Basic CAR model

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```
library(here)
```

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

```
## Loading required package: ggplot2
```
```
## Registered S3 method overwritten by 'GGally':
##   method from
##   +.gg   ggplot2
```
```
fls_model_df <- readRDS(here("intermediary_data/fls_model_df.rds"))

W <- readRDS(here("intermediary_data", "countyadj_reorganize.rds"))
```
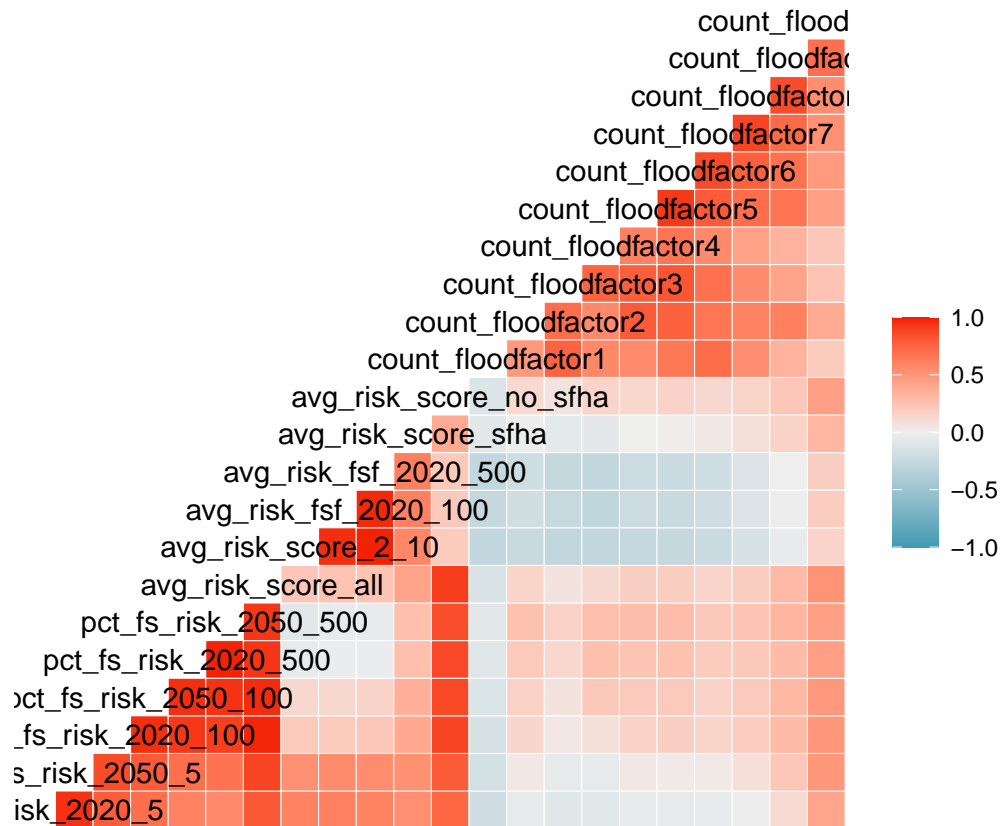
Checking for multicollinearity among the covariates

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

Flood risk variables

```
ggcorr(data = fls_model_df[, 17:38], progress = F)
```

```
## Warning: Ignoring unknown parameters: progress
```

```
(flood_cor <- cor(fls_model_df[complete.cases(fls_model_df[, 17:38]), 17:38]))
```

```
##                      pct_fs_risk_2020_5 pct_fs_risk_2050_5
## pct_fs_risk_2020_5          1.000000000         0.94988106
## pct_fs_risk_2050_5          0.949881058         1.00000000
## pct_fs_risk_2020_100        0.791039515         0.86049641
## pct_fs_risk_2050_100        0.698778151         0.79462942
## pct_fs_risk_2020_500        0.606293585         0.70060821
## pct_fs_risk_2050_500        0.566877770         0.68183527
## avg_risk_score_all          0.807789515         0.89007056
## avg_risk_score_2_10         0.601497146         0.52627442
## avg_risk_fsf_2020_100       0.608993848         0.55588894
## avg_risk_fsf_2020_500       0.607514257         0.54858150
## avg_risk_score_sfha         0.535526833         0.52924282
## avg_risk_score_no_sfha      0.742474752         0.79997202
## count_floodfactor1         -0.188059248        -0.16969607
## count_floodfactor2         -0.050520562         0.03553517
## count_floodfactor3         -0.087514471        -0.04351309
## count_floodfactor4         -0.076889837        -0.04325982
## count_floodfactor5         -0.050059624         0.03038026
## count_floodfactor6         -0.050728887         0.02615172
## count_floodfactor7         -0.043735537         0.02788600
## count_floodfactor8         -0.009538892         0.08610186
## count_floodfactor9          0.114562109         0.22582066
## count_floodfactor10         0.415545175         0.49237181
##                      pct_fs_risk_2020_100 pct_fs_risk_2050_100
## pct_fs_risk_2020_5            0.79103952           0.69877815
## pct_fs_risk_2050_5            0.86049641           0.79462942
```

