Weather, conflicts and IDPs in Somalia

Data

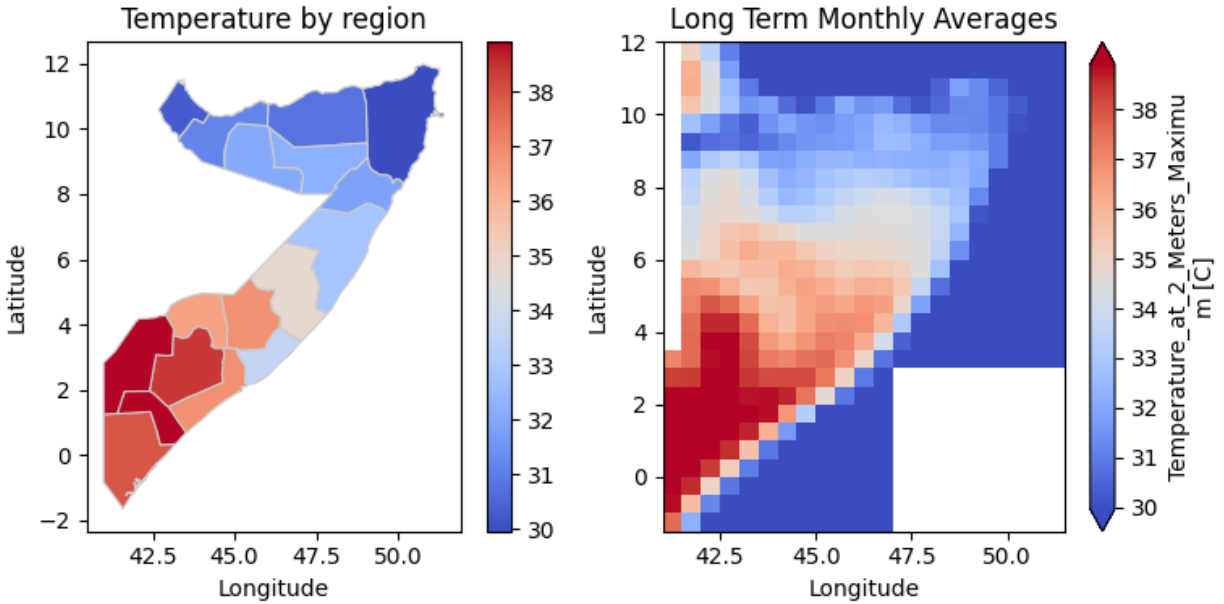
- **Conflict data** → Armed Conflict Location and Event Data Project (ACLED) database, which records violent conflict events

- **Extreme weather** → University of East Anglia Climatic Research United (UEA-CRU 2011), which reports average temperatures and total precipitation by months at data points of a high-resolution grid (of 0.5 × 0.5 degree)

- **Displacement data** → Protection and Return Monitoring Network (PRMN) survey, collected by the United Nations High Commissioner for Refugees (UNHCR)

Variables

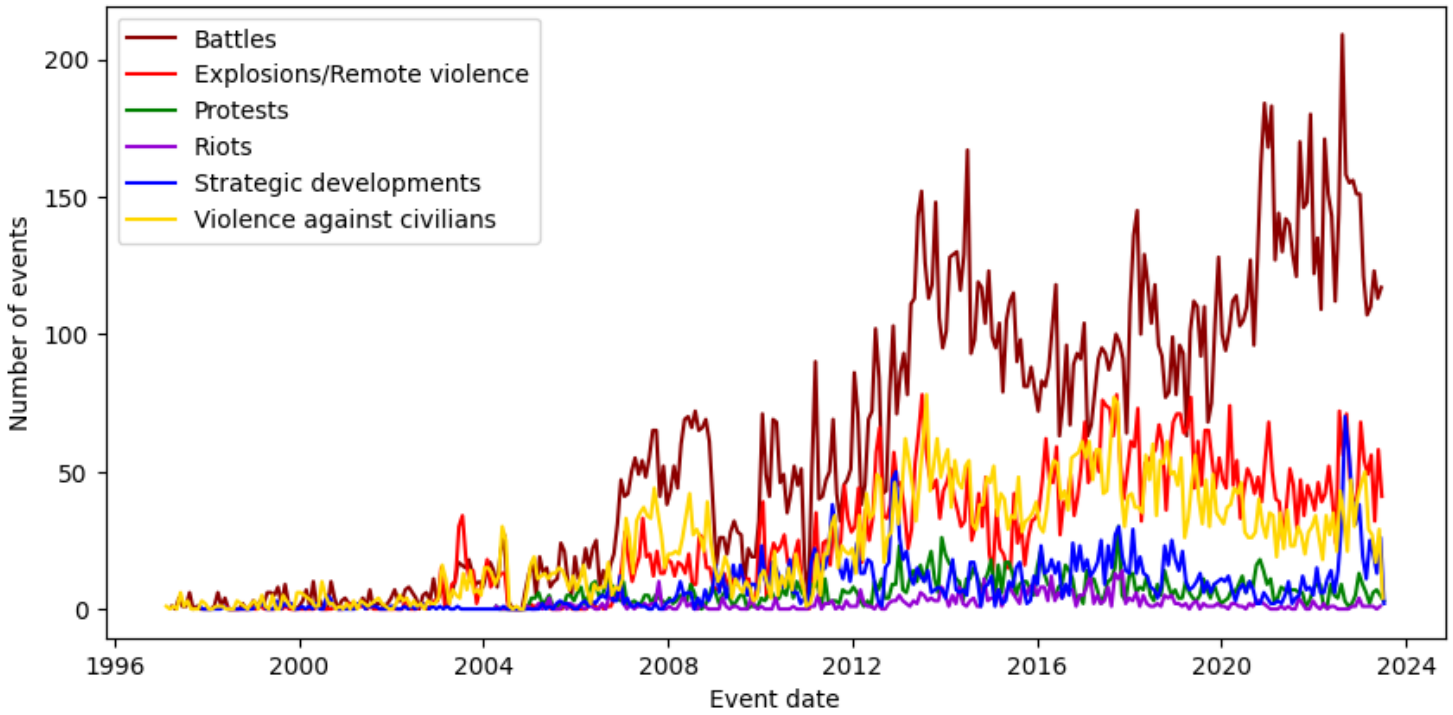
- Transformed the gridded temperature data into a **single data point** for each administrative unit
- Computed the **long-term averages** for each region and each month, from 1901
- Computed the **standardized difference** with the maximum temperature for each region and for each month
- Calculated a **moving average** of these standardized values over a **window of 3 and 4 months**
- **Drought Lenght** variable is defined as the number of consecutive months with positive temperature anomalies.

