Windows of Peace

The Effect of Ceasefires on Economic Well-being

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War and peace

- **Cost of conflict is huge**: life losses, military spending, and long-lasting consequences of destruction [Stiglitz and Bilmes, 2012; de Groot et al, 2022]
  - Much of the literature focuses on **causes and consequences of conflicts** [Blattman and Miguel, 2010; Rohner and Thoenig, 2021]
- The **consequences of transitioning into peace** have been rarely studied in the economic literature
  - Path to peace is very different from the path to conflict [Collier et al., 2008]
  - Recent literature on civilian cooperation [Berman et al., 2018], military disengagement [Fetzer et al., 2021], and demobilization [Armand et al., 2020]
- The **identification problem**: confounding factors drive the endogeneity of the presence of peace deals with respect to economic well-being
  - Evidence on **causal effects of peace** on economic development remains scarce

Pacification and economic well-being

Address causality by focusing on ceasefires

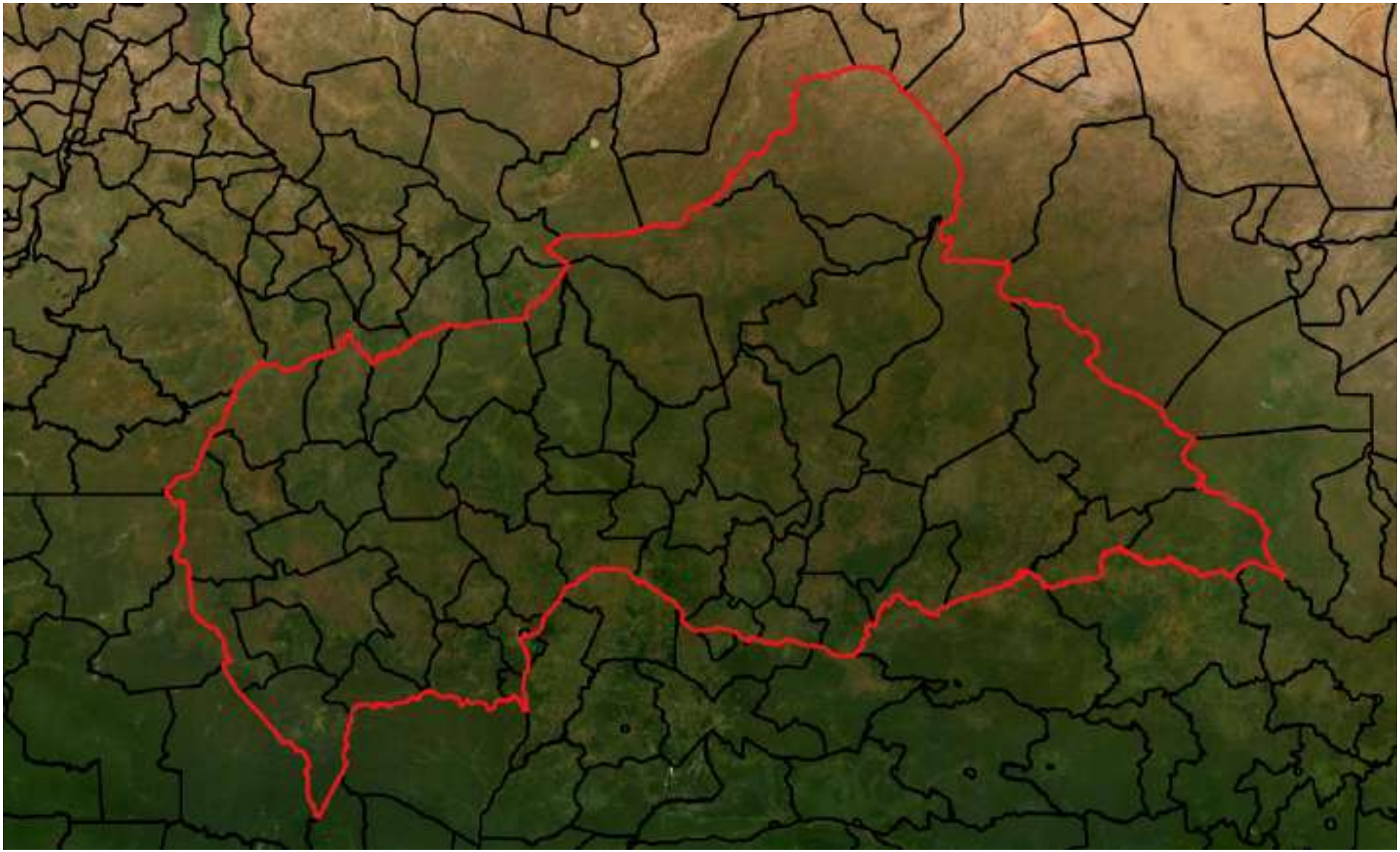
- Exploit ceasefires to study (temporal) discontinuities in conflict
- Match the universe of ceasefires since 1990 with temporally- and geographically-granular data on conflict and on satellite-based nightlight luminosity
  1. **Temporal and spatial variation in ceasefires** $\Rightarrow$ identify the causal effect of ceasefires on violence and on economic well-being
  2. **Heterogeneity in ceasefires** $\Rightarrow$ study the asymmetric effect of pacification vs conflict

Why ceasefires?

