_df))])
```




```
flood_cor <- cor(fhs_model_df[complete.cases(fhs_model_df[, c(fr_index, ncol(fhs_model_df))]), c(fr_ind

flood_cor[nrow(flood_cor), ] # correlation with dependent variable
```

```
##    pct_fs_risk_2020_5    pct_fs_risk_2050_5  pct_fs_risk_2020_100
##           0.028703467           0.013699636           0.053585772
##  pct_fs_risk_2050_100  pct_fs_risk_2020_500  pct_fs_risk_2050_500
##           0.060164340           0.072378089           0.066051913
##    avg_risk_score_all     sd_risk_score_all     cv_risk_score_all
##           0.052739411           0.088976754           0.006287786
##   avg_risk_score_2_10 avg_risk_fsf_2020_100 avg_risk_fsf_2020_500
##          -0.000661695          -0.011451127          -0.003586298
##      pct_floodfactor1      pct_floodfactor2      pct_floodfactor3
##          -0.066084071           0.035628588           0.022041402
##      pct_floodfactor4      pct_floodfactor5      pct_floodfactor6
##           0.062106455           0.032507082           0.040710421
##      pct_floodfactor7      pct_floodfactor8      pct_floodfactor9
##           0.028293267          -0.004997891          -0.011414654
##     pct_floodfactor10      Data_Value_MHLTH
##           0.033368238           1.000000000
```

For each variable, I take the summary of its correlations with other variables, not including itself.

```r
diag(flood_cor) <- NA

summary(flood_cor)
```

```
##  pct_fs_risk_2020_5 pct_fs_risk_2050_5 pct_fs_risk_2020_100
##  Min.   :-0.41258   Min.   :-0.5036    Min.   :-0.8052
##  1st Qu.: 0.03317   1st Qu.: 0.0418    1st Qu.: 0.1848
##  Median : 0.42470   Median : 0.4285    Median : 0.4121
##  Mean   : 0.32982   Mean   : 0.3539    Mean   : 0.3872
##  3rd Qu.: 0.54557   3rd Qu.: 0.6171    3rd Qu.: 0.6688
##  Max.   : 0.88390   Max.   : 0.8829    Max.   : 0.9373
##  NA's   :1          NA's   :1          NA's   :1
##  pct_fs_risk_2050_100 pct_fs_risk_2020_500 pct_fs_risk_2050_500
##  Min.   :-0.8672      Min.   :-0.9656      Min.   :-1.0000
##  1st Qu.: 0.1670      1st Qu.: 0.1012      1st Qu.: 0.1173
##  Median : 0.4207      Median : 0.4081      Median : 0.3988
##  Mean   : 0.3762      Mean   : 0.3388      Mean   : 0.3366
##  3rd Qu.: 0.6291      3rd Qu.: 0.5681      3rd Qu.: 0.5650
##  Max.   : 0.9373      Max.   : 0.9656      Max.   : 0.9656
##  NA's   :1            NA's   :1            NA's   :1
##  avg_risk_score_all sd_risk_score_all cv_risk_score_all  avg_risk_score_2_10
##  Min.   :-0.9013    Min.   :-0.3256   Min.   :-0.45146   Min.   :-0.36560
##  1st Qu.: 0.2599    1st Qu.: 0.1610   1st Qu.:-0.31476   1st Qu.:-0.01594
##  Median : 0.4296    Median : 0.3352   Median :-0.11407   Median : 0.25807
##  Mean   : 0.4103    Mean   : 0.3021   Mean   :-0.03583   Mean   : 0.23244
##  3rd Qu.: 0.6805    3rd Qu.: 0.4341   3rd Qu.: 0.04764   3rd Qu.: 0.47516
##  Max.   : 0.9332    Max.   : 0.6054   Max.   : 0.57772   Max.   : 0.96516
##  NA's   :1          NA's   :1         NA's   :1          NA's   :1
##  avg_risk_fsf_2020_100 avg_risk_fsf_2020_500 pct_floodfactor1
##  Min.   :-0.35635      Min.   :-0.308819     Min.   :-1.0000
##  1st Qu.:-0.05283      1st Qu.:-0.003222     1st Qu.:-0.6554
##  Median : 0.18534      Median : 0.255205     Median :-0.4204
##  Mean   : 0.20935      Mean   : 0.243471     Mean   :-0.4274
##  3rd Qu.: 0.45731      3rd Qu.: 0.489202     3rd Qu.:-0.2847
##  Max.   : 0.91241      Max.   : 0.965161     Max.   : 0.4514
##  NA's   :1             NA's   :1             NA's   :1
##  pct_floodfactor2   pct_floodfactor3   pct_floodfactor4   pct_floodfactor5
##  Min.   :-0.33290   Min.   :-0.52073   Min.   :-0.57504   Min.   :-0.53499
##  1st Qu.:-0.01982   1st Qu.:-0.03180   1st Qu.:-0.04915   1st Qu.: 0.02091
##  Median : 0.03029   Median : 0.01718   Median :-0.01931   Median : 0.11932
##  Mean   : 0.02048   Mean   : 0.03583   Mean   : 0.03601   Mean   : 0.13565
##  3rd Qu.: 0.12165   3rd Qu.: 0.23844   3rd Qu.: 0.21566   3rd Qu.: 0.34498
##  Max.   : 0.33275   Max.   : 0.52045   Max.   : 0.58485   Max.   : 0.53506
##  NA's   :1          NA's   :1          NA's   :1          NA's   :1
##  pct_floodfactor6   pct_floodfactor7  pct_floodfactor8   pct_floodfactor9
##  Min.   :-0.68214   Min.   :-0.3593   Min.   :-0.27107   Min.   :-0.42826
##  1st Qu.: 0.04623   1st Qu.: 0.0763   1st Qu.: 0.04401   1st Qu.: 0.01582
##  Median : 0.16419   Median : 0.2623   Median : 0.25821   Median : 0.38830
##  Mean   : 0.19445   Mean   : 0.2218   Mean   : 0.19782   Mean   : 0.29026
##  3rd Qu.: 0.41876   3rd Qu.: 0.3772   3rd Qu.: 0.34150   3rd Qu.: 0.44108
##  Max.   : 0.69827   Max.   : 0.5021   Max.   : 0.46059   Max.   : 0.78917
##  NA's   :1          NA's   :1         NA's   :1          NA's   :1
##  pct_floodfactor10  Data_Value_MHLTH
##  Min.   :-0.38505   Min.   :-0.066084
```

```
##  1st Qu.: 0.02112   1st Qu.: 0.001076
##  Median : 0.36135   Median : 0.030605
##  Mean   : 0.28196   Mean   : 0.027229
##  3rd Qu.: 0.45601   3rd Qu.: 0.053374
##  Max.   : 0.88390   Max.   : 0.088977
##  NA's   :1          NA's   :1
```

Many of the flood risk variables are very correlated.

Using VIF to exclude variables

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