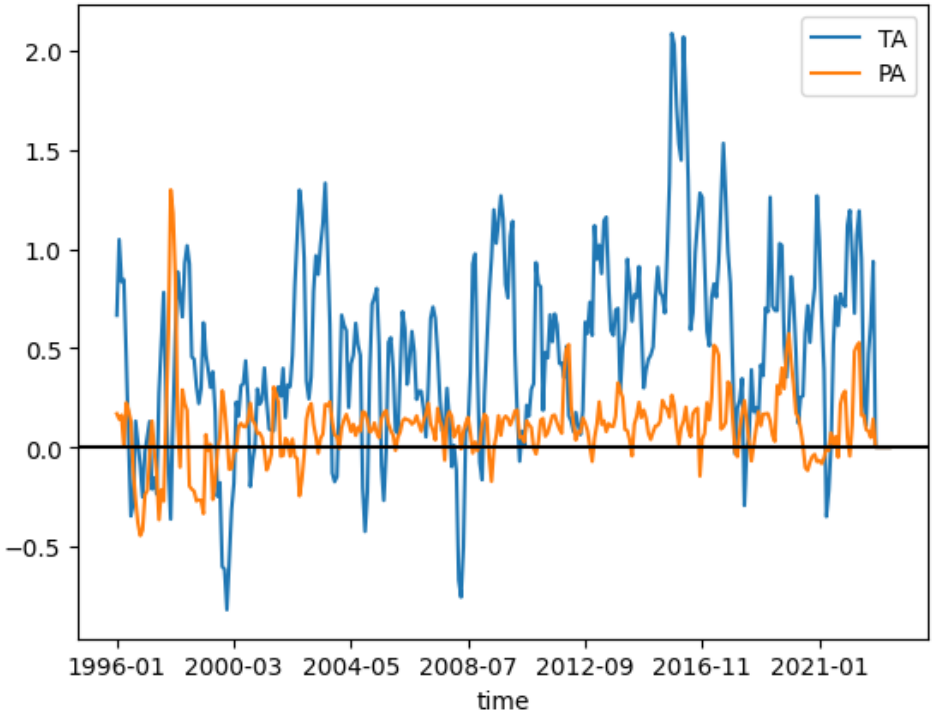


$$TA^{n}_{i,m,y} = \frac{1}{n}\sum_{n}\frac{T_{i,m,y} - \mu^{T}_{i,m}}{\sigma^{T}_{i,m}}$$

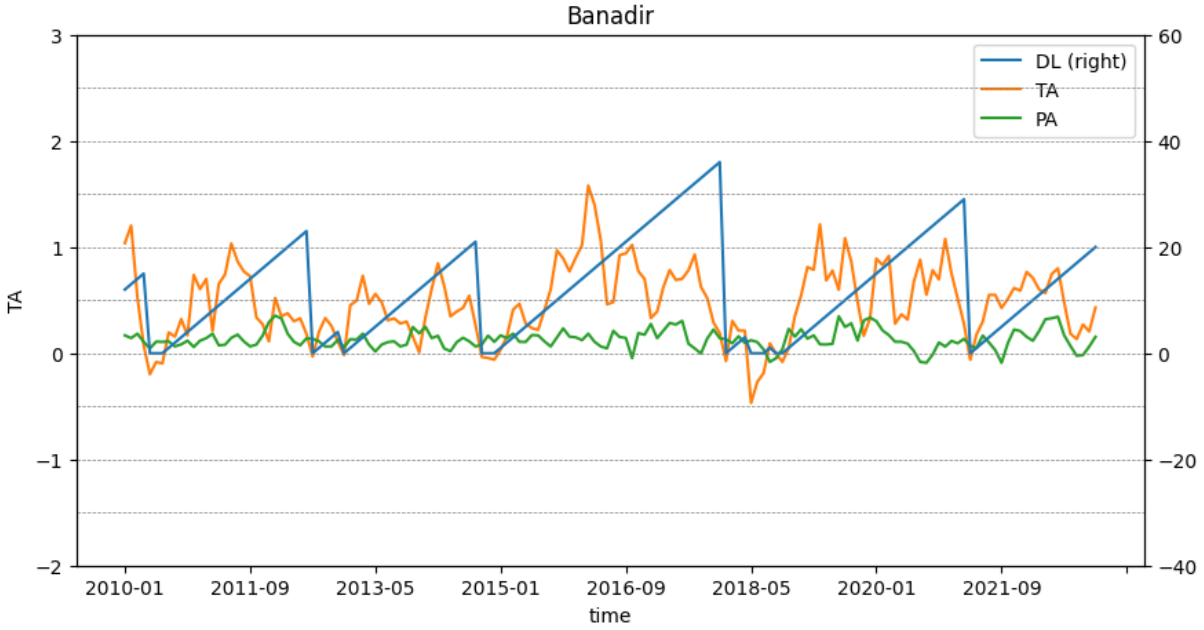
$$PA^{n}_{i,m,y} = \frac{1}{n}\sum_{n}\frac{R_{i,m,y} - \mu^{R}_{i,m}}{\sigma^{R}_{i,m}}$$