```
## pct_fs_risk_2020_100              1.00000000              0.95837746
## pct_fs_risk_2050_100              0.95837746              1.00000000
## pct_fs_risk_2020_500              0.92853570              0.95416114
## pct_fs_risk_2050_500              0.90508171              0.94716576
## avg_risk_score_all               0.97883884              0.96205479
## avg_risk_score_2_10              0.20790417              0.12622123
## avg_risk_fsf_2020_100            0.19979962              0.12693926
## avg_risk_fsf_2020_500            0.22160754              0.15190441
## avg_risk_score_sfha             0.39400275              0.36021480
## avg_risk_score_no_sfha          0.89210416              0.87736401
## count_floodfactor1             -0.15122052             -0.12851351
## count_floodfactor2              0.13580520              0.16997002
## count_floodfactor3              0.04143961              0.06422365
## count_floodfactor4              0.08602565              0.21657666
## count_floodfactor5              0.16699383              0.20793046
## count_floodfactor6              0.17886571              0.20916776
## count_floodfactor7              0.15009028              0.16515448
## count_floodfactor8              0.18773724              0.20814362
## count_floodfactor9              0.29255766              0.31035104
## count_floodfactor10             0.49686439              0.48764627
##                          pct_fs_risk_2020_500 pct_fs_risk_2050_500
## pct_fs_risk_2020_5               0.60629359              0.56687777
## pct_fs_risk_2050_5               0.70060821              0.68183527
## pct_fs_risk_2020_100             0.92853570              0.90508171
## pct_fs_risk_2050_100             0.95416114              0.94716576
## pct_fs_risk_2020_500             1.00000000              0.98497840
## pct_fs_risk_2050_500             0.98497840              1.00000000
## avg_risk_score_all               0.93891838              0.93021061
## avg_risk_score_2_10             -0.03807242             -0.07720879
## avg_risk_fsf_2020_100           -0.02589823             -0.04036507
## avg_risk_fsf_2020_500           -0.02346836             -0.04116396
## avg_risk_score_sfha             0.27046716              0.27001980
## avg_risk_score_no_sfha          0.87591336              0.85654125
## count_floodfactor1             -0.09582890             -0.07982670
## count_floodfactor2              0.21503268              0.26182183
## count_floodfactor3              0.13333739              0.16663223
## count_floodfactor4              0.27181948              0.27536853
## count_floodfactor5              0.24379447              0.28489310
## count_floodfactor6              0.25922235              0.28704059
## count_floodfactor7              0.19635447              0.21761307
## count_floodfactor8              0.21581345              0.24327700
## count_floodfactor9              0.29263071              0.32150065
## count_floodfactor10             0.44175399              0.44805519
##                          avg_risk_score_all avg_risk_score_2_10
## pct_fs_risk_2020_5               0.80778952              0.60149715
## pct_fs_risk_2050_5               0.89007056              0.52627442
## pct_fs_risk_2020_100             0.97883884              0.20790417
## pct_fs_risk_2050_100             0.96205479              0.12622123
## pct_fs_risk_2020_500             0.93891838             -0.03807242
## pct_fs_risk_2050_500             0.93021061             -0.07720879
## avg_risk_score_all               1.00000000              0.22136714
## avg_risk_score_2_10              0.22136714              1.00000000
## avg_risk_fsf_2020_100            0.24393298              0.95541955
## avg_risk_fsf_2020_500            0.24646127              0.98490095
```

```
## avg_risk_score_sfha             0.42462906           0.58287098
## avg_risk_score_no_sfha          0.91714061           0.20129593
## count_floodfactor1             -0.13680843          -0.28320378
## count_floodfactor2              0.15168013          -0.24384648
## count_floodfactor3              0.06357023          -0.28505981
## count_floodfactor4              0.12544320          -0.28029149
## count_floodfactor5              0.17665953          -0.25775607
## count_floodfactor6              0.18439375          -0.26234329
## count_floodfactor7              0.14512924          -0.23272034
## count_floodfactor8              0.18574052          -0.14887476
## count_floodfactor9              0.29555510          -0.03991423
## count_floodfactor10             0.51494684           0.14732222
##                     avg_risk_fsf_2020_100 avg_risk_fsf_2020_500
## pct_fs_risk_2020_5           0.608993848           0.607514257
## pct_fs_risk_2050_5           0.555888943           0.548581500
## pct_fs_risk_2020_100         0.199799624           0.221607540
## pct_fs_risk_2050_100         0.126939261           0.151904410
## pct_fs_risk_2020_500        -0.025898232          -0.023468360
## pct_fs_risk_2050_500        -0.040365067          -0.041163959
## avg_risk_score_all           0.243932984           0.246461265
## avg_risk_score_2_10          0.955419553           0.984900948
## avg_risk_fsf_2020_100        1.000000000           0.970996340
## avg_risk_fsf_2020_500        0.970996340           1.000000000
## avg_risk_score_sfha          0.610352301           0.617917067
## avg_risk_score_no_sfha       0.209984788           0.213868810
## count_floodfactor1          -0.263759397          -0.269444032
## count_floodfactor2          -0.191425305          -0.203784873
## count_floodfactor3          -0.251019609          -0.263559982
## count_floodfactor4          -0.288228756          -0.274386174
## count_floodfactor5          -0.220607273          -0.221611414
## count_floodfactor6          -0.238504067          -0.237078969
## count_floodfactor7          -0.208359171          -0.205874993
## count_floodfactor8          -0.119101913          -0.115613426
## count_floodfactor9           0.001491015          -0.002517033
## count_floodfactor10          0.189426722           0.178426553
##                     avg_risk_score_sfha avg_risk_score_no_sfha
## pct_fs_risk_2020_5           0.535526833            0.74247475
## pct_fs_risk_2050_5           0.529242820            0.79997202
## pct_fs_risk_2020_100         0.394002753            0.89210416
## pct_fs_risk_2050_100         0.360214796            0.87736401
## pct_fs_risk_2020_500         0.270467163            0.87591336
## pct_fs_risk_2050_500         0.270019797            0.85654125
## avg_risk_score_all           0.424629062            0.91714061
## avg_risk_score_2_10          0.582870980            0.20129593
## avg_risk_fsf_2020_100        0.610352301            0.20998479
## avg_risk_fsf_2020_500        0.617917067            0.21386881
## avg_risk_score_sfha          1.000000000            0.39181510
## avg_risk_score_no_sfha       0.391815096            1.00000000
## count_floodfactor1          -0.075961499           -0.11819310
## count_floodfactor2          -0.013012188            0.11968428
## count_floodfactor3          -0.062663317            0.06161253
## count_floodfactor4          -0.064387515            0.14968696
## count_floodfactor5           0.002520926            0.13559878
## count_floodfactor6           0.011804447            0.15422312
```