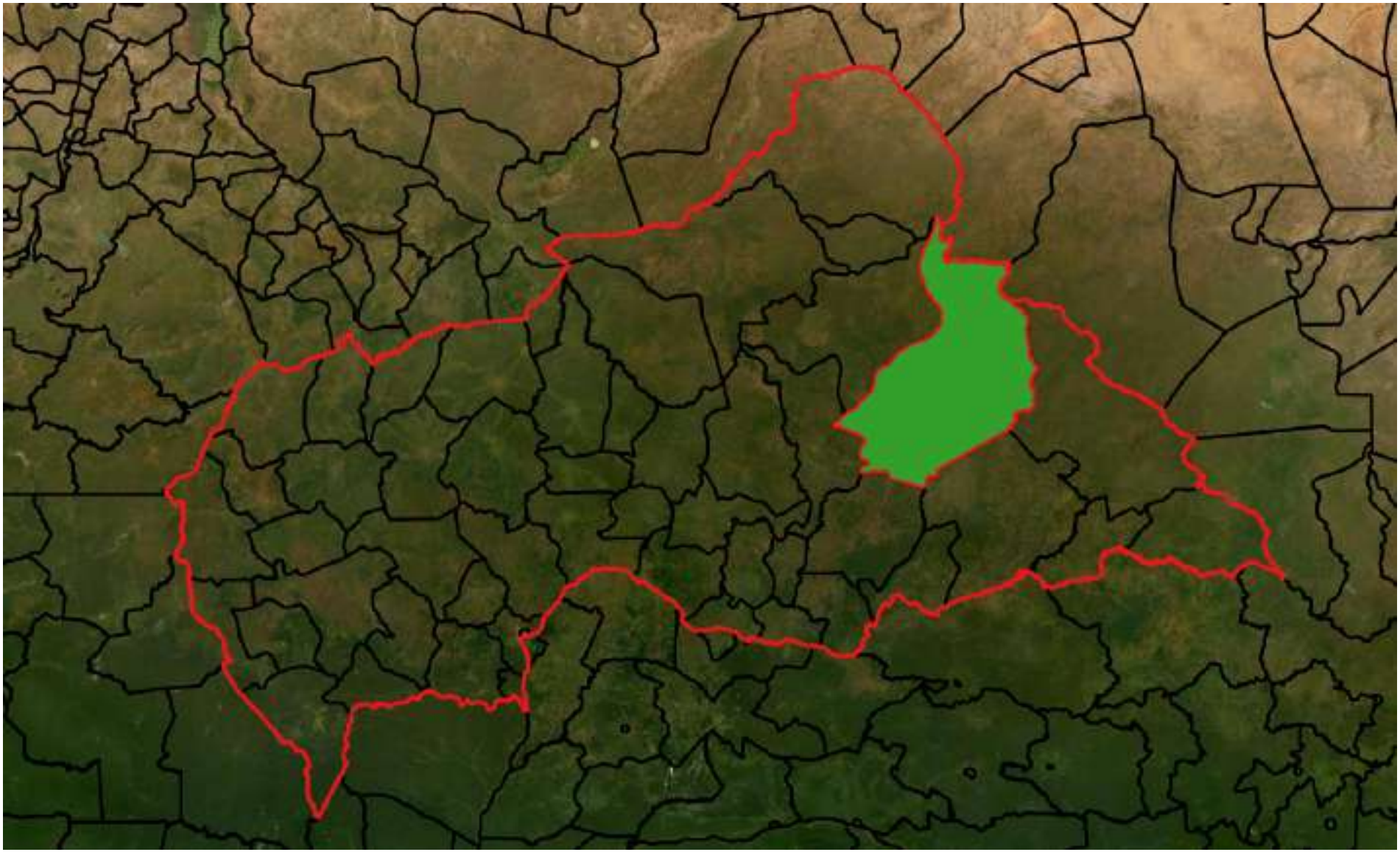
Agreements in which each fighting side agrees with the other to suspend aggressive actions

- Existed at least by the time of the Middle Ages ("truce of God")
- More limited than a broader armistice
- **Two-fold use**:
  1. Humanitarian gesture, prior to a political agreement, or with the intention of resolving a conflict
  2. Abused by parties as cover to re-arm or reposition forces (*failed ceasefires*)
- Major factor for the success of peace agreements [Berman et al., 2011]
- Opportunity for **identification using time-space variation**