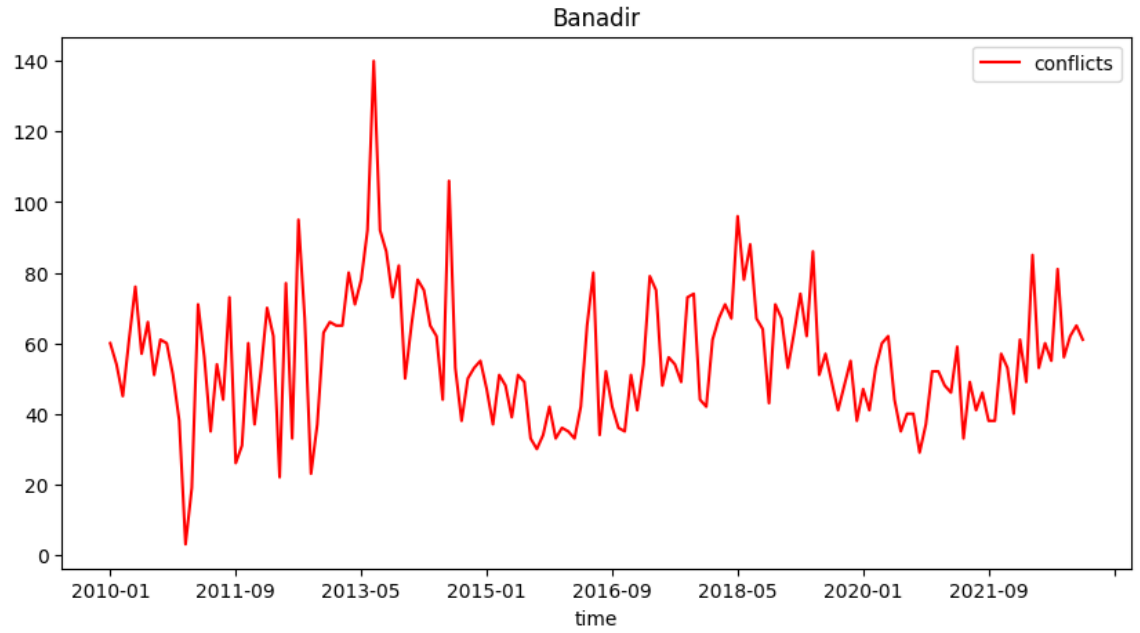
Conflicts and weather anomalies from 1996



