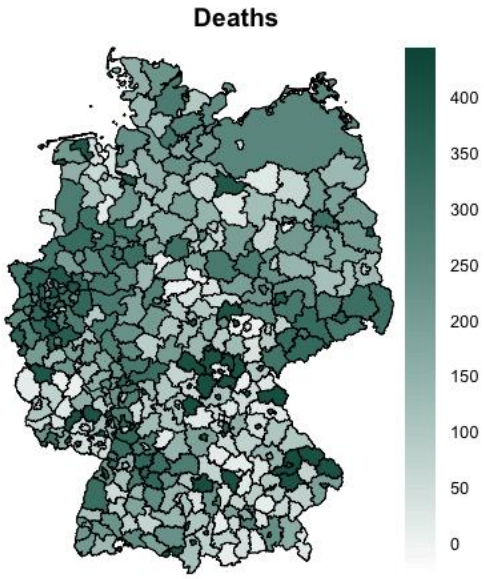
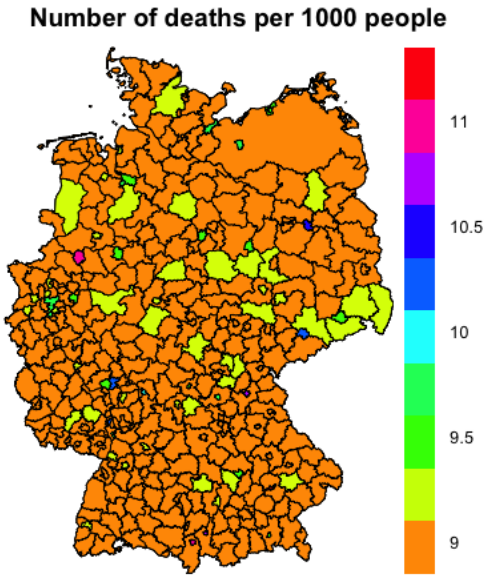
Variable Death is chosen as a dependent, it shows number of deaths in each Germany region in 2017 year.



After merging this data with variables Fertility rate and Population, creating plot showing the number of deaths per 1000 people

```
# Number of deaths per 1000 people
map@data$deathspp <- map@data$Deaths / map@data$Popultn * 1000
```



SAR models

- maximum likelihood gives following results

```
             Estimate Std. Error  z value  Pr(>|z|)
(Intercept) 4626.5213   574.8294   8.0485 8.882e-16
Popultn      -19.1261     1.7870 -10.7026 < 2.2e-16
Fertlty        9.0357     1.8272   4.9451 7.609e-07

Rho: -0.091721, LR test value: 0.63386, p-value: 0.42594
Approximate (numerical Hessian) standard error: 0.11583
    z-value: -0.79184, p-value: 0.42846
Wald statistic: 0.627, p-value: 0.42846

Log likelihood: -4067.168 for lag model
ML residual variance (sigma squared): 20932000, (sigma: 4575.2)
Number of observations: 413
Number of parameters estimated: 5
AIC: 8144.3, (AIC for lm: 8143)
```

Both coefficients are statistically significant according to their p-value. AIC = 8144.3

```
Moran I statistic standard deviate = 0.23979, p-value = 0.4052
```

There is no spatial autocorrelation between variables considering p-value from Moran's test

- least squares

```
Moran I statistic standard deviate = 2.3947, p-value = 0.008317
```

In this case p-value is very small and it tells about existence of spatial autocorrelation

SEM

- maximum likelihood

```
Coefficients: (asymptotic standard errors)
             Estimate Std. Error z value  Pr(>|z|)
(Intercept) 99.392997  14.133494  7.0324 2.029e-12
Popultn      0.115940   0.044786  2.5888  0.009632
Fertlty      0.346399   0.045867  7.5523 4.285e-14

Lambda: 0.15399, LR test value: 4.1727, p-value: 0.04108
Asymptotic standard error: 0.080912
    z-value: 1.9032, p-value: 0.057021
Wald statistic: 3.622, p-value: 0.057021

Log likelihood: -2542.54 for error model
ML residual variance (sigma squared): 12985, (sigma: 113.95)
Number of observations: 413
Number of parameters estimated: 5
AIC: 5095.1, (AIC for lm: 5097.3)
```

Again, variables are statistically significant but AIC criteria better than in SAR model

```
Moran I statistic standard deviate = -0.096227, p-value = 0.5383
```

There is no autocorrelation here because p-value is 0.5383

- least squares

```
Moran I statistic standard deviate = 2.4007, p-value = 0.008182
```

Least squares shows another result, there exists spatial autocorrelation

SLX

```
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 99.99035   13.76840   7.262 1.93e-12 ***
Popultn      0.11421    0.04497   2.540   0.0115 *
Fertlty      0.35450    0.04598   7.710 9.59e-14 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 115.1 on 410 degrees of freedom
Multiple R-squared:  0.1509,    Adjusted R-squared:  0.1467
F-statistic: 36.42 on 2 and 410 DF,  p-value: 2.753e-15
```

Variables are statistically significant. Adjusted R-squared = 0.1467 (not that great).

Output of Moran’s test:

```
Moran I statistic standard deviate = 2.3947, p-value = 0.008317
```

p-value tells that there is a spatial autocorrelation