```
X <- fhs_model_df[, 19:(ncol(fhs_model_df) - 4)]

X <- X[, names(X) != "pct_floodfactor1"]



X           <- scale(X) # Scale covariates

X <- data.frame(X)
```

```
vif(X)
```

```
##                Variables          VIF
## 1     pct_fs_risk_2020_5    11.465666
## 2     pct_fs_risk_2050_5    21.182886
## 3   pct_fs_risk_2020_100    21.459315
## 4   pct_fs_risk_2050_100    23.869460
## 5   pct_fs_risk_2020_500    48.104435
## 6   pct_fs_risk_2050_500 42324.109965
## 7     avg_risk_score_all          Inf
## 8      sd_risk_score_all     5.911560
## 9      cv_risk_score_all     6.803326
## 10   avg_risk_score_2_10    29.820665
## 11 avg_risk_fsf_2020_100     7.989054
## 12 avg_risk_fsf_2020_500    34.691647
## 13      pct_floodfactor2          Inf
## 14      pct_floodfactor3          Inf
## 15      pct_floodfactor4          Inf
## 16      pct_floodfactor5          Inf
## 17      pct_floodfactor6          Inf
## 18      pct_floodfactor7          Inf
## 19      pct_floodfactor8          Inf
## 20      pct_floodfactor9          Inf
## 21     pct_floodfactor10          Inf
## 22                EP_POV     3.578009
## 23              EP_UNEMP     1.858901
## 24                EP_PCI     2.843404
## 25             EP_NOHSDP     5.612552
## 26              EP_AGE65     2.392680
## 27              EP_AGE17     2.669909
```

```
## 28             EP_DISABL     2.851190
## 29             EP_SNGPNT     2.594343
## 30             EP_MINRTY     3.757778
## 31             EP_LIMENG     3.845793
## 32              EP_MUNIT     2.000401
## 33             EP_MOBILE     1.668577
## 34              EP_CROWD     2.846717
## 35              EP_NOVEH     3.260477
## 36             EP_GROUPQ     1.394116
## 37            EP_UNINSUR     2.448594
## 38                    co     9.168513
## 39                   no2    13.674682
## 40                    o3     2.967362
## 41                  pm10     3.810859
## 42                  pm25     5.265031
## 43                   so2     2.740892
## 44           summer_tmmx     4.611565
## 45           winter_tmmx     5.370145
## 46           summer_rmax     3.537477
## 47           winter_rmax     3.314355
## 48   Data_Value_CSMOKING     6.151036
```

```
vifstep(X)
```

```
## 8 variables from the 48 input variables have collinearity problem:
##
## avg_risk_score_all pct_fs_risk_2050_500 pct_fs_risk_2020_500 pct_fs_risk_2050_5 avg_risk_fsf_2020_50
##
## After excluding the collinear variables, the linear correlation coefficients ranges between:
## min correlation ( EP_AGE65 ~ pct_floodfactor2 ):  -0.0001046878
## max correlation ( avg_risk_fsf_2020_100 ~ avg_risk_score_2_10 ):  0.8776504
##
## ---------- VIFs of the remained variables --------
##                Variables      VIF
## 1     pct_fs_risk_2020_5 6.735162
## 2      sd_risk_score_all 5.848256
## 3      cv_risk_score_all 7.351120
## 4    avg_risk_score_2_10 8.210073
## 5  avg_risk_fsf_2020_100 5.996743
## 6       pct_floodfactor2 1.436963
## 7       pct_floodfactor3 1.515328
## 8       pct_floodfactor4 1.552008
## 9       pct_floodfactor5 1.428890
## 10      pct_floodfactor6 1.985568
## 11      pct_floodfactor7 1.754579
## 12      pct_floodfactor8 1.726176
## 13      pct_floodfactor9 2.243287
## 14     pct_floodfactor10 5.489516
## 15                EP_POV 3.553052
## 16              EP_UNEMP 1.925548
## 17                EP_PCI 2.792975
## 18             EP_NOHSDP 5.117330
## 19              EP_AGE65 2.377178
## 20              EP_AGE17 2.730325
## 21             EP_DISABL 2.730621
```

```
## 22             EP_SNGPNT 2.524202
## 23             EP_MINRTY 3.776391
## 24             EP_LIMENG 3.575261
## 25              EP_MUNIT 2.052669
## 26             EP_MOBILE 1.654346
## 27              EP_CROWD 2.506884
## 28              EP_NOVEH 2.828391
## 29             EP_GROUPQ 1.449686
## 30            EP_UNINSUR 2.433550
## 31                    co 4.873870
## 32                    o3 2.887367
## 33                  pm10 3.643857
## 34                  pm25 4.621878
## 35                   so2 2.539562
## 36           summer_tmmx 4.417985
## 37           winter_tmmx 4.654570
## 38           summer_rmax 3.635268
## 39           winter_rmax 2.917975
## 40   Data_Value_CSMOKING 5.851991
```

This procedure detects that the following variables have collinearity problems. Let's exclude these variables and then rerun the analysis.

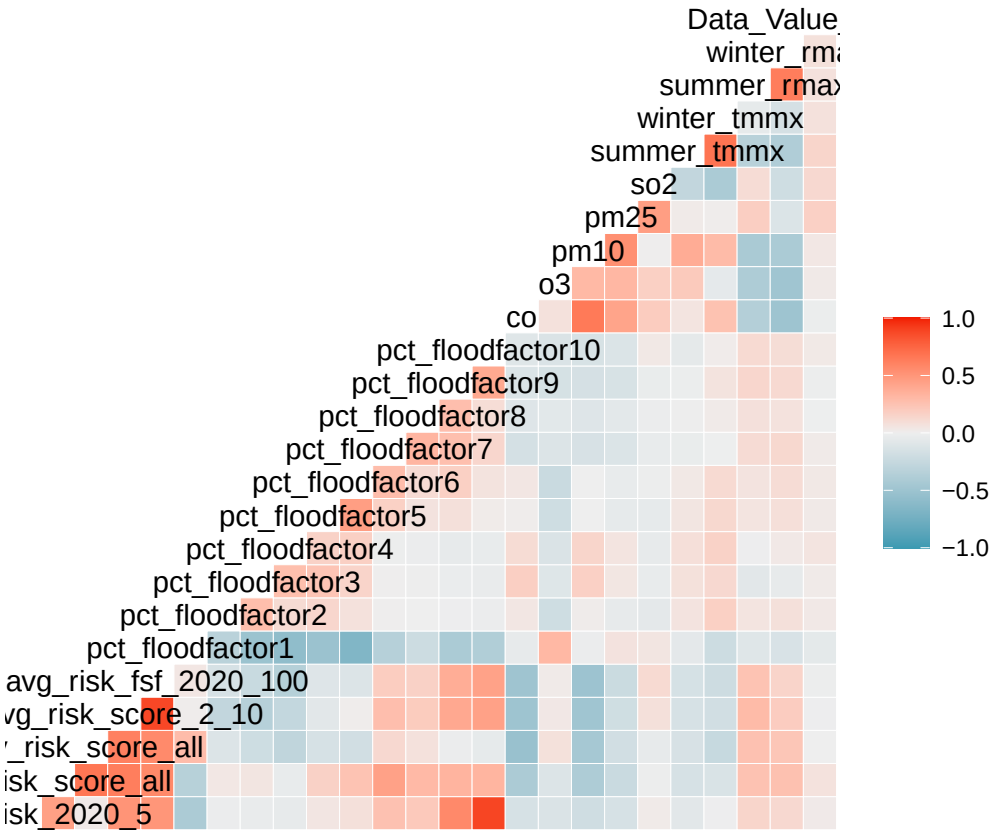
```
collin_var_names <- c("avg_risk_score_all", "pct_fs_risk_2050_500", "pct_fs_risk_2020_500", "avg_risk_fs
```

Correlations among climate related variables: flood risk, pollution, and GRIDMET variables

Excluding variables in collin_var_names