```
## count_floodfactor7           0.039419061          0.12395506
## count_floodfactor8           0.085517876          0.15165391
## count_floodfactor9           0.158834543          0.22365870
## count_floodfactor10          0.319241091          0.44578299
##                   count_floodfactor1 count_floodfactor2 count_floodfactor3
## pct_fs_risk_2020_5        -0.1880592        -0.05052056         -0.08751447
## pct_fs_risk_2050_5        -0.1696961         0.03553517         -0.04351309
## pct_fs_risk_2020_100      -0.1512205         0.13580520          0.04143961
## pct_fs_risk_2050_100      -0.1285135         0.16997002          0.06422365
## pct_fs_risk_2020_500      -0.0958289         0.21503268          0.13333739
## pct_fs_risk_2050_500      -0.0798267         0.26182183          0.16663223
## avg_risk_score_all        -0.1368084         0.15168013          0.06357023
## avg_risk_score_2_10       -0.2832038        -0.24384648         -0.28505981
## avg_risk_fsf_2020_100     -0.2637594        -0.19142530         -0.25101961
## avg_risk_fsf_2020_500     -0.2694440        -0.20378487         -0.26355998
## avg_risk_score_sfha       -0.0759615        -0.01301219         -0.06266332
## avg_risk_score_no_sfha    -0.1181931         0.11968428          0.06161253
## count_floodfactor1         1.0000000         0.48108224          0.75921346
## count_floodfactor2         0.4810822         1.00000000          0.70722260
## count_floodfactor3         0.7592135         0.70722260          1.00000000
## count_floodfactor4         0.5756465         0.57007578          0.75425274
## count_floodfactor5         0.5573027         0.79496231          0.78253669
## count_floodfactor6         0.6588797         0.76936024          0.81661016
## count_floodfactor7         0.7119478         0.66838964          0.69811200
## count_floodfactor8         0.5461498         0.60440391          0.55427231
## count_floodfactor9         0.3406568         0.61901681          0.42283822
## count_floodfactor10        0.2000844         0.39094893          0.24745957
##                   count_floodfactor4 count_floodfactor5 count_floodfactor6
## pct_fs_risk_2020_5       -0.07688984       -0.050059624         -0.05072889
## pct_fs_risk_2050_5       -0.04325982        0.030380263          0.02615172
## pct_fs_risk_2020_100      0.08602565        0.166993828          0.17886571
## pct_fs_risk_2050_100      0.21657666        0.207930460          0.20916776
## pct_fs_risk_2020_500      0.27181948        0.243794469          0.25922235
## pct_fs_risk_2050_500      0.27536853        0.284893102          0.28704059
## avg_risk_score_all        0.12544320        0.176659532          0.18439375
## avg_risk_score_2_10      -0.28029149       -0.257756073         -0.26234329
## avg_risk_fsf_2020_100    -0.28822876       -0.220607273         -0.23850407
## avg_risk_fsf_2020_500    -0.27438617       -0.221611414         -0.23707897
## avg_risk_score_sfha      -0.06438751        0.002520926          0.01180445
## avg_risk_score_no_sfha    0.14968696        0.135598775          0.15422312
## count_floodfactor1        0.57564651        0.557302726          0.65887974
## count_floodfactor2        0.57007578        0.794962313          0.76936024
## count_floodfactor3        0.75425274        0.782536693          0.81661016
## count_floodfactor4        1.00000000        0.608852741          0.67129918
## count_floodfactor5        0.60885274        1.000000000          0.92653752
## count_floodfactor6        0.67129918        0.926537524          1.00000000
## count_floodfactor7        0.56225534        0.793868216          0.86520567
## count_floodfactor8        0.43871888        0.705941377          0.77245211
## count_floodfactor9        0.33689913        0.674569551          0.69078550
## count_floodfactor10       0.22458312        0.447566771          0.47626882
##                   count_floodfactor7 count_floodfactor8 count_floodfactor9
## pct_fs_risk_2020_5       -0.04373554       -0.009538892         0.114562109
## pct_fs_risk_2050_5        0.02788600        0.086101859         0.225820656
## pct_fs_risk_2020_100      0.15009028        0.187737245         0.292557661
```

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```
## pct_fs_risk_2050_100            0.16515448        0.208143618         0.310351044
## pct_fs_risk_2020_500            0.19635447        0.215813451         0.292630710
## pct_fs_risk_2050_500            0.21761307        0.243277004         0.321500650
## avg_risk_score_all             0.14512924        0.185740517         0.295555097
## avg_risk_score_2_10           -0.23272034       -0.148874760        -0.039914226
## avg_risk_fsf_2020_100         -0.20835917       -0.119101913         0.001491015
## avg_risk_fsf_2020_500         -0.20587499       -0.115613426        -0.002517033
## avg_risk_score_sfha            0.03941906        0.085517876         0.158834543
## avg_risk_score_no_sfha         0.12395506        0.151653914         0.223658699
## count_floodfactor1            0.71194785        0.546149844         0.340656756
## count_floodfactor2            0.66838964        0.604403913         0.619016809
## count_floodfactor3            0.69811200        0.554272315         0.422838216
## count_floodfactor4            0.56225534        0.438718875         0.336899133
## count_floodfactor5            0.79386822        0.705941377         0.674569551
## count_floodfactor6            0.86520567        0.772452107         0.690785500
## count_floodfactor7            1.00000000        0.886423079         0.727721120
## count_floodfactor8            0.88642308        1.000000000         0.856413232
## count_floodfactor9            0.72772112        0.856413232         1.000000000
## count_floodfactor10           0.53228275        0.540650571         0.699582920
##                            count_floodfactor10
## pct_fs_risk_2020_5                   0.4155452
## pct_fs_risk_2050_5                   0.4923718
## pct_fs_risk_2020_100                 0.4968644
## pct_fs_risk_2050_100                 0.4876463
## pct_fs_risk_2020_500                 0.4417540
## pct_fs_risk_2050_500                 0.4480552
## avg_risk_score_all                   0.5149468
## avg_risk_score_2_10                  0.1473222
## avg_risk_fsf_2020_100                0.1894267
## avg_risk_fsf_2020_500                0.1784266
## avg_risk_score_sfha                  0.3192411
## avg_risk_score_no_sfha               0.4457830
## count_floodfactor1                   0.2000844
## count_floodfactor2                   0.3909489
## count_floodfactor3                   0.2474596
## count_floodfactor4                   0.2245831
## count_floodfactor5                   0.4475668
## count_floodfactor6                   0.4762688
## count_floodfactor7                   0.5322827
## count_floodfactor8                   0.5406506
## count_floodfactor9                   0.6995829
## count_floodfactor10                  1.0000000
```