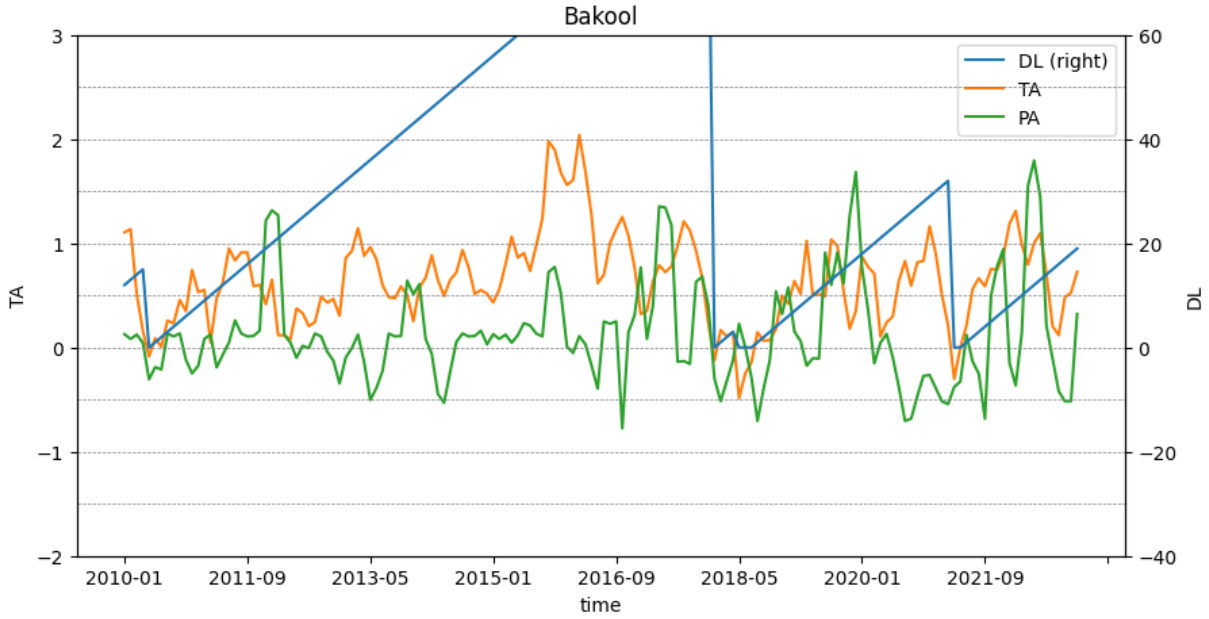


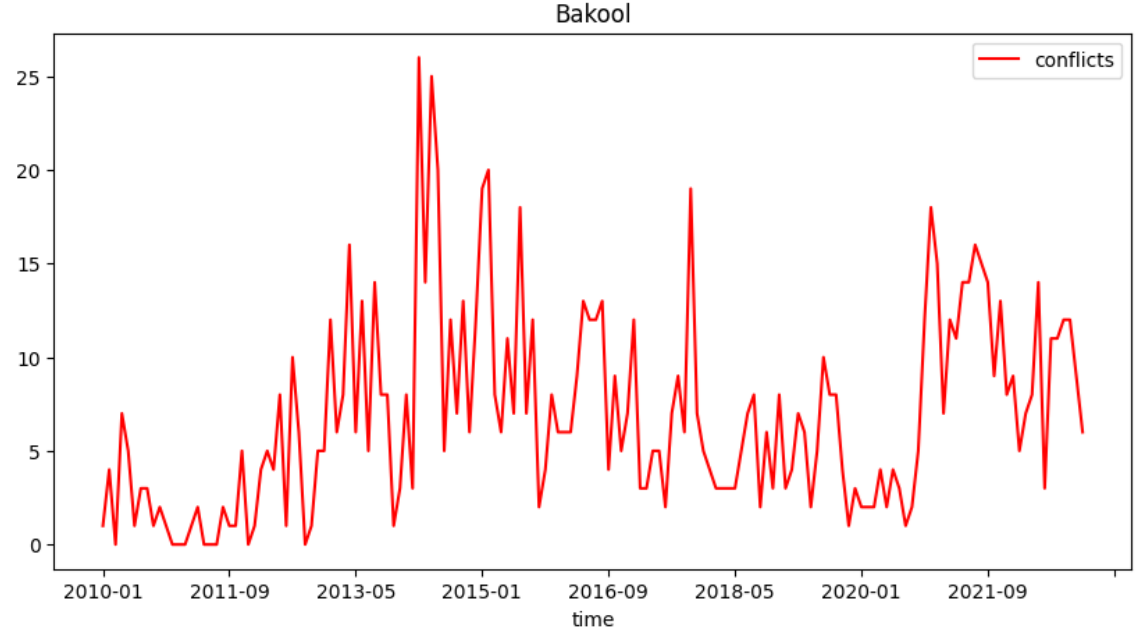
Climate variables and conflicts in Banadir region (2010-2022)





Climate variables and conflicts in Bakool region (2010-2022)





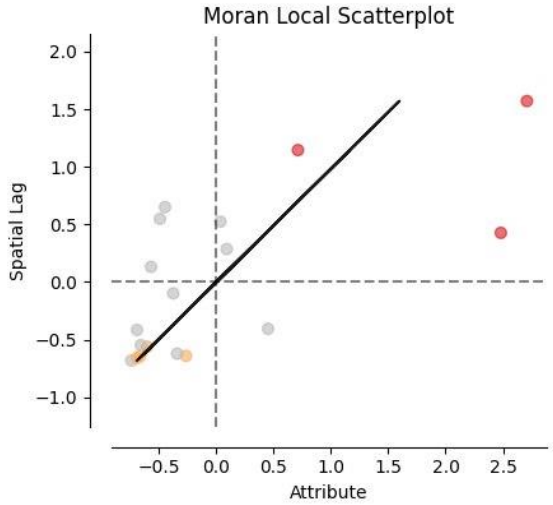
Reduced-form regression

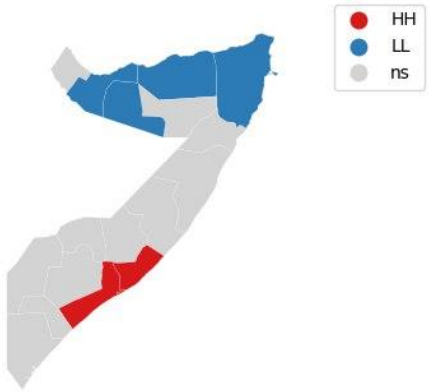
$$Conflicts_{i,m,y} = c + \alpha TA_{i,m,y} + \beta PA_{i,m,y} + \gamma DL^{TA}_{i,m,y} + \psi_i + \theta_{m,y} + \epsilon_{i,m,y}$$