```
climate_var_idx <- c(fr_index, 57:66)

climate_var_idx_exclude <- climate_var_idx[-which(names(fhs_model_df)[climate_var_idx] %in% collin_var_
```

```
ggcorr(data = fhs_model_df[, c(climate_var_idx_exclude, ncol(fhs_model_df))])
```




```
climate_cor <- cor(fhs_model_df[complete.cases(fhs_model_df[, c(climate_var_idx_exclude, ncol(fhs_model_

climate_cor[nrow(climate_cor), ] # correlation with dependent variable
```

```
##    pct_fs_risk_2020_5     sd_risk_score_all     cv_risk_score_all
##           0.0299804997           0.0889601742           0.0060502492
##   avg_risk_score_2_10 avg_risk_fsf_2020_100      pct_floodfactor1
##          -0.0004361047          -0.0112722648          -0.0665488462
##      pct_floodfactor2      pct_floodfactor3      pct_floodfactor4
##           0.0356060183           0.0220103942           0.0620835478
##      pct_floodfactor5      pct_floodfactor6      pct_floodfactor7
##           0.0324997455           0.0407283782           0.0287804262
##      pct_floodfactor8      pct_floodfactor9     pct_floodfactor10
##          -0.0048493860          -0.0112121004           0.0349543674
##                      co                    o3                  pm10
##          -0.0196370204           0.0226626739           0.0405151007
##                    pm25                   so2           summer_tmmx
##           0.1832766126           0.1537557332           0.1454940393
##            winter_tmmx           summer_rmax           winter_rmax
##           0.0731103518           0.0944951518           0.0855385378
##       Data_Value_MHLTH
##           1.0000000000
```

For each variable, I take the summary of its correlations with other variables, not including itself.

```
diag(climate_cor) <- NA

summary(climate_cor)
```

```
##  pct_fs_risk_2020_5 sd_risk_score_all cv_risk_score_all  avg_risk_score_2_10
##  Min.   :-0.40902   Min.   :-0.3474   Min.   :-0.44990   Min.   :-0.45656
##  1st Qu.:-0.05581   1st Qu.:-0.1228   1st Qu.:-0.26268   1st Qu.:-0.17685
##  Median : 0.03657   Median : 0.1166   Median :-0.04901   Median : 0.04197
##  Mean   : 0.11607   Mean   : 0.1228   Mean   :-0.01306   Mean   : 0.08615
##  3rd Qu.: 0.27656   3rd Qu.: 0.3371   3rd Qu.: 0.11207   3rd Qu.: 0.29873
##  Max.   : 0.88042   Max.   : 0.5955   Max.   : 0.58195   Max.   : 0.87512
##  NA's   :1          NA's   :1         NA's   :1          NA's   :1
##  avg_risk_fsf_2020_100 pct_floodfactor1   pct_floodfactor2
##  Min.   :-0.50351      Min.   :-0.68385   Min.   :-0.333951
##  1st Qu.:-0.16835      1st Qu.:-0.38829   1st Qu.:-0.051353
##  Median : 0.04115      Median :-0.17383   Median : 0.013113
##  Mean   : 0.07535      Mean   :-0.19129   Mean   :-0.001026
##  3rd Qu.: 0.28041      3rd Qu.:-0.03059   3rd Qu.: 0.078299
##  Max.   : 0.87512      Max.   : 0.44949   Max.   : 0.301375
##  NA's   :1             NA's   :1          NA's   :1
##  pct_floodfactor3    pct_floodfactor4   pct_floodfactor5   pct_floodfactor6
##  Min.   :-0.522389   Min.   :-0.57674   Min.   :-0.53652   Min.   :-0.6838548
##  1st Qu.:-0.052386   1st Qu.:-0.04865   1st Qu.:-0.04306   1st Qu.:-0.0004318
##  Median : 0.003107   Median :-0.01916   Median : 0.04986   Median : 0.0689923
##  Mean   : 0.002413   Mean   :-0.02058   Mean   : 0.03239   Mean   : 0.0400112
##  3rd Qu.: 0.150393   3rd Qu.: 0.13801   3rd Qu.: 0.14366   3rd Qu.: 0.1535915
##  Max.   : 0.310142   Max.   : 0.31014   Max.   : 0.46674   Max.   : 0.4667402
##  NA's   :1           NA's   :1          NA's   :1          NA's   :1
##  pct_floodfactor7   pct_floodfactor8   pct_floodfactor9   pct_floodfactor10
##  Min.   :-0.35804   Min.   :-0.27042   Min.   :-0.42623   Min.   :-0.38138
##  1st Qu.:-0.02109   1st Qu.:-0.02231   1st Qu.:-0.05628   1st Qu.:-0.06516
##  Median : 0.04330   Median : 0.03359   Median : 0.03625   Median : 0.02956
##  Mean   : 0.07881   Mean   : 0.07684   Mean   : 0.09221   Mean   : 0.08918
##  3rd Qu.: 0.21338   3rd Qu.: 0.16632   3rd Qu.: 0.28783   3rd Qu.: 0.14090
##  Max.   : 0.45756   Max.   : 0.45756   Max.   : 0.58777   Max.   : 0.88042
##  NA's   :1          NA's   :1          NA's   :1          NA's   :1
##        co                 o3                pm10               pm25
##  Min.   :-0.49037   Min.   :-0.50981   Min.   :-0.50351   Min.   :-0.22305
##  1st Qu.:-0.18352   1st Qu.:-0.13751   1st Qu.:-0.23089   1st Qu.:-0.13091
##  Median :-0.05265   Median :-0.09970   Median :-0.02814   Median :-0.03210
##  Mean   :-0.04405   Mean   :-0.04017   Mean   :-0.02623   Mean   : 0.03357
##  3rd Qu.: 0.11930   3rd Qu.: 0.08466   3rd Qu.: 0.17628   3rd Qu.: 0.09245
##  Max.   : 0.62502   Max.   : 0.34745   Max.   : 0.62502   Max.   : 0.54279
##  NA's   :1          NA's   :1          NA's   :1          NA's   :1
##       so2            summer_tmmx         winter_tmmx        summer_rmax
##  Min.   :-0.41123   Min.   :-0.354306   Min.   :-0.41123   Min.   :-0.39896
##  1st Qu.:-0.04441   1st Qu.:-0.148715   1st Qu.:-0.13020   1st Qu.:-0.03477
##  Median : 0.02180   Median :-0.010138   Median : 0.01709   Median : 0.08962
##  Mean   : 0.01892   Mean   : 0.001591   Mean   : 0.02280   Mean   : 0.04483
##  3rd Qu.: 0.11396   3rd Qu.: 0.072685   3rd Qu.: 0.14145   3rd Qu.: 0.14923
##  Max.   : 0.46857   Max.   : 0.692370   Max.   : 0.69237   Max.   : 0.59653
##  NA's   :1          NA's   :1           NA's   :1          NA's   :1
##   winter_rmax        Data_Value_MHLTH
##  Min.   :-0.509809   Min.   :-0.066549
##  1st Qu.:-0.132134   1st Qu.: 0.004429
##  Median : 0.079918   Median : 0.033727
##  Mean   :-0.007747   Mean   : 0.044439
##  3rd Qu.: 0.111153   3rd Qu.: 0.076217
```