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

```
diag(flood_cor) <- NA
```

```
summary(flood_cor)
```

```
## pct_fs_risk_2020_5 pct_fs_risk_2050_5 pct_fs_risk_2020_100
## Min.   :-0.18806   Min.   :-0.16970   Min.   :-0.1512
## 1st Qu.:-0.05006   1st Qu.: 0.03038   1st Qu.: 0.1670
## Median : 0.53553   Median : 0.52627   Median : 0.2216
## Mean   : 0.35665   Mean   : 0.40501   Mean   : 0.4249
## 3rd Qu.: 0.60899   3rd Qu.: 0.70061   3rd Qu.: 0.8605
```

```
##  Max.   : 0.94988   Max.   : 0.94988   Max.    : 0.9788
##  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.   :-0.1285      Min.   :-0.09583     Min.   :-0.07983
##  1st Qu.: 0.1652      1st Qu.: 0.19635     1st Qu.: 0.21761
##  Median : 0.2166      Median : 0.27047     Median : 0.28489
##  Mean   : 0.4223      Mean   : 0.39745     Mean   : 0.40049
##  3rd Qu.: 0.7946      3rd Qu.: 0.70061     3rd Qu.: 0.68184
##  Max.   : 0.9621      Max.   : 0.98498     Max.   : 0.98498
##  NA's   :1            NA's   :1            NA's   :1
##  avg_risk_score_all avg_risk_score_2_10 avg_risk_fsf_2020_100
##  Min.   :-0.1368     Min.   :-0.28506    Min.   :-0.288229
##  1st Qu.: 0.1767     1st Qu.:-0.24385    1st Qu.:-0.208359
##  Median : 0.2465     Median :-0.03807    Median : 0.001491
##  Mean   : 0.4413     Mean   : 0.11456    Mean   : 0.134569
##  3rd Qu.: 0.8901     3rd Qu.: 0.22137    3rd Qu.: 0.243933
##  Max.   : 0.9788     Max.   : 0.98490    Max.   : 0.970996
##  NA's   :1           NA's   :1           NA's   :1
##  avg_risk_fsf_2020_500 avg_risk_score_sfha avg_risk_score_no_sfha
##  Min.   :-0.274386     Min.   :-0.07596    Min.   :-0.1182
##  1st Qu.:-0.205875     1st Qu.: 0.01180    1st Qu.: 0.1497
##  Median :-0.002517     Median : 0.27047    Median : 0.2139
##  Mean   : 0.137318     Mean   : 0.25659    Mean   : 0.4012
##  3rd Qu.: 0.246461     3rd Qu.: 0.42463    3rd Qu.: 0.8000
##  Max.   : 0.984901     Max.   : 0.61792    Max.   : 0.9171
##  NA's   :1             NA's   :1           NA's   :1
##  count_floodfactor1 count_floodfactor2 count_floodfactor3 count_floodfactor4
##  Min.   :-0.28320    Min.   :-0.24385   Min.   :-0.28506   Min.   :-0.28823
##  1st Qu.:-0.15122    1st Qu.: 0.03554   1st Qu.:-0.04351   1st Qu.:-0.04326
##  Median :-0.07983    Median : 0.21503   Median : 0.13334   Median : 0.22458
##  Mean   : 0.13669    Mean   : 0.28535   Mean   : 0.25143   Mean   : 0.23048
##  3rd Qu.: 0.54615    3rd Qu.: 0.60440   3rd Qu.: 0.69811   3rd Qu.: 0.56226
##  Max.   : 0.75921    Max.   : 0.79496   Max.   : 0.81661   Max.   : 0.75425
##  NA's   :1           NA's   :1          NA's   :1          NA's   :1
##  count_floodfactor5 count_floodfactor6 count_floodfactor7 count_floodfactor8
##  Min.   :-0.25776    Min.   :-0.26234   Min.   :-0.23272   Min.   :-0.1489
##  1st Qu.: 0.03038    1st Qu.: 0.02615   1st Qu.: 0.03942   1st Qu.: 0.0861
##  Median : 0.24379    Median : 0.25922   Median : 0.19635   Median : 0.2158
##  Mean   : 0.32338    Mean   : 0.34141   Mean   : 0.32482   Mean   : 0.3274
##  3rd Qu.: 0.67457    3rd Qu.: 0.69079   3rd Qu.: 0.69811   3rd Qu.: 0.5543
##  Max.   : 0.92654    Max.   : 0.92654   Max.   : 0.88642   Max.   : 0.8864
##  NA's   :1           NA's   :1          NA's   :1          NA's   :1
##  count_floodfactor9 count_floodfactor10
##  Min.   :-0.03991    Min.   :0.1473
##  1st Qu.: 0.22366    1st Qu.:0.2475
##  Median : 0.31035    Median :0.4458
##  Mean   : 0.36014    Mean   :0.3970
##  3rd Qu.: 0.61902    3rd Qu.:0.4924
##  Max.   : 0.85641    Max.   :0.6996
##  NA's   :1           NA's   :1
```
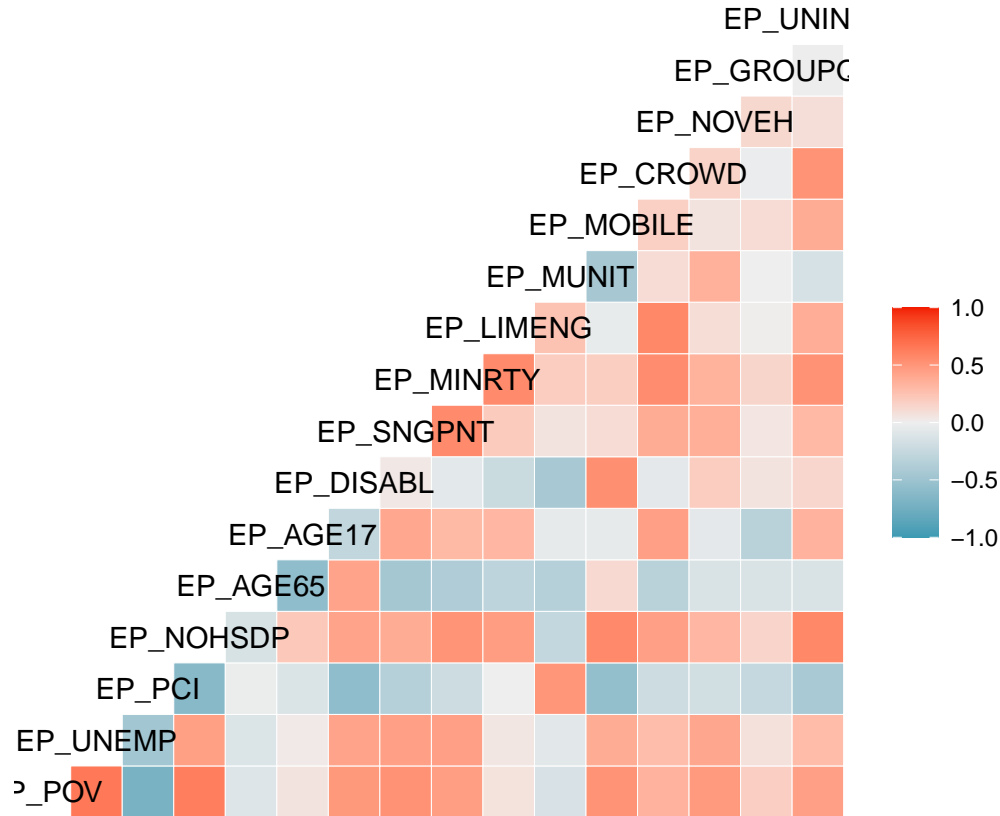
Many of the flood risk variables are very correlated.