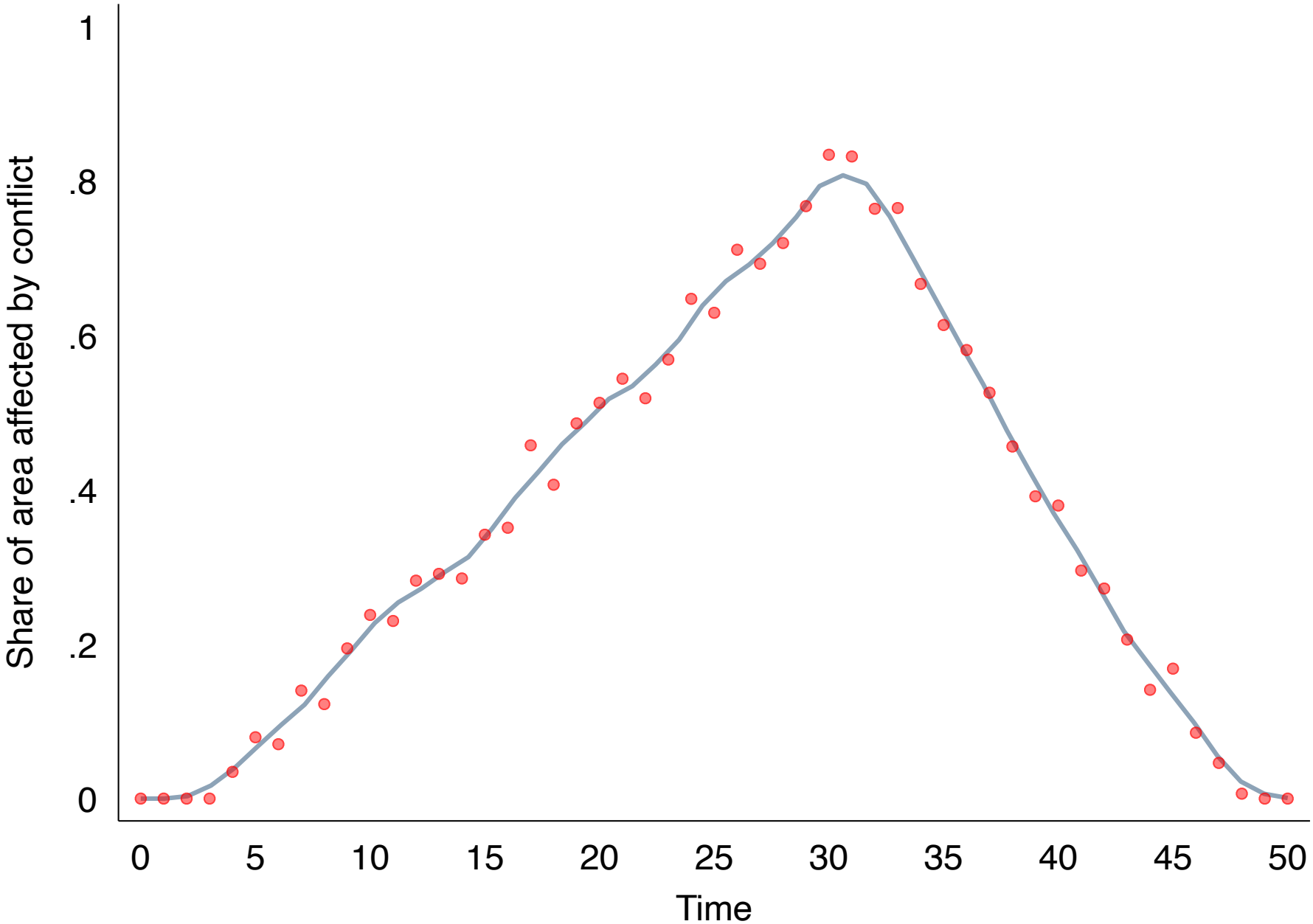
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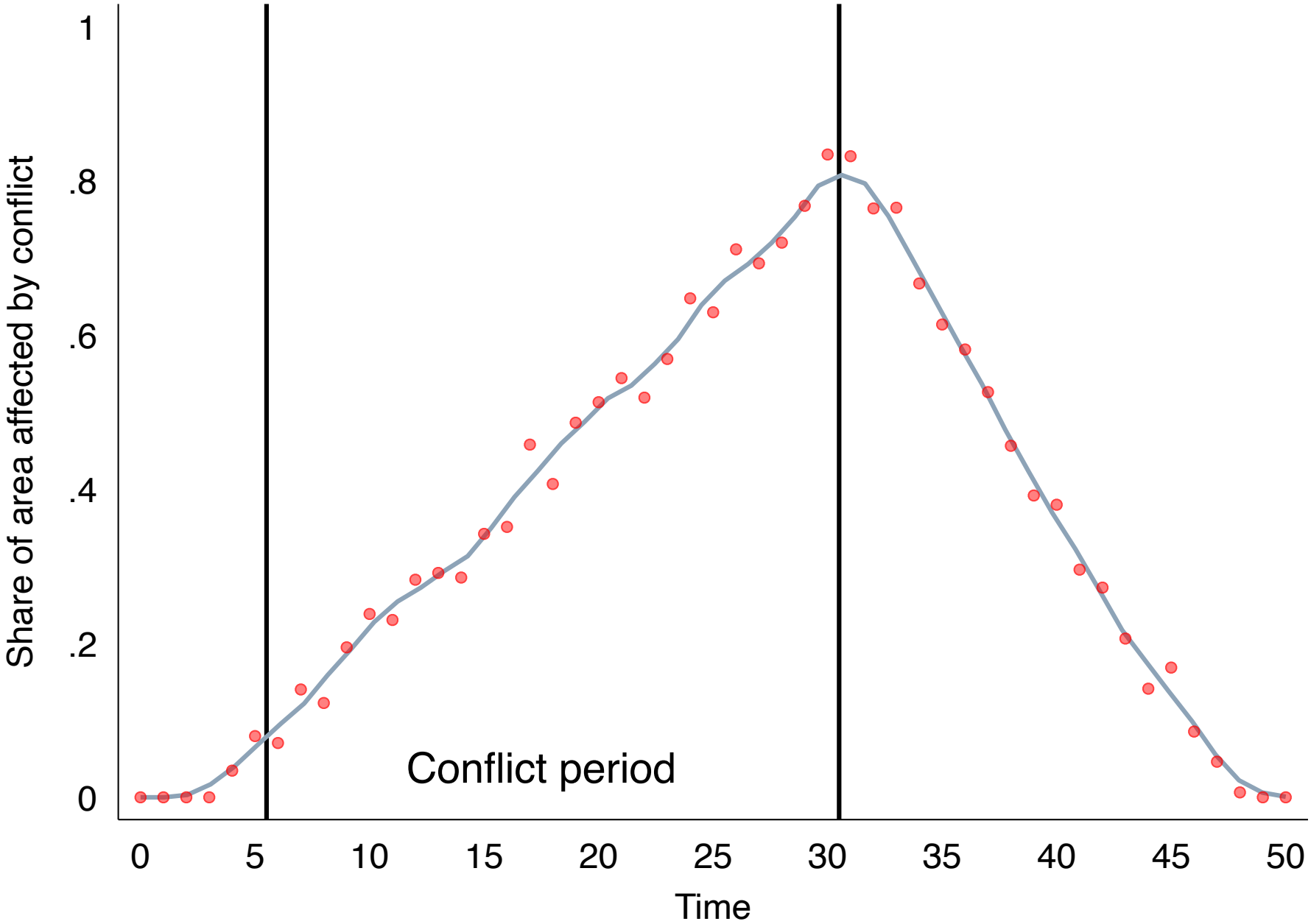