```
##  Max.   : 0.596532   Max.   : 0.183277
##  NA's   :1           NA's   :1
```

Climate variables other than flood risk are not too correlated.

Non-spatial modeling

```
Y <- fhs_model_df$Data_Value_CHD

X <- fhs_model_df[, 19:(ncol(fhs_model_df) - 4)]

X <- X[, names(X) != "pct_floodfactor1"]

# exclude some more variables selected by vifstep, to account for multicollinearity
# excluding all of the pct_fs_risk variables, as well as 3 of the avg_risk_score variables

collin_var_names <- c("avg_risk_score_all", "pct_fs_risk_2050_500", "pct_fs_risk_2020_500", "avg_risk_fs

X <- X[, !(names(X) %in% collin_var_names)]

# # also removing avg_risk_score_sfha due to large numbers of NAs
# X <- X[, names(X) != "avg_risk_score_sfha"]



X           <- scale(X) # Scale covariates
X[is.na(X)] <- 0        # Fill in missing values with the mean

# if I do mean imputation (which may be problematic), all the counties
# will have neighbors in W

# X <- data.frame(X)
```

```
fhs_lm <- lm(Y ~ X)
```

```
summary(fhs_lm)
```

```
##
## Call:
## lm(formula = Y ~ X)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -9.8599 -0.4803 -0.0189  0.4575 17.7353
##
## Coefficients:
##                           Estimate Std. Error  t value Pr(>|t|)
## (Intercept)             6.6601517  0.0031357 2123.978  < 2e-16 ***
## Xpct_fs_risk_2020_5     0.0041458  0.0086312    0.480 0.630996
## Xsd_risk_score_all      0.0552776  0.0077439    7.138 9.54e-13 ***
## Xcv_risk_score_all      0.0141664  0.0074888    1.892 0.058538 .
## Xavg_risk_score_2_10   -0.0320944  0.0075740   -4.237 2.26e-05 ***
## Xavg_risk_fsf_2020_100  0.0064095  0.0064859    0.988 0.323050
```