SVI Variables

```
ggcorr(data = fls_model_df[, 39:54], progress = F)
```

```
## Warning: Ignoring unknown parameters: progress
```



```
(svi_cor <- cor(fls_model_df[complete.cases(fls_model_df[, 39:54]), 39:54]))
```

```
##                    EP_POV      EP_UNEMP         EP_PCI   EP_NOHSDP     EP_AGE65
## EP_POV         1.00000000    0.65154857  -0.7103056275   0.6254853  -0.10657946
## EP_UNEMP       0.65154857    1.00000000  -0.4612103295   0.4532279  -0.12022992
## EP_PCI        -0.71030563   -0.46121033   1.0000000000  -0.6262797  -0.01683822
## EP_NOHSDP      0.62548531    0.45322790  -0.6262796652   1.0000000  -0.14111559
## EP_AGE65      -0.10657946   -0.12022992  -0.0168382185  -0.1411156   1.00000000
## EP_AGE17       0.06475125    0.02827912  -0.1243383212   0.2177170  -0.57476412
## EP_DISABL      0.48586544    0.42395670  -0.5794913164   0.4271945   0.42412972
## EP_SNGPNT      0.51887260    0.44944620  -0.3470227931   0.3785708  -0.45743733
## EP_MINRTY      0.45604006    0.44889574  -0.2090773909   0.5090794  -0.38753061
## EP_LIMENG      0.07009639    0.04580458  -0.0009591033   0.4598988  -0.29887556
## EP_MUNIT      -0.13836697   -0.07605523   0.4995965155  -0.2657774  -0.35262468
## EP_MOBILE      0.51545109    0.37718262  -0.5600628496   0.5625601   0.12101238
## EP_CROWD       0.34431163    0.28356947  -0.2148883334   0.4496746  -0.32904339
## EP_NOVEH       0.48055115    0.40918645  -0.1791498409   0.3147644  -0.12910911
## EP_GROUPQ      0.18226204    0.07750866  -0.2538691690   0.1511509  -0.13308534
## EP_UNINSUR     0.44883447    0.28895719  -0.4289763742   0.5736897  -0.12938690
##                  EP_AGE17     EP_DISABL      EP_SNGPNT      EP_MINRTY      EP_LIMENG
## EP_POV         0.06475125    0.48586544     0.51887260     0.45604006   0.0700963895
## EP_UNEMP       0.02827912    0.42395670     0.44944620     0.44889574   0.0458045846
```

```
## EP_PCI      -0.12433832 -0.57949132 -0.34702279 -0.20907739 -0.0009591033
## EP_NOHSDP    0.21771701  0.42719446  0.37857077  0.50907944  0.4598988190
## EP_AGE65    -0.57476412  0.42412972 -0.45743733 -0.38753061 -0.2988755623
## EP_AGE17     1.00000000 -0.27658786  0.40354000  0.30149642  0.3149737539
## EP_DISABL   -0.27658786  1.00000000  0.04096641 -0.07177311 -0.2240600940
## EP_SNGPNT    0.40354000  0.04096641  1.00000000  0.56026164  0.2001874832
## EP_MINRTY    0.30149642 -0.07177311  0.56026164  1.00000000  0.5624017490
## EP_LIMENG    0.31497375 -0.22406009  0.20018748  0.56240175  1.0000000000
## EP_MUNIT    -0.04236691 -0.43118805  0.06426726  0.19472114  0.2498708116
## EP_MOBILE   -0.05200253  0.53993350  0.10384622  0.18382861 -0.0380200909
## EP_CROWD     0.44438111 -0.06539029  0.37813629  0.55290358  0.5775159407
## EP_NOVEH    -0.06444933  0.19360660  0.36659333  0.34205431  0.1000213363
## EP_GROUPQ   -0.32948858  0.06484295  0.05079929  0.14754534  0.0065066513
## EP_UNINSUR   0.33667300  0.13672110  0.30741216  0.52056679  0.3744399807
##                  EP_MUNIT    EP_MOBILE      EP_CROWD     EP_NOVEH     EP_GROUPQ
## EP_POV       -0.138366969  0.51545109  0.34431163  0.48055115  0.182262045
## EP_UNEMP     -0.076055227  0.37718262  0.28356947  0.40918645  0.077508662
## EP_PCI        0.499596515 -0.56006285 -0.21488833 -0.17914984 -0.253869169
## EP_NOHSDP    -0.265777410  0.56256010  0.44967465  0.31476438  0.151150853
## EP_AGE65     -0.352624675  0.12101238 -0.32904339 -0.12910911 -0.133085338
## EP_AGE17     -0.042366909 -0.05200253  0.44438111 -0.06444933 -0.329488580
## EP_DISABL    -0.431188049  0.53993350 -0.06539029  0.19360660  0.064842953
## EP_SNGPNT     0.064267262  0.10384622  0.37813629  0.36659333  0.050799287
## EP_MINRTY     0.194721142  