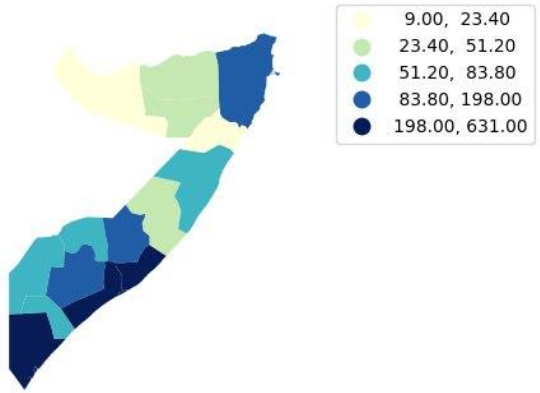
where ψ_i is the $n \times 1$ vector of region fixed effects, $\theta_{m,y}$ is the $my \times 1$ vector of time fixed effects and $\epsilon_{i,m,y}$ is an idiosyncratic error term. The total number of observations in the panel is $N \times T$, where $N = 18$ is the number of entities, i.e. regions of Somalia, and $T = 84$ is the number of months between 2016-01 and 2022-12.

Spatial autocorrelation

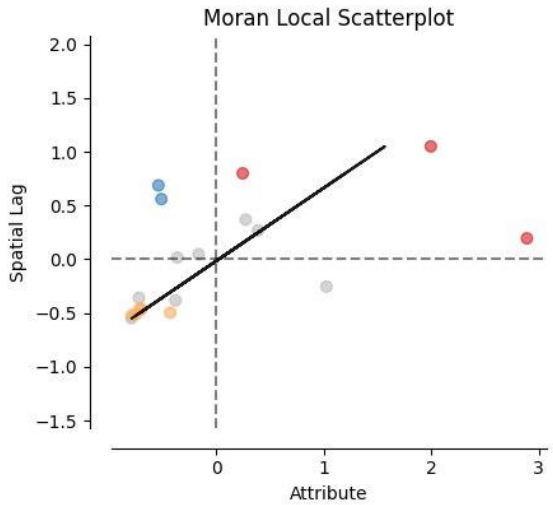
2019

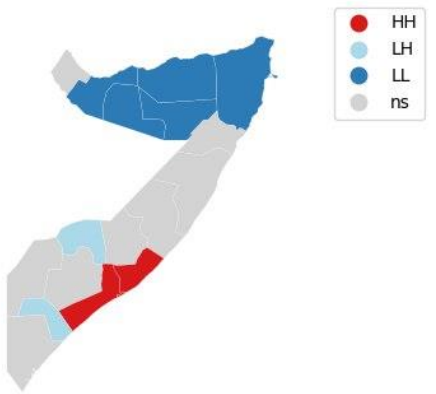


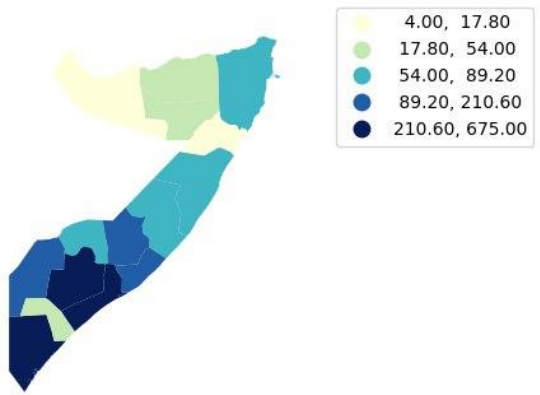




2020







Spatial Lag Model

SAR model

$$Conflicts_{i,m,y} = c + \rho W_i Conflicts_{i,m,y} + \alpha TA_{i,m,y} + \beta PA_{i,m,y} + \gamma DL^{TA}_{i,m,y} + \psi_i + \theta_{m,y} + \epsilon_{i,m,y}$$

SARAR model

$$Conflicts_{i,m,y} = c + \rho W_i Conflicts_{i,m,y} + \alpha TA_{i,m,y} + \beta PA_{i,m,y} + \gamma DL^{TA}_{i,m,y} + \psi_i + \theta_{m,y} + u_{i,m,y}$$

$$u_{i,m,y} = \lambda W_i u_{i,m,y} + \epsilon_{i,m,y}$$

where W_i is the $N \times N$ spatial weight matrix, ρ and λ are the unknown spatial autoregressive parameters to be estimated.

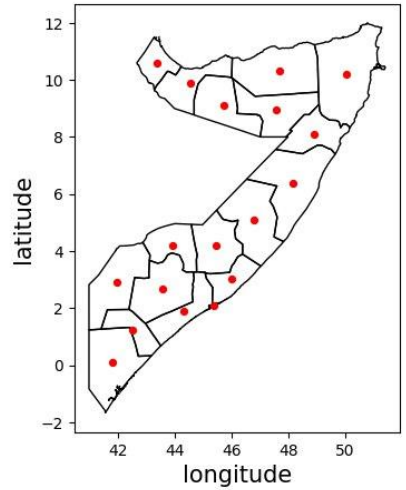
Spatial weight matrix

- **Adjacency matrix**, where neighbouring regions weight 1 and the rest 0

} regions in direct proximity have a greater influence compared to those situated at greater distances