```
## Xpct_floodfactor2      -0.0175671  0.0036160   -4.858 1.19e-06 ***
## Xpct_floodfactor3      -0.0116605  0.0038324   -3.043 0.002346 **
## Xpct_floodfactor4      -0.0112754  0.0036872   -3.058 0.002229 **
## Xpct_floodfactor5      -0.0025495  0.0037888   -0.673 0.501012
## Xpct_floodfactor6      -0.0077272  0.0042902   -1.801 0.071688 .
## Xpct_floodfactor7      -0.0002381  0.0039344   -0.061 0.951752
## Xpct_floodfactor8      -0.0081307  0.0041329   -1.967 0.049152 *
## Xpct_floodfactor9      -0.0099330  0.0044657   -2.224 0.026133 *
## Xpct_floodfactor10      0.0252324  0.0077199    3.268 0.001082 **
## XEP_POV                 0.3390289  0.0059369   57.105  < 2e-16 ***
## XEP_UNEMP               0.0157048  0.0043573    3.604 0.000313 ***
## XEP_PCI                -0.0258376  0.0052305   -4.940 7.84e-07 ***
## XEP_NOHSDP              0.2126295  0.0074081   28.702  < 2e-16 ***
## XEP_AGE65               1.4712867  0.0047719  308.324  < 2e-16 ***
## XEP_AGE17               0.3361792  0.0053876   62.398  < 2e-16 ***
## XEP_DISABL              0.3453552  0.0051798   66.673  < 2e-16 ***
## XEP_SNGPNT             -0.1013951  0.0050818  -19.953  < 2e-16 ***
## XEP_MINRTY             -0.0666869  0.0059761  -11.159  < 2e-16 ***
## XEP_LIMENG             -0.0073262  0.0062244   -1.177 0.239195
## XEP_MUNIT              -0.0592066  0.0044919  -13.181  < 2e-16 ***
## XEP_MOBILE              0.0416902  0.0039966   10.431  < 2e-16 ***
## XEP_CROWD              -0.0675969  0.0053378  -12.664  < 2e-16 ***
## XEP_NOVEH               0.0455598  0.0056279    8.095 5.80e-16 ***
## XEP_GROUPQ             -0.0756168  0.0038800  -19.489  < 2e-16 ***
## XEP_UNINSUR             0.1515184  0.0048360   31.331  < 2e-16 ***
## Xco                     0.0175963  0.0071454    2.463 0.013796 *
## Xo3                    -0.0628817  0.0050313  -12.498  < 2e-16 ***
## Xpm10                  -0.0072726  0.0062277   -1.168 0.242902
## Xpm25                  -0.0073628  0.0064447   -1.142 0.253268
## Xso2                    0.0821766  0.0051917   15.829  < 2e-16 ***
## Xsummer_tmmx            0.1184252  0.0066269   17.870  < 2e-16 ***
## Xwinter_tmmx            0.0633490  0.0066074    9.588  < 2e-16 ***
## Xsummer_rmax            0.0599815  0.0062598    9.582  < 2e-16 ***
## Xwinter_rmax            0.0821721  0.0056402   14.569  < 2e-16 ***
## XData_Value_CSMOKING    0.8362653  0.0075716  110.447  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.84 on 71794 degrees of freedom
##   (702 observations deleted due to missingness)
## Multiple R-squared:  0.8553, Adjusted R-squared:  0.8552
## F-statistic: 1.061e+04 on 40 and 71794 DF,  p-value: < 2.2e-16
```

–>

PCA

PCA with Centering and Scaling beforehand

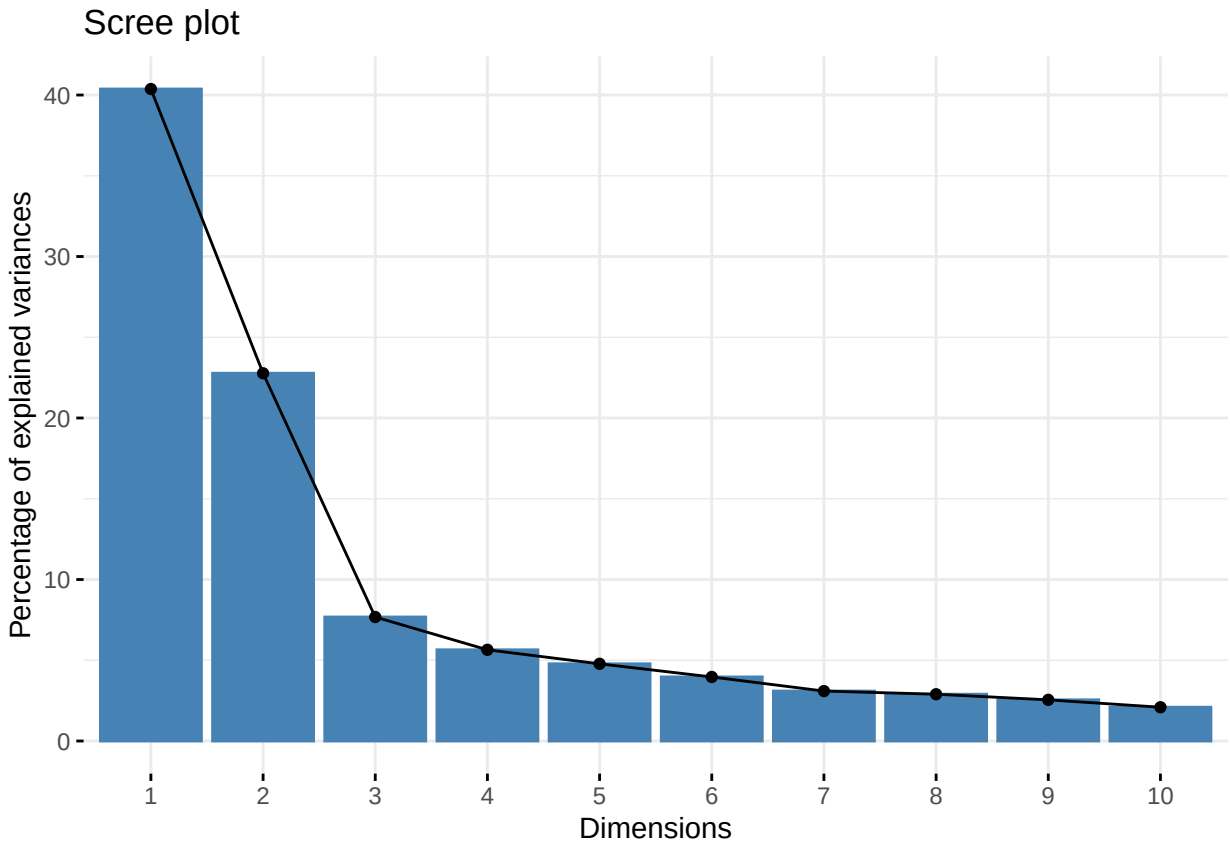
Conduct PCA on the correlated flood risk variables

```
first_var <- 19
```

```
fr_index <- first_var:(first_var + 21)

flood_risk <- fhs_model_df[, fr_index]
```

```
fr_pca <- prcomp(flood_risk[complete.cases(flood_risk),], center = T, scale. = T)

fr_loadings <- fr_pca$rotation
```

```
fviz_eig(fr_pca)
```




```
summ_pca <- summary(fr_pca)

summ_pca$importance[,1:10]
```

```
##                             PC1      PC2      PC3      PC4      PC5       PC6
## Standard deviation     2.980165 2.238176 1.299683 1.114667 1.025496 0.9341738
## Proportion of Variance 0.403700 0.227700 0.076780 0.056480 0.047800 0.0396700
## Cumulative Proportion  0.403700 0.631400 0.708180 0.764660 0.812460 0.8521300
##                             PC7       PC8      PC9      PC10
## Standard deviation     0.8249525 0.7983534 0.748906 0.6784936
## Proportion of Variance 0.0309300 0.0289700 0.025490 0.0209300
## Cumulative Proportion  0.8830600 0.9120300 0.937530 0.9584500
```

We started out with 22 variables. Including five PC scores would include 80% of the variance.

Including eight PC scores would include 90% of the variance.

Printing out the loadings, from most negative to least

```
# First PC Score
fr_loadings[, 1]
```

```
##    pct_fs_risk_2020_5    pct_fs_risk_2050_5  pct_fs_risk_2020_100
##           -0.24042633           -0.26657190           -0.31448378
##  pct_fs_risk_2050_100  pct_fs_risk_2020_500  pct_fs_risk_2050_500
##           -0.31380335           -0.29916654           -0.29619111
##    avg_risk_score_all     sd_risk_score_all     cv_risk_score_all
##           -0.33168172           -0.17484099            0.08495769
##   avg_risk_score_2_10 avg_risk_fsf_2020_100 avg_risk_fsf_2020_500
##           -0.11957319           -0.09942242           -0.12471527
##      pct_floodfactor1      pct_floodfactor2      pct_floodfactor3
##            0.29616865           -0.04683405           -0.07886906
##      pct_floodfactor4      pct_floodfactor5      pct_floodfactor6
##           -0.09763011           -0.14143760           -0.19907514
##      pct_floodfactor7      pct_floodfactor8      pct_floodfactor9
##           -0.16323272           -0.14190186           -0.22217802
##     pct_floodfactor10
##           -0.21807090
```

The first PC score is very interpretable. Only the loading for pct_floodfactor1 is positive.