0.18382861  0.55290358  0.34205431  0.147545344
## EP_LIMENG     0.249870812 -0.03802009  0.57751594  0.10002134  0.006506651
## EP_MUNIT      1.000000000 -0.44223776  0.10540992  0.35186391 -0.000369879
## EP_MOBILE    -0.442237763  1.00000000  0.17663229  0.06226905  0.105594681
## EP_CROWD      0.105409916  0.17663229  1.00000000  0.15812169 -0.023615080
## EP_NOVEH      0.351863906  0.06226905  0.15812169  1.00000000  0.129367093
## EP_GROUPQ    -0.000369879  0.10559468 -0.02361508  0.12936709  1.000000000
## EP_UNINSUR   -0.155772925  0.37796514  0.51676600  0.09040975  0.003735602
##                EP_UNINSUR
## EP_POV        0.448834467
## EP_UNEMP      0.288957193
## EP_PCI       -0.428976374
## EP_NOHSDP     0.573689707
## EP_AGE65     -0.129386901
## EP_AGE17      0.336673001
## EP_DISABL     0.136721103
## EP_SNGPNT     0.307412160
## EP_MINRTY     0.520566789
## EP_LIMENG     0.374439981
## EP_MUNIT     -0.155772925
## EP_MOBILE     0.377965140
## EP_CROWD      0.516766001
## EP_NOVEH      0.090409750
## EP_GROUPQ     0.003735602
## EP_UNINSUR    1.000000000
```

```
diag(svi_cor) <- NA

summary(svi_cor)
```

```
##     EP_POV            EP_UNEMP           EP_PCI           EP_NOHSDP
## Min.   :-0.71031   Min.   :-0.46121   Min.   :-0.7103   Min.   :-0.6263
```

```
##    1st Qu.: 0.06742    1st Qu.: 0.03704    1st Qu.:-0.5106    1st Qu.: 0.1844
##    Median : 0.44883    Median : 0.28896    Median :-0.2539    Median : 0.4272
##    Mean   : 0.25925    Mean   : 0.21867    Mean   :-0.2809    Mean   : 0.2727
##    3rd Qu.: 0.50066    3rd Qu.: 0.43643    3rd Qu.:-0.1517    3rd Qu.: 0.4845
##    Max.   : 0.65155    Max.   : 0.65155    Max.   : 0.4996    Max.   : 0.6255
##    NA's   :1           NA's   :1           NA's   :1          NA's   :1
##      EP_AGE65            EP_AGE17            EP_DISABL           EP_SNGPNT
##    Min.   :-0.5748    Min.   :-0.57476    Min.   :-0.57949    Min.   :-0.45744
##    1st Qu.:-0.3408    1st Qu.:-0.09439    1st Qu.:-0.14792    1st Qu.: 0.05753
##    Median :-0.1331    Median : 0.02828    Median : 0.06484    Median : 0.30741
##    Mean   :-0.1754    Mean   : 0.04319    Mean   : 0.07258    Mean   : 0.20123
##    3rd Qu.:-0.1134    3rd Qu.: 0.30824    3rd Qu.: 0.42404    3rd Qu.: 0.39106
##    Max.   : 0.4241    Max.   : 0.44438    Max.   : 0.53993    Max.   : 0.56026
##    NA's   :1          NA's   :1           NA's   :1           NA's   :1
##      EP_MINRTY           EP_LIMENG           EP_MUNIT            EP_MOBILE
##    Min.   :-0.3875    Min.   :-0.298876   Min.   :-0.44224    Min.   :-0.56006
##    1st Qu.: 0.1657    1st Qu.: 0.002774   1st Qu.:-0.21078    1st Qu.: 0.01212
##    Median : 0.3421    Median : 0.100021   Median :-0.04237    Median : 0.12101
##    Mean   : 0.2741    Mean   : 0.159987   Mean   :-0.02927    Mean   : 0.13560
##    3rd Qu.: 0.5148    3rd Qu.: 0.344707   3rd Qu.: 0.15007    3rd Qu.: 0.37757
##    Max.   : 0.5624    Max.   : 0.577516   Max.   : 0.49960    Max.   : 0.56256
##    NA's   :1          NA's   :1           NA's   :1           NA's   :1
##      EP_CROWD            EP_NOVEH            EP_GROUPQ           EP_UNINSUR
##    Min.   :-0.3290    Min.   :-0.17915    Min.   :-0.32949    Min.   :-0.42898
##    1st Qu.: 0.0409    1st Qu.: 0.07634    1st Qu.:-0.01199    1st Qu.: 0.04707
##    Median : 0.2836    Median : 0.15812    Median : 0.05080    Median : 0.30741
##    Mean   : 0.2236    Mean   : 0.17507    Mean   : 0.01193    Mean   : 0.21747
##    3rd Qu.: 0.4470    3rd Qu.: 0.34696    3rd Qu.: 0.11748    3rd Qu.: 0.41340
##    Max.   : 0.5775    Max.   : 0.48055    Max.   : 0.18226    Max.   : 0.57369
##    NA's   :1          NA's   :1           NA's   :1           NA's   :1
```