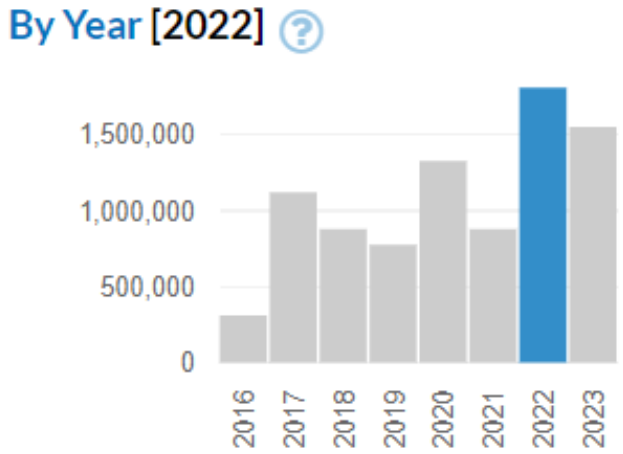
- **Normalised inverse distance matrix**, calculated between the centroids of the regions

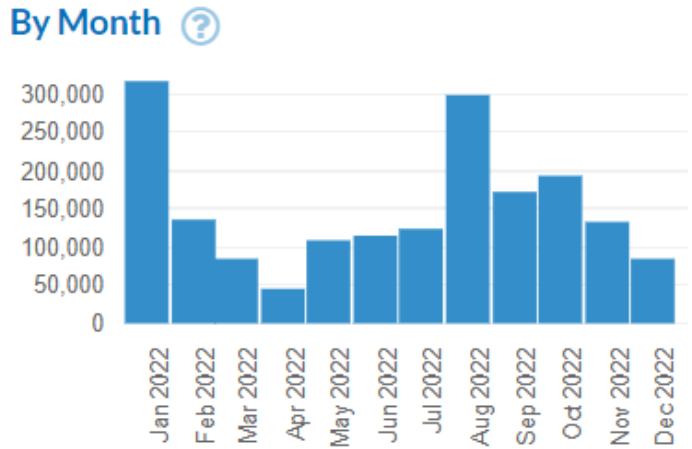
} influence decreases over space but is still accounted for in non-neighbouring regions.



$$W = \begin{pmatrix} 0 & w_{12} & \dots & w_{1N} \\ w_{21} & \ddots & w_{ij} & \vdots \\ \vdots & w_{ji} & 0 & \vdots \\ w_{N1} & \dots & \dots & 0 \end{pmatrix}$$

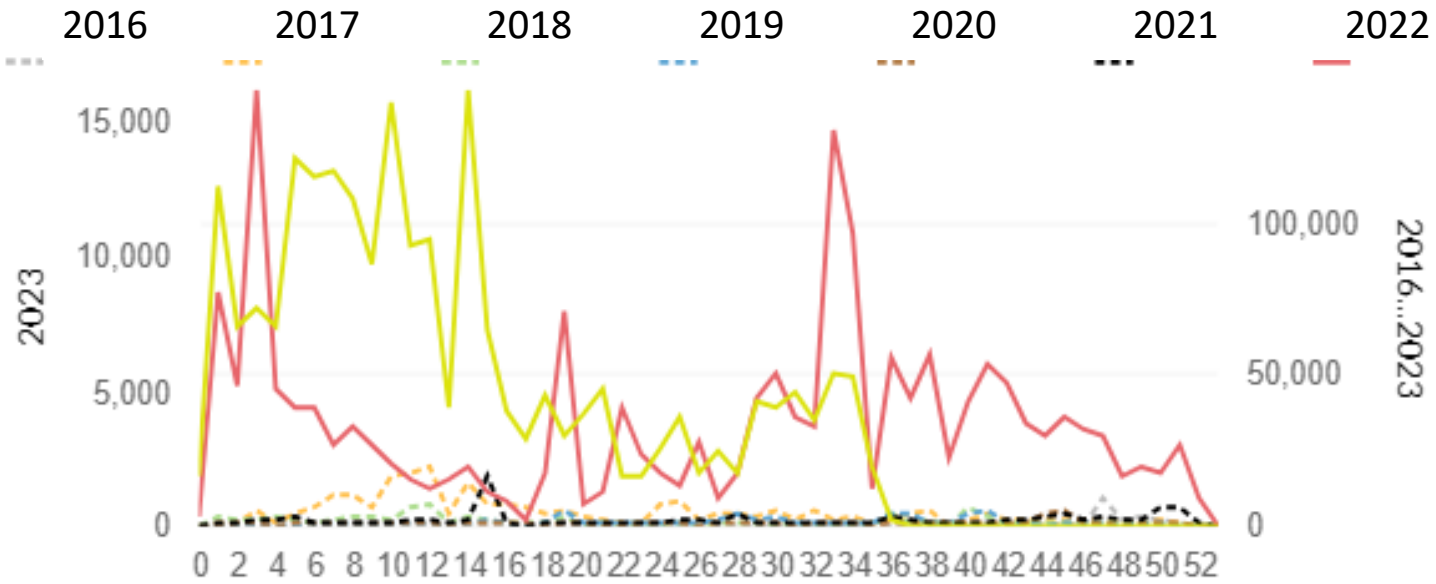
Internal displacements





There has been a significant increase in the number of IDPs in the past years

Number of IDPs in Somalia, by week



Spatial Lag Model + IDPs

SAR + IDPs

$$Conflicts_{i,m,y} = c + \rho W_i Conflicts_{i,m,y} + \alpha TA_{i,m,y} + \beta PA_{i,m,y} + \gamma DL^{TA}_{i,m,y} + \\ + \delta SumIDPs_{i,m,y} + \psi_i + \theta_{m,y} + \epsilon_{i,m,y}$$