```
# Second PC Score
fr_loadings[, 2]
```

```
##    pct_fs_risk_2020_5    pct_fs_risk_2050_5  pct_fs_risk_2020_100
##            0.18936889            0.15849267           -0.01897480
##  pct_fs_risk_2050_100  pct_fs_risk_2020_500  pct_fs_risk_2050_500
##           -0.07046075           -0.17012069           -0.19136490
##    avg_risk_score_all     sd_risk_score_all     cv_risk_score_all
##           -0.03653999            0.21123041            0.32161350
##   avg_risk_score_2_10 avg_risk_fsf_2020_100 avg_risk_fsf_2020_500
##            0.38327527            0.37692053            0.37889776
##      pct_floodfactor1      pct_floodfactor2      pct_floodfactor3
##            0.19143421           -0.14797990           -0.23221303
##      pct_floodfactor4      pct_floodfactor5      pct_floodfactor6
##           -0.26037249           -0.16487957           -0.16615218
##      pct_floodfactor7      pct_floodfactor8      pct_floodfactor9
##            0.05646518            0.08178865            0.12622288
##     pct_floodfactor10
##            0.15921169
```

Less interpretable–more of a mix of positive and negative loadings.

```
# Third PC Score
fr_loadings[, 3]
```

```
##    pct_fs_risk_2020_5    pct_fs_risk_2050_5  pct_fs_risk_2020_100
##         -3.127449e-01         -3.277179e-01          6.653306e-05
##  pct_fs_risk_2050_100  pct_fs_risk_2020_500  pct_fs_risk_2050_500
##          1.561162e-02          5.586528e-02          7.239793e-02
##    avg_risk_score_all     sd_risk_score_all     cv_risk_score_all
##         -6.145985e-02          3.825294e-01          3.797622e-01
##   avg_risk_score_2_10 avg_risk_fsf_2020_100 avg_risk_fsf_2020_500
##          1.100369e-01          9.448015e-02          1.166077e-01
##      pct_floodfactor1      pct_floodfactor2      pct_floodfactor3
```

```
##         -7.242690e-02          6.525560e-02          1.011418e-01
##      pct_floodfactor4      pct_floodfactor5      pct_floodfactor6
##          2.101051e-02          2.505114e-01          2.561423e-01
##      pct_floodfactor7      pct_floodfactor8      pct_floodfactor9
##          3.122515e-01          1.516808e-01         -1.739074e-01
##     pct_floodfactor10
##         -3.974122e-01
```

```
# Fourth PC Score
fr_loadings[, 4]
```

```
##    pct_fs_risk_2020_5    pct_fs_risk_2050_5  pct_fs_risk_2020_100
##           0.121314451           0.036713873          -0.179542754
##  pct_fs_risk_2050_100  pct_fs_risk_2020_500  pct_fs_risk_2050_500
##          -0.152650065           0.006693033           0.124019886
##    avg_risk_score_all     sd_risk_score_all     cv_risk_score_all
##          -0.017134527           0.250355627           0.202762749
##   avg_risk_score_2_10 avg_risk_fsf_2020_100 avg_risk_fsf_2020_500
##          -0.007181716           0.161299133           0.075307417
##      pct_floodfactor1      pct_floodfactor2      pct_floodfactor3
##          -0.124261583           0.511960031           0.467353486
##      pct_floodfactor4      pct_floodfactor5      pct_floodfactor6
##           0.135511378          -0.022257200          -0.260406423
##      pct_floodfactor7      pct_floodfactor8      pct_floodfactor9
##          -0.277781005          -0.281315502          -0.110473643
##     pct_floodfactor10
##           0.161271275
```

```
# Fifth PC Score
fr_loadings[, 5]
```

```
##    pct_fs_risk_2020_5    pct_fs_risk_2050_5  pct_fs_risk_2020_100
##          -0.03398928           -0.12115849            0.03411119
##  pct_fs_risk_2050_100  pct_fs_risk_2020_500  pct_fs_risk_2050_500
##           0.11255958            0.09349197            0.02552728
##    avg_risk_score_all     sd_risk_score_all     cv_risk_score_all
##           0.03486906            0.01664289            0.05708426
##   avg_risk_score_2_10 avg_risk_fsf_2020_100 avg_risk_fsf_2020_500
##           0.18644632            0.08098052            0.13769357
##      pct_floodfactor1      pct_floodfactor2      pct_floodfactor3
##          -0.02532959           -0.40980031           -0.15375374
##      pct_floodfactor4      pct_floodfactor5      pct_floodfactor6
##           0.20952684            0.19187611            0.25781763
##      pct_floodfactor7      pct_floodfactor8      pct_floodfactor9
##          -0.36985923           -0.59925282           -0.22463544
##     pct_floodfactor10
##           0.10070678
```

```
round(fr_loadings[, 1:5], digits = 2)
```

```
##                       PC1   PC2   PC3   PC4   PC5
## pct_fs_risk_2020_5    -0.24  0.19 -0.31  0.12 -0.03
## pct_fs_risk_2050_5    -0.27  0.16 -0.33  0.04 -0.12
## pct_fs_risk_2020_100  -0.31 -0.02  0.00 -0.18  0.03
## pct_fs_risk_2050_100  -0.31 -0.07  0.02 -0.15  0.11
## pct_fs_risk_2020_500  -0.30 -0.17  0.06  0.01  0.09
```

```
## pct_fs_risk_2050_500  -0.30 -0.19  0.07  0.12  0.03
## avg_risk_score_all    -0.33 -0.04 -0.06 -0.02  0.03
## sd_risk_score_all     -0.17  0.21  0.38  0.25  0.02
## cv_risk_score_all      0.08  0.32  0.38  0.20  0.06
## avg_risk_score_2_10   -0.12  0.38  0.11 -0.01  0.19
## avg_risk_fsf_2020_100 -0.10  0.38  0.09  0.16  0.08
## avg_risk_fsf_2020_500 -0.12  0.38  0.12  0.08  0.14
## pct_floodfactor1       0.30  0.19 -0.07 -0.12 -0.03
## pct_floodfactor2      -0.05 -0.15  0.07  0.51 -0.41
## pct_floodfactor3      -0.08 -0.23  0.10  0.47 -0.15
## pct_floodfactor4      -0.10 -0.26  0.02  0.14  0.21
## pct_floodfactor5      -0.14 -0.16  0.25 -0.02  0.19
## pct_floodfactor6      -0.20 -0.17  0.26 -0.26  0.26
## pct_floodfactor7      -0.16  0.06  0.31 -0.28 -0.37
## pct_floodfactor8      -0.14  0.08  0.15 -0.28 -0.60
## pct_floodfactor9      -0.22  0.13 -0.17 -0.11 -0.22
## pct_floodfactor10     -0.22  0.16 -0.40  0.16  0.10
```