Air pollution variables

```
ggpairs(data = fls_model_df, columns = 55:60, progress = F)
```

```
## Warning: Removed 1 rows containing non-finite values (stat_density).

## Warning in ggally_statistic(data = data, mapping = mapping, na.rm = na.rm, :
## Removing 1 row that contained a missing value

## Warning in ggally_statistic(data = data, mapping = mapping, na.rm = na.rm, :
## Removing 1 row that contained a missing value

## Warning in ggally_statistic(data = data, mapping = mapping, na.rm = na.rm, :
## Removing 1 row that contained a missing value

## Warning in ggally_statistic(data = data, mapping = mapping, na.rm = na.rm, :
## Removing 1 row that contained a missing value

## Warning in ggally_statistic(data = data, mapping = mapping, na.rm = na.rm, :
## Removing 1 row that contained a missing value

## Warning: Removed 1 rows containing missing values (geom_point).
```

```
## Warning: Removed 1 rows containing non-finite values (stat_density).

## Warning in ggally_statistic(data = data, mapping = mapping, na.rm = na.rm, :
## Removing 1 row that contained a missing value

## Warning in ggally_statistic(data = data, mapping = mapping, na.rm = na.rm, :
## Removing 1 row that contained a missing value

## Warning in ggally_statistic(data = data, mapping = mapping, na.rm = na.rm, :
## Removing 1 row that contained a missing value

## Warning in ggally_statistic(data = data, mapping = mapping, na.rm = na.rm, :
## Removing 1 row that contained a missing value

## Warning: Removed 1 rows containing missing values (geom_point).

## Warning: Removed 1 rows containing missing values (geom_point).

## Warning: Removed 1 rows containing non-finite values (stat_density).

## Warning in ggally_statistic(data = data, mapping = mapping, na.rm = na.rm, :
## Removing 1 row that contained a missing value

## Warning in ggally_statistic(data = data, mapping = mapping, na.rm = na.rm, :
## Removing 1 row that contained a missing value

## Warning in ggally_statistic(data = data, mapping = mapping, na.rm = na.rm, :
## Removing 1 row that contained a missing value

## Warning: Removed 1 rows containing missing values (geom_point).

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## Warning: Removed 1 rows containing missing values (geom_point).