SARAR + IDPs

$$Conflicts_{i,m,y} = c + \rho W_i Conflicts_{i,m,y} + \alpha TA_{i,m,y} + \beta PA_{i,m,y} + \gamma DL^{TA}_{i,m,y} + \\ + \delta SumIDPs_{i,m,y} + \psi_i + \theta_{m,y} + u_{i,m,y}$$

$$u_{i,m,y} = \lambda W_i u_{i,m,y} + \epsilon_{i,m,y}$$

Results

Table 1:

	n=3				
	treat	sar	sarar	sar+disp	sarar+disp
TA_{lag1}	1.167*	1.288*	1.311*	1.189*	1.209*
	(0.566)	(0.543)	(0.525)	(0.540)	(0.521)
PA_{lag1}	−0.934	−0.991.	−0.993.	−0.993.	−0.992.
	(0.620)	(0.596)	(0.582)	(0.592)	(0.578)
DL_{lag1}	0.0005	0.001	0.001	−0.0006	0.0003
	(0.007)	(0.007)		(0.007)	(0.007)
$SumDisp$				$6.680*10^{-5***}$	$6.662*10^{-5***}$
				$(6.762*10^{-5})$	$(1.367*10^{-5})$
ρ		−0.256**	−0.135	−0.250**	−0.178
		(0.081)	(0.113)	(0.080)	(0.111)
λ			−0.161		−0.164
			(0.114)		(0.114)
F-test	2.2115 .				
AIC	10374.74	7385.33	7385.1	7363.05	7362.73
N	1512	1512	1512	1512	1512

Signif. codes: 0 '***' , 0.001 '**' , 0.01 '*' , 0.05 '.' , 0.1 ' '

Results

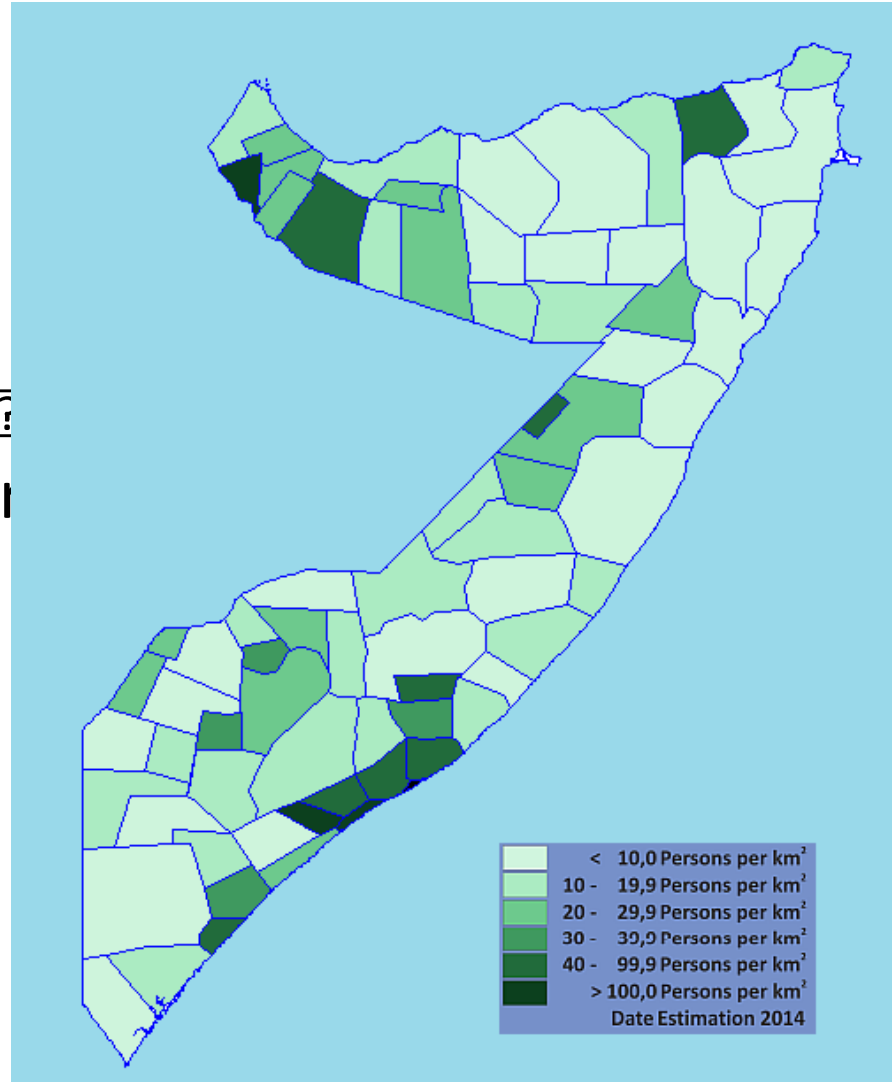
Table 2:

	n=4				
	treat	sar	sarar	sar+disp	sarar+disp
TA_{lag1}	1.598**	1.751**	1.758**	1.641**	1.644**
	(0.610)	(0.585)	(0.562)	(0.582)	(0.558)
PA_{lag1}	−1.419.	−1.419*	−1.473*	−1.546*	−1.520*
	(0.734)	(0.704)	(0.684)	(0.700)	(0.679)
DL_{lag1}	0.012	0.013.	0.014.	0.012	0.013.
	(0.008)	(0.008)	(0.007)	(0.007)	(0.007)
$SumDisp$				$6.586*10^{-5}$***	$6.662*10^{-5}$***
				$(1.364*10^{-5})$	$(1.364*10^{-5})$
ρ		−0.271***	−0.131	−0.265**	−0.127
		(0.081)	(0.113)	(0.081)	(0.111)
λ			−0.187		−0.186
			(0.116)		(0.115)
F-test	4.5332				
AIC	10367.31	7376.69	7375.77	7354.94	7354.03
N	1512	1512	1512	1512	1512

Signif. codes: 0 '***' , 0.001 '**' , 0.01 '*' , 0.05 '.' , 0.1 ' '

Population density

- We incorporated population density as a control variable.
- No statistical significance for this variable the effect of population density is accounted for in the fixed effects
- Absolute number of conflicts as the dependent variable, rather than conflicts per capita.



Absolute number of conflicts

Conflicts pro capite

n = 3

```
> summary(fe)
Twoways effects Within Model

Call:
plm(formula = formlin, data = data1, effect = "twoways", model = "within",
    index = c("admin1", "time"))

Balanced Panel: n = 18, T = 84, N = 1512

Residuals:
     Min.   1st Qu.    Median   3rd Qu.      Max.
-30.72706  -3.62392  -0.46491   2.85535  55.34155

Coefficients:
           Estimate  Std. Error t-value Pr(>|t|)
TA_lag1  1.16678379  0.56559175  2.0629   0.0393 *
PA_lag1 -0.93447184  0.62093104 -1.5050   0.1326
DL_lag1  0.00050379  0.00693800  0.0726   0.9421
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Total Sum of Squares:    74017
Residual Sum of Squares: 73669
R-Squared:      0.0046899
Adj. R-Squared: -0.06812
F-statistic: 2.21151 on 3 and 1408 DF, p-value: 0.084999
```

```
> summary(fe)
Twoways effects Within Model

Call:
plm(formula = formlin, data = data1, effect = "twoways", model = "within",
    index = c("admin1", "time"))

Balanced Panel: n = 18, T = 84, N = 1512

Residuals:
      Min.    1st Qu.     Median    3rd Qu.       Max.
-0.2327731 -0.0399045 -0.0058024  0.0295092  1.0183720

Coefficients:
           Estimate  Std. Error t-value Pr(>|t|)
TA_lag1  0.01896348  0.00615072  3.0831 0.002088 **
PA_lag1 -0.00472218  0.00675253 -0.6993 0.484468
DL_lag1 -0.00012101  0.00007545 -1.6039 0.108969
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Total Sum of Squares:    8.7968
Residual Sum of Squares: 8.7123
R-Squared:      0.0096088
Adj. R-Squared: -0.062842
F-statistic: 4.55347 on 3 and 1408 DF, p-value: 0.0035044
```

n = 4

```
> summary(fe)
Twoways effects Within Model

Call:
plm(formula = formlin, data = data1, effect = "twoways", model = "within",
    index = c("admin1", "time"))

Balanced Panel: n = 18, T = 84, N = 1512

Residuals:
     Min.   1st Qu.    Median   3rd Qu.      Max.
-30.91696  -3.58496  -0.43884   2.80642  55.69164

Coefficients:
          Estimate Std. Error t-value Pr(>|t|)
TA_lag1  1.5984125  0.6098788  2.6209 0.008865 **
PA_lag1 -1.4191201  0.7341196 -1.9331 0.053425 .
DL_lag1  0.0121532  0.0078244  1.5532 0.120590
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Total Sum of Squares:    74017
Residual Sum of Squares: 73308
R-Squared:      0.0095665
Adj. R-Squared: -0.062887
F-statistic: 4.53324 on 3 and 1408 DF, p-value: 0.0036043
```

```
> summary(fe)
Twoways effects Within Model

Call:
plm(formula = formlin, data = data1, effect = "twoways", model = "within",
    index = c("admin1", "time"))

Balanced Panel: n = 18, T = 84, N = 1512

Residuals:
      Min.    1st Qu.     Median    3rd Qu.       Max.
-0.2306254 -0.0394451 -0.0050717  0.0284543  1.0212490

Coefficients:
           Estimate  Std. Error t-value  Pr(>|t|)
TA_lag1  2.6648e-02  6.6393e-03  4.0136 6.294e-05 ***
PA_lag1 -6.7706e-03  7.9918e-03 -0.8472    0.3970
DL_lag1  4.8184e-05  8.5178e-05  0.5657    0.5717
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Total Sum of Squares:    8.7968
Residual Sum of Squares: 8.6877
R-Squared:      0.012401
Adj. R-Squared: -0.059846
F-statistic: 5.89314 on 3 and 1408 DF, p-value: 0.00053801
```