```
round(fr_loadings[, 1:8], digits = 2)
```

```
##                        PC1   PC2   PC3   PC4   PC5   PC6   PC7   PC8
## pct_fs_risk_2020_5    -0.24  0.19 -0.31  0.12 -0.03  0.00 -0.05  0.23
## pct_fs_risk_2050_5    -0.27  0.16 -0.33  0.04 -0.12  0.06 -0.05 -0.02
## pct_fs_risk_2020_100  -0.31 -0.02  0.00 -0.18  0.03  0.05  0.12  0.08
## pct_fs_risk_2050_100  -0.31 -0.07  0.02 -0.15  0.11  0.00  0.10 -0.04
## pct_fs_risk_2020_500  -0.30 -0.17  0.06  0.01  0.09 -0.14  0.02 -0.01
## pct_fs_risk_2050_500  -0.30 -0.19  0.07  0.12  0.03 -0.05  0.00 -0.04
## avg_risk_score_all    -0.33 -0.04 -0.06 -0.02  0.03  0.02  0.00  0.02
## sd_risk_score_all     -0.17  0.21  0.38  0.25  0.02 -0.09  0.02  0.17
## cv_risk_score_all      0.08  0.32  0.38  0.20  0.06 -0.10  0.05  0.02
## avg_risk_score_2_10   -0.12  0.38  0.11 -0.01  0.19 -0.06  0.02 -0.13
## avg_risk_fsf_2020_100 -0.10  0.38  0.09  0.16  0.08  0.04 -0.07 -0.15
## avg_risk_fsf_2020_500 -0.12  0.38  0.12  0.08  0.14  0.01  0.03 -0.17
## pct_floodfactor1       0.30  0.19 -0.07 -0.12 -0.03  0.05  0.00  0.04
## pct_floodfactor2      -0.05 -0.15  0.07  0.51 -0.41  0.35  0.58 -0.13
## pct_floodfactor3      -0.08 -0.23  0.10  0.47 -0.15 -0.06 -0.62  0.11
## pct_floodfactor4      -0.10 -0.26  0.02  0.14  0.21 -0.68  0.19 -0.21
## pct_floodfactor5      -0.14 -0.16  0.25 -0.02  0.19  0.48 -0.37 -0.14
## pct_floodfactor6      -0.20 -0.17  0.26 -0.26  0.26  0.28  0.17  0.01
## pct_floodfactor7      -0.16  0.06  0.31 -0.28 -0.37 -0.10  0.08  0.55
## pct_floodfactor8      -0.14  0.08  0.15 -0.28 -0.60 -0.19 -0.19 -0.25
## pct_floodfactor9      -0.22  0.13 -0.17 -0.11 -0.22  0.04 -0.08 -0.51
## pct_floodfactor10     -0.22  0.16 -0.40  0.16  0.10  0.04  0.00  0.35
```

PCA with Centering but no Scaling beforehand

Do PCA *without* scaling beforehand, and use biplots, etc. to compare results with those in the last section. I think just scaling all covariates once, *after* PCA, will lead to more interpretable results

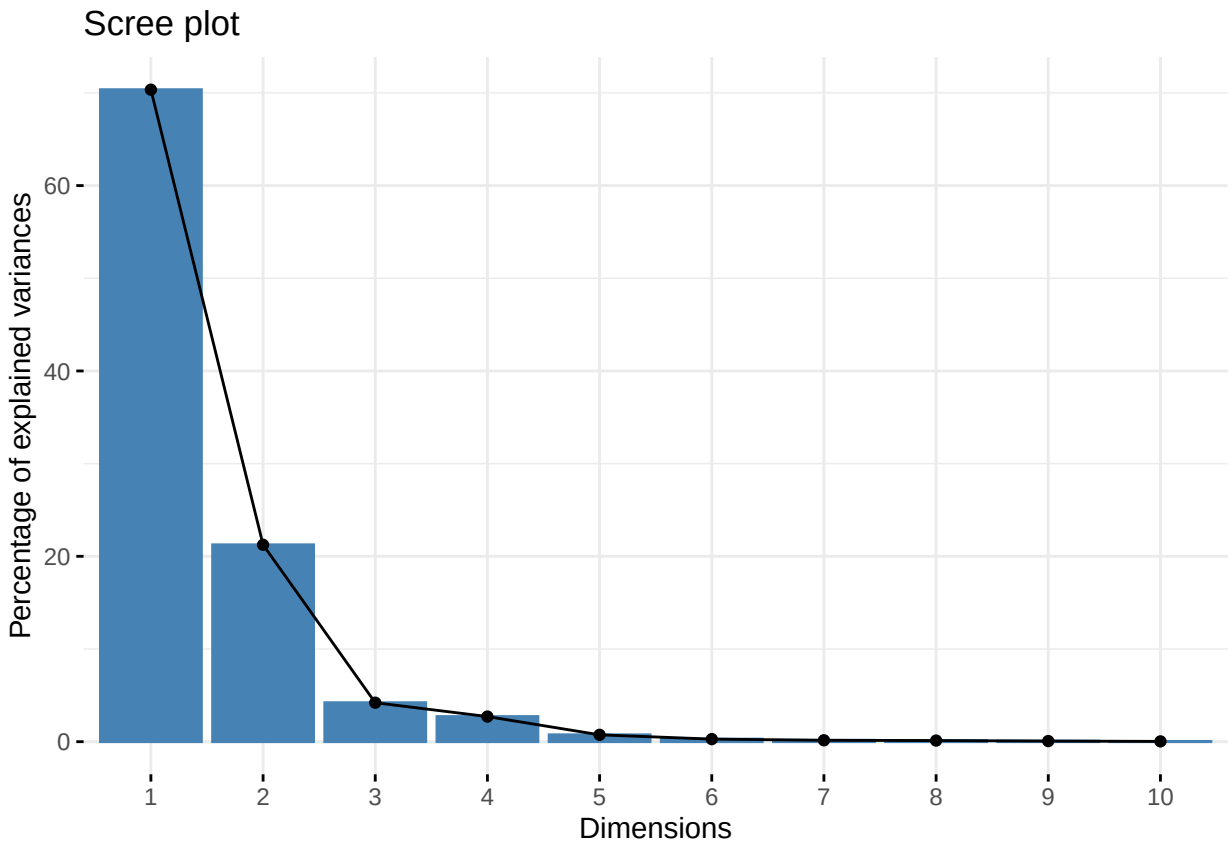
Conduct PCA on the correlated flood risk variables

```
first_var <- 19

fr_index <- first_var:(first_var + 21)
```

```
flood_risk <- fhs_model_df[, fr_index]
```

```
fr_pca <- prcomp(flood_risk[complete.cases(flood_risk),], center = T, scale. = F)

fr_loadings <- fr_pca$rotation
```

```
fviz_eig(fr_pca)
```




```
summ_pca <- summary(fr_pca)

summ_pca$importance[,1:10]
```

```
##                            PC1      PC2       PC3       PC4       PC5
## Standard deviation     2.156094 1.184867 0.5271685 0.4232675 0.2213399
## Proportion of Variance 0.703430 0.212440 0.0420500 0.0271100 0.0074100
## Cumulative Proportion  0.703430 0.915870 0.9579200 0.9850300 0.9924500
##                            PC6       PC7        PC8       PC9       PC10
## Standard deviation     0.1354879 0.1002485 0.08885766 0.0664214 0.04515333
## Proportion of Variance 0.0027800 0.0015200 0.00119000 0.0006700 0.00031000
## Cumulative Proportion  0.9952200 0.9967400 0.99794000 0.9986100 0.99891000
```

We started out with 22 variables. Including two PC scores would include >90% of the variance. Perhaps I can also look at the top 5 PCs, to get > 99% variance explained.

Printing out the loadings, from most negative to least