## Warning: Removed 1 rows containing non-finite values (stat_density).

## Warning in ggally_statistic(data = data, mapping = mapping, na.rm = na.rm, :
## Removing 1 row that contained a missing value

## Warning in ggally_statistic(data = data, mapping = mapping, na.rm = na.rm, :
## Removing 1 row that contained a missing value

## Warning: Removed 1 rows containing missing values (geom_point).

## Warning: Removed 1 rows containing missing values (geom_point).

## Warning: Removed 1 rows containing missing values (geom_point).

## Warning: Removed 1 rows containing missing values (geom_point).

## Warning: Removed 1 rows containing non-finite values (stat_density).

## Warning in ggally_statistic(data = data, mapping = mapping, na.rm = na.rm, :
## Removing 1 row that contained a missing value

## Warning: Removed 1 rows containing missing values (geom_point).

## Warning: Removed 1 rows containing missing values (geom_point).
```
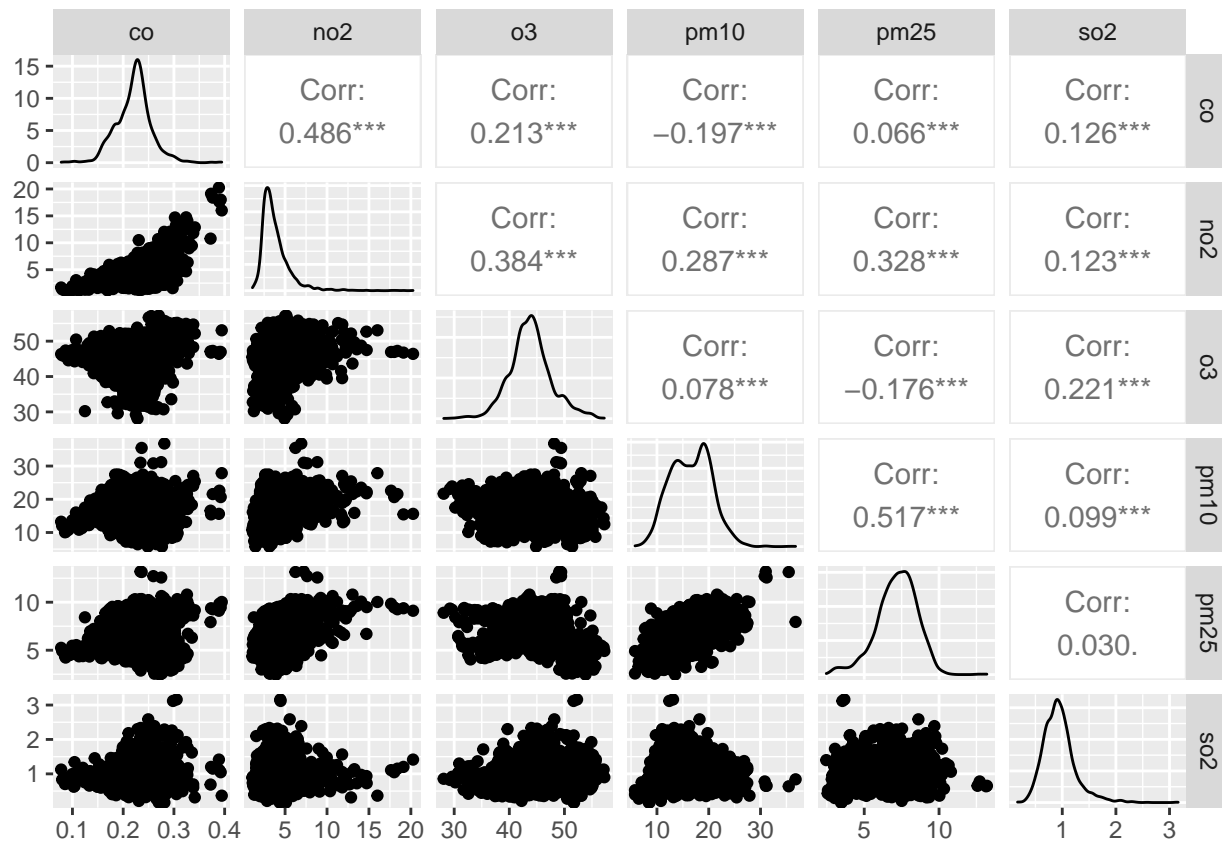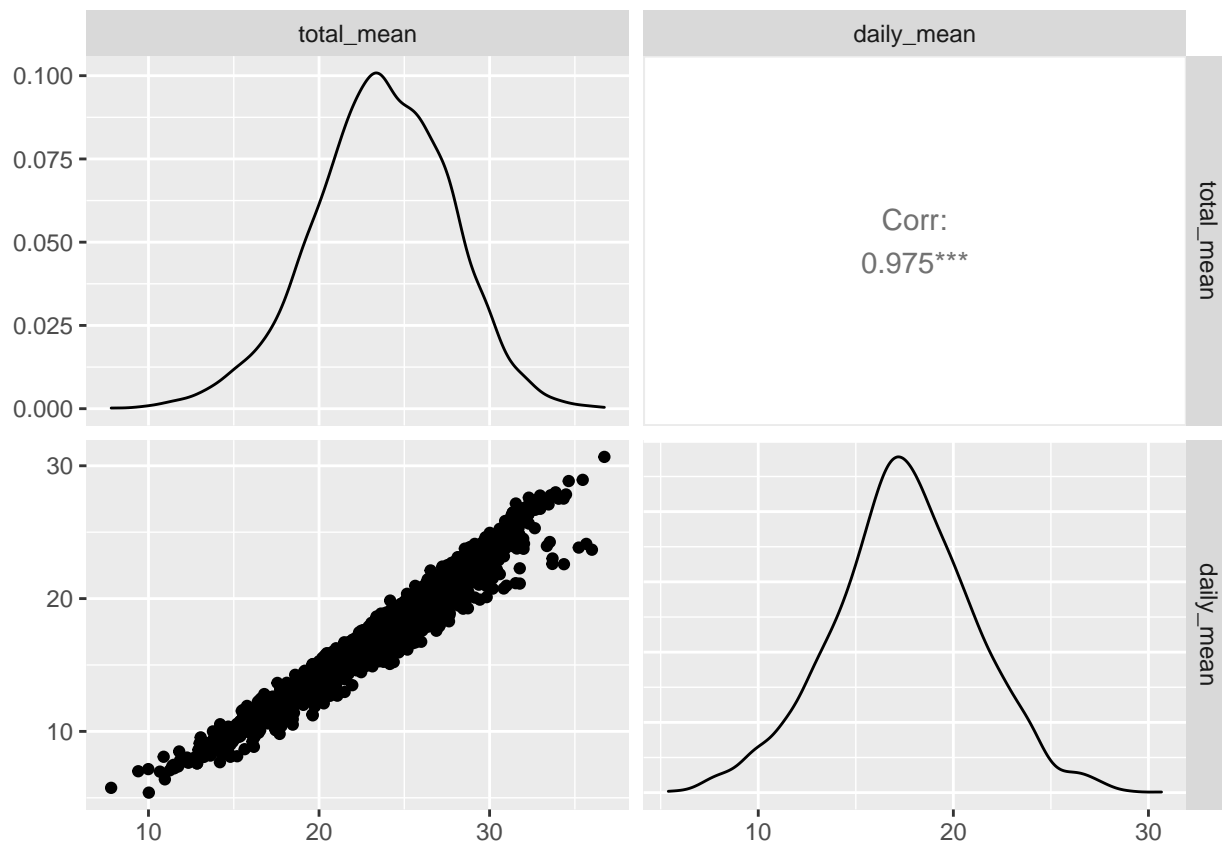
```
## Warning: Removed 1 rows containing missing values (geom_point).

## Warning: Removed 1 rows containing missing values (geom_point).

## Warning: Removed 1 rows containing missing values (geom_point).
## Warning: Removed 1 rows containing non-finite values (stat_density).
```


Smoking prevalence variables

```
ggpairs(data = fls_model_df, columns = 61:62, progress = F)
```

The correlation between total_mean and daily_mean is almost one.

Checking for spatial autocorrelation

Moran's I

```
(moran_results <- Moran.I(fls_model_df$`Life expectancy, 2014*`, W))
```

```
## $observed
## [1] 0.6847712
##
## $expected
## [1] -0.0003218539
##
## $sd
## [1] 0.01058084
##
## $p.value
## [1] 0
```

The p-value is negligible, so we can reject the null hypothesis of zero spatial autocorrelation. Since the observed value of I is significantly greater then the expected value, the life expectancies are positively autocorrelated, in contrast to negatively autocorrelated. Thus, using a CAR model is justified.