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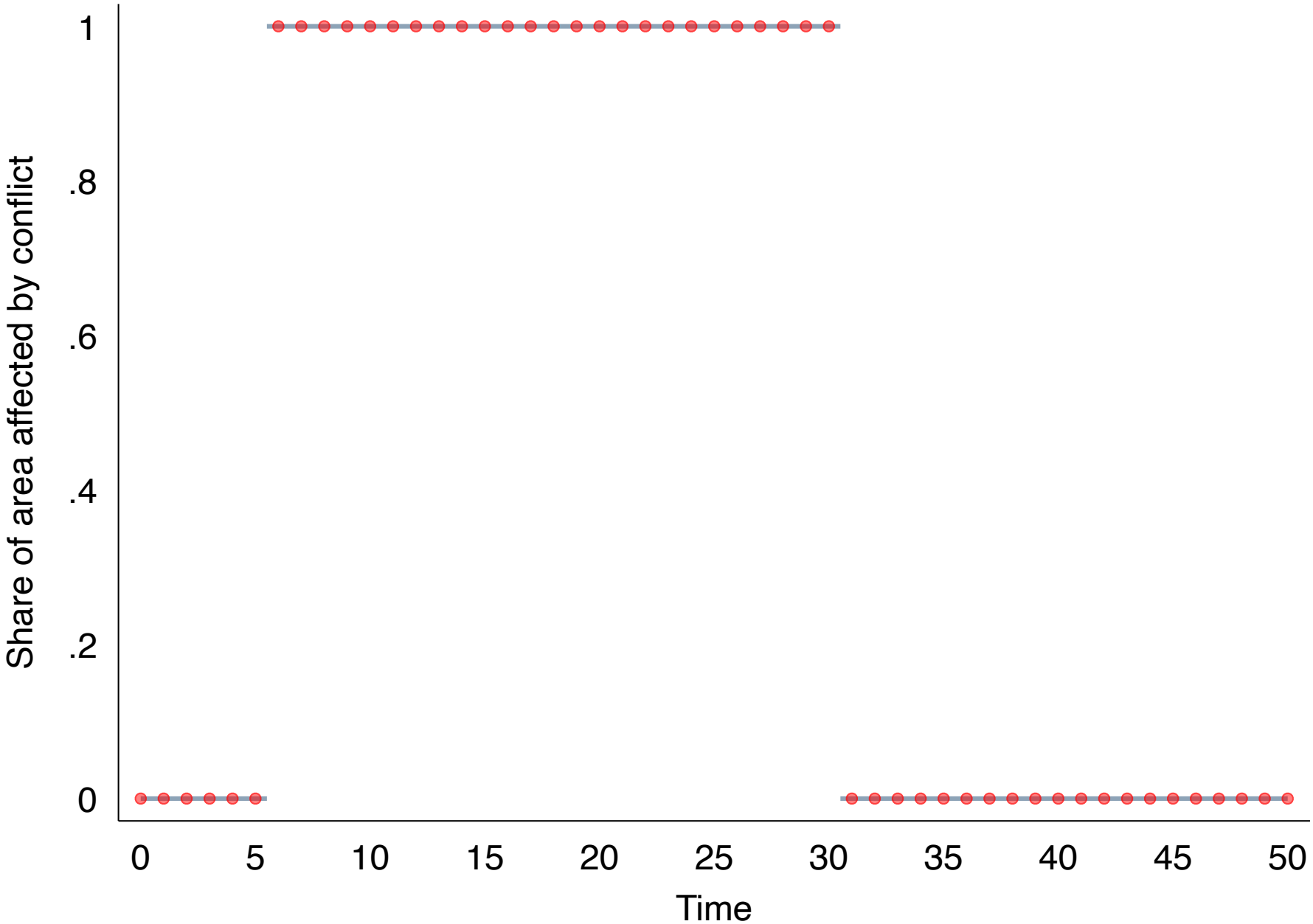
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