```
# First PC Score
fr_loadings[, 1]
```

```
##    pct_fs_risk_2020_5    pct_fs_risk_2050_5  pct_fs_risk_2020_100
##          -0.021240339          -0.026200603          -0.027287959
##  pct_fs_risk_2050_100  pct_fs_risk_2020_500  pct_fs_risk_2050_500
##          -0.025890403          -0.012937437          -0.011239303
##    avg_risk_score_all     sd_risk_score_all     cv_risk_score_all
##          -0.206655116          -0.224161348          -0.065925907
##   avg_risk_score_2_10 avg_risk_fsf_2020_100 avg_risk_fsf_2020_500
##          -0.581194182          -0.477386598          -0.577512216
##      pct_floodfactor1      pct_floodfactor2      pct_floodfactor3
##           0.011215117           0.002775862           0.006705547
##      pct_floodfactor4      pct_floodfactor5      pct_floodfactor6
##           0.010804712           0.000436761          -0.001712055
##      pct_floodfactor7      pct_floodfactor8      pct_floodfactor9
##          -0.003673378          -0.001119415          -0.010331553
##     pct_floodfactor10
##          -0.015101598
```

The first PC score is very interpretable. Only the loadings for the first five pct_floodfactor variables are positive.

```
# Second PC Score
fr_loadings[, 2]
```

```
##    pct_fs_risk_2020_5    pct_fs_risk_2050_5  pct_fs_risk_2020_100
##           0.030877735           0.048298401           0.110524027
##  pct_fs_risk_2050_100  pct_fs_risk_2020_500  pct_fs_risk_2050_500
##           0.130411155           0.162847406           0.176634178
##    avg_risk_score_all     sd_risk_score_all     cv_risk_score_all
##           0.882803822           0.144210669          -0.127097694
##   avg_risk_score_2_10 avg_risk_fsf_2020_100 avg_risk_fsf_2020_500
##          -0.130010196          -0.161871141          -0.117887932
##      pct_floodfactor1      pct_floodfactor2      pct_floodfactor3
##          -0.176663004           0.006636052           0.019301215
##      pct_floodfactor4      pct_floodfactor5      pct_floodfactor6
##           0.035596848           0.012790780           0.048754950
##      pct_floodfactor7      pct_floodfactor8      pct_floodfactor9
##           0.007900621           0.001889291           0.018931063
##     pct_floodfactor10
##           0.024862184
```

The second PC score only has negative loadings for pct_floodfactor1 and some of the avg_risk_score variables.

```
round(fr_loadings[, 1:2], digits = 2)
```

```
##                        PC1   PC2
## pct_fs_risk_2020_5    -0.02  0.03
## pct_fs_risk_2050_5    -0.03  0.05
## pct_fs_risk_2020_100  -0.03  0.11
## pct_fs_risk_2050_100  -0.03  0.13
## pct_fs_risk_2020_500  -0.01  0.16
## pct_fs_risk_2050_500  -0.01  0.18
## avg_risk_score_all    -0.21  0.88
## sd_risk_score_all     -0.22  0.14
## cv_risk_score_all     -0.07 -0.13
## avg_risk_score_2_10   -0.58 -0.13
```

```
## avg_risk_fsf_2020_100 -0.48 -0.16
## avg_risk_fsf_2020_500 -0.58 -0.12
## pct_floodfactor1       0.01 -0.18
## pct_floodfactor2       0.00  0.01
## pct_floodfactor3       0.01  0.02
## pct_floodfactor4       0.01  0.04
## pct_floodfactor5       0.00  0.01
## pct_floodfactor6       0.00  0.05
## pct_floodfactor7       0.00  0.01
## pct_floodfactor8       0.00  0.00
## pct_floodfactor9      -0.01  0.02
## pct_floodfactor10     -0.02  0.02
```

```
round(fr_loadings[, 1:8], digits = 2)
```

```
##                         PC1   PC2   PC3   PC4   PC5   PC6   PC7   PC8
## pct_fs_risk_2020_5    -0.02  0.03  0.02 -0.02 -0.02  0.23 -0.04 -0.24
## pct_fs_risk_2050_5    -0.03  0.05  0.04 -0.02 -0.02  0.30  0.02 -0.25
## pct_fs_risk_2020_100  -0.03  0.11  0.02  0.04 -0.02  0.07  0.11  0.40
## pct_fs_risk_2050_100  -0.03  0.13  0.03  0.04  0.01 -0.10  0.07  0.34
## pct_fs_risk_2020_500  -0.01  0.16 -0.01  0.02 -0.06 -0.39 -0.01 -0.03
## pct_fs_risk_2050_500  -0.01  0.18 -0.02 -0.03  0.08 -0.44 -0.04 -0.11
## avg_risk_score_all    -0.21  0.88  0.16 -0.06 -0.05  0.20  0.16 -0.06
## sd_risk_score_all     -0.22  0.14 -0.93  0.07  0.01  0.10 -0.23  0.03
## cv_risk_score_all     -0.07 -0.13 -0.25  0.06 -0.04 -0.09  0.93 -0.17
## avg_risk_score_2_10   -0.58 -0.13  0.17  0.52 -0.56 -0.08 -0.08 -0.03
## avg_risk_fsf_2020_100 -0.48 -0.16  0.02 -0.83 -0.23 -0.06  0.00  0.05
## avg_risk_fsf_2020_500 -0.58 -0.12  0.14  0.14  0.78  0.03  0.00  0.00
## pct_floodfactor1       0.01 -0.18  0.02  0.03 -0.08  0.44  0.04  0.11
## pct_floodfactor2       0.00  0.01 -0.01 -0.02  0.05 -0.03  0.00 -0.04
## pct_floodfactor3       0.01  0.02 -0.02 -0.03  0.04 -0.13 -0.05 -0.17
## pct_floodfactor4       0.01  0.04  0.00  0.02  0.01 -0.37 -0.10 -0.36
## pct_floodfactor5       0.00  0.01  0.00  0.00  0.01 -0.05  0.00  0.08
## pct_floodfactor6       0.00  0.05  0.00  0.02  0.01 -0.15  0.07  0.57
## pct_floodfactor7       0.00  0.01 -0.01  0.00  0.00  0.01  0.01  0.06
## pct_floodfactor8       0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.01
## pct_floodfactor9      -0.01  0.02  0.01 -0.01 -0.01  0.09  0.04 -0.03
## pct_floodfactor10     -0.02  0.02  0.02 -0.01 -0.02  0.20 -0.02 -0.21
```