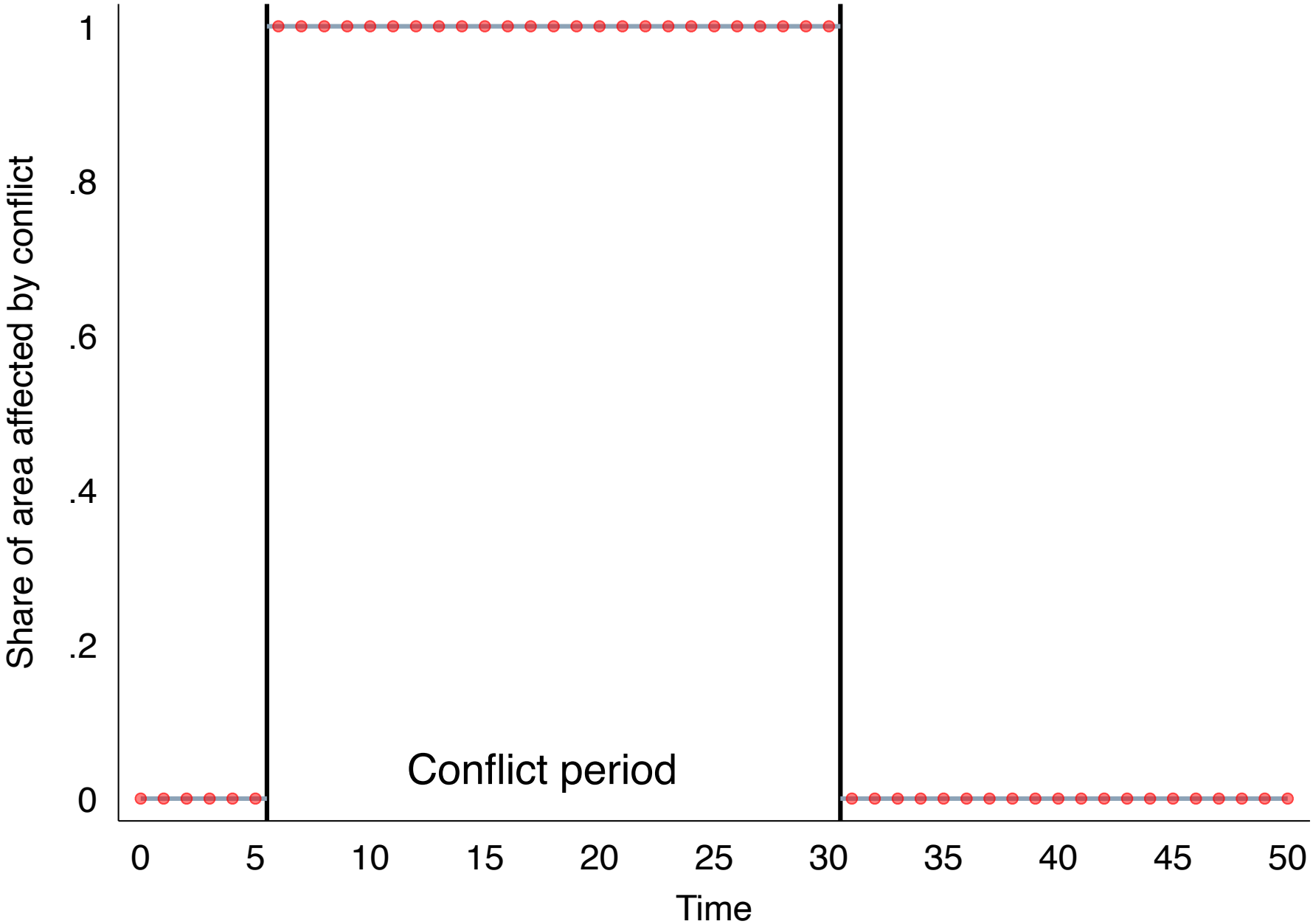
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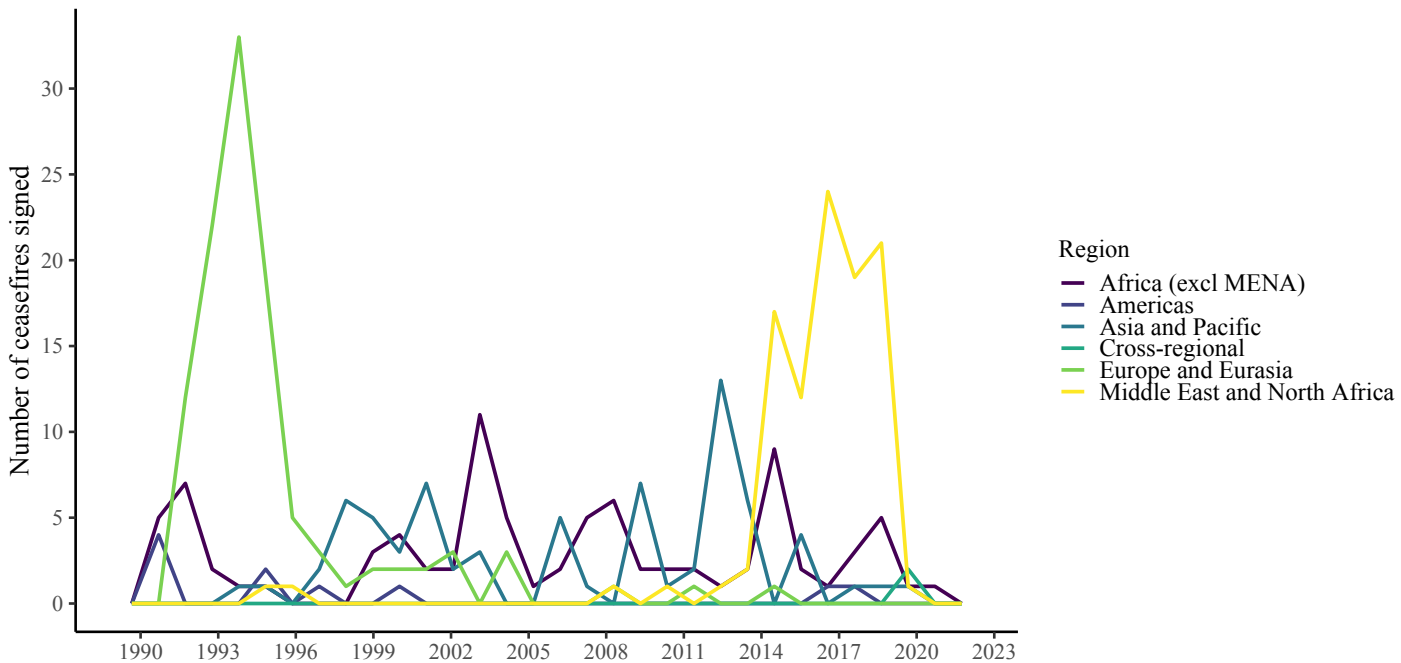


Why ceasefires?



Data about ceasefires

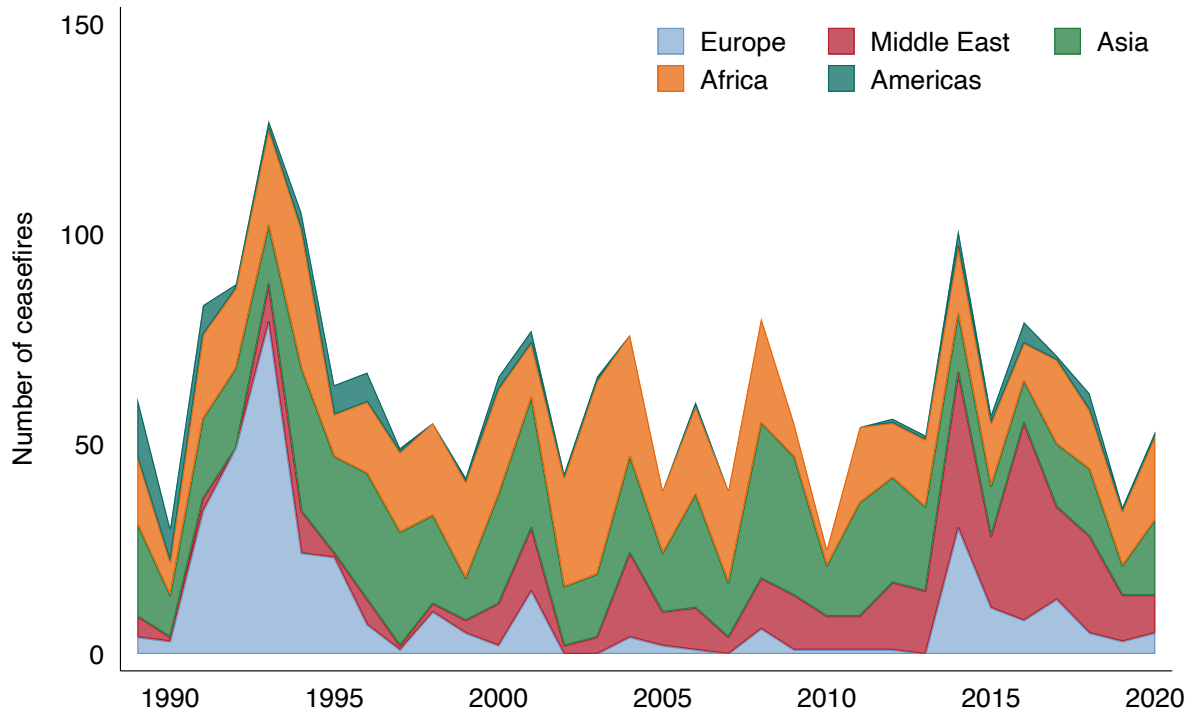
- **Peace Agreement Database (PAX)**: information on **peace agreements** globally since 1990
  - *"Formal, publicly-available documents, produced after discussion with conflict protagonists and mutually agreed to by some or all of them, addressing conflict with a view to ending it"*
- **374 ceasefire agreements**: majority is state vs. non-state actor (67%)



▸ Descriptives

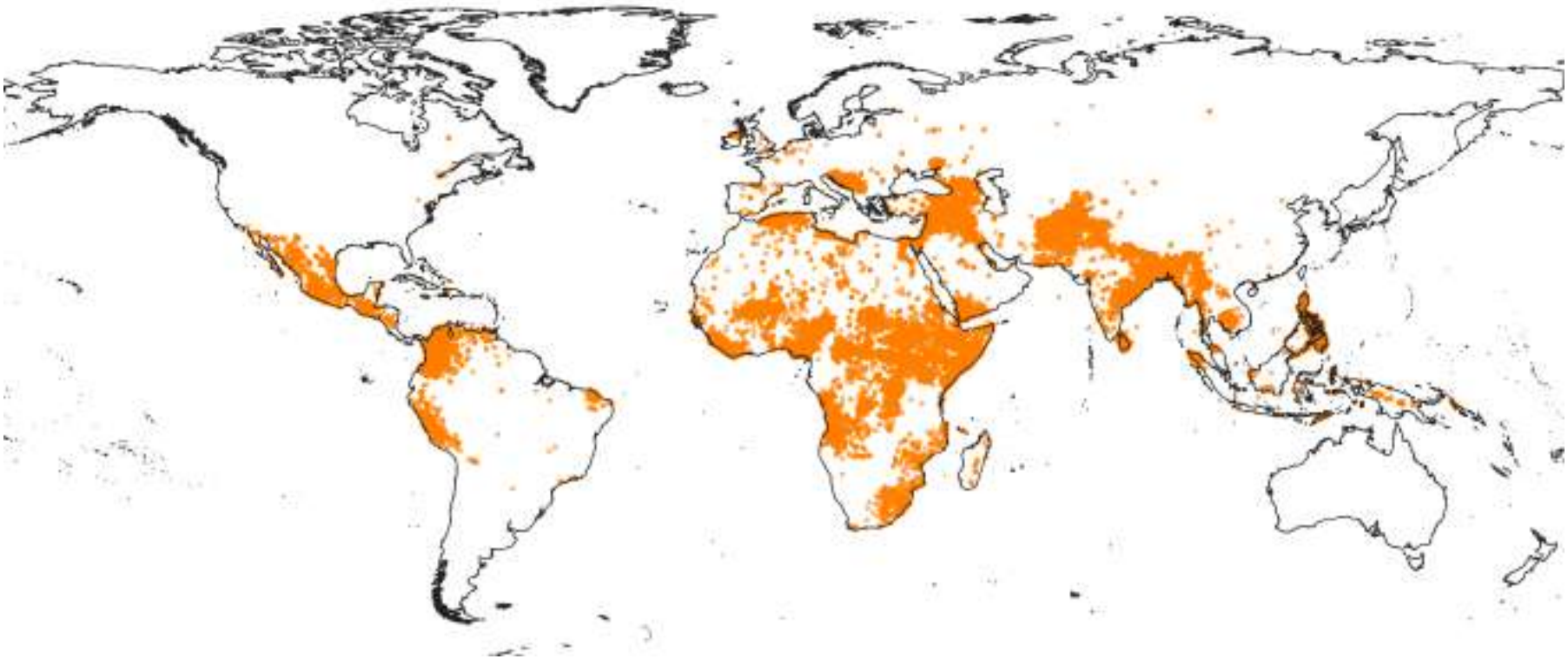
Data about ceasefires

- **ETH/PRIO Civil Conflict Ceasefire Dataset**: **2,202 ceasefires** across 66 countries and 109 civil conflicts from 1989 to 2020 [Clayton et al., 2022]
- Definition:
  1. **Declaration (written or verbal)** in which at least one actor commits to stopping violence
  2. An **exact point in time** is specified
  3. Includes a **commitment to stop violent activity** ($\neq$ "de-escalation measures")



Combine with violence data

- **Uppsala Conflict Data Program (UCDP)**: dates and geo-coded locations of violent events from 1989–today
- **Event** = incident characterized by **armed force by an organized actor** against another organized actor, or against civilians, resulting in **at least 1 direct death**



▸ Descriptives

Economic well-being: satellite-based nightlight luminosity

- Proxy for economic productivity, growth and human development [Henderson et al., 2012; Bruederle and Hodler, 2018]
- **Light Every Night (LEN) project**
  - Daily nightlight luminosity (no light at 0 – full light at 63)
  - Spatial resolution $\approx$ 4.9 km at the equator for the period 1992–2017
  - VIS processed imagery band: non-human light emissions are removed and non-light values are set to zero
  - The entire time series is based on DMSP-OLS sensor technology
- Average nightlight luminosity within each grid cell Distribution

Defining areas affected by ceasefires

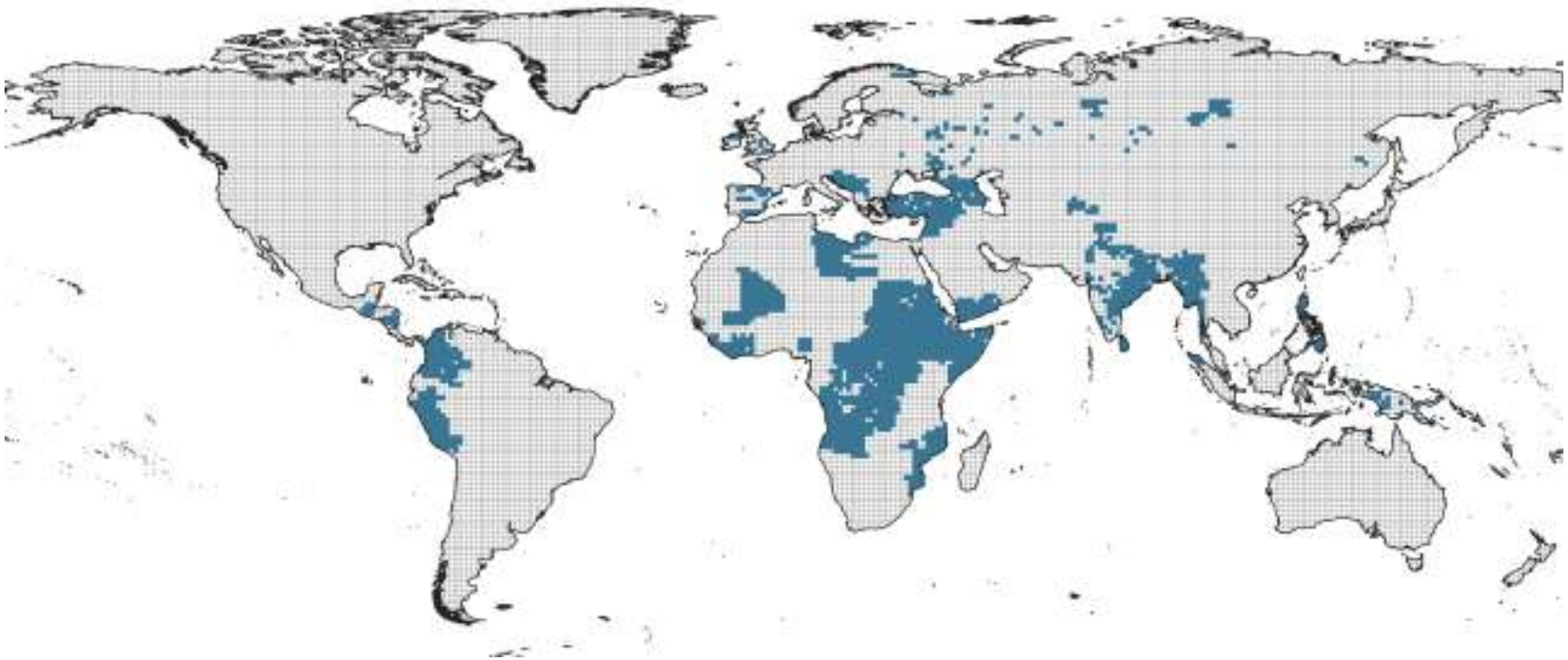
- Lack of a **specific geographical area**
  1. **Global grid** at the $1^\circ \times 1^\circ$ resolution (unit of analysis)
  2. Match signatories of a ceasefire with actors in the UCDP dataset
  3. Select one cell if at least one of the signatory has been active by perpetrating or participating in violence
  4. Drop cells if no activity before the ceasefire ▸ Ex: Mali ▸ Ex: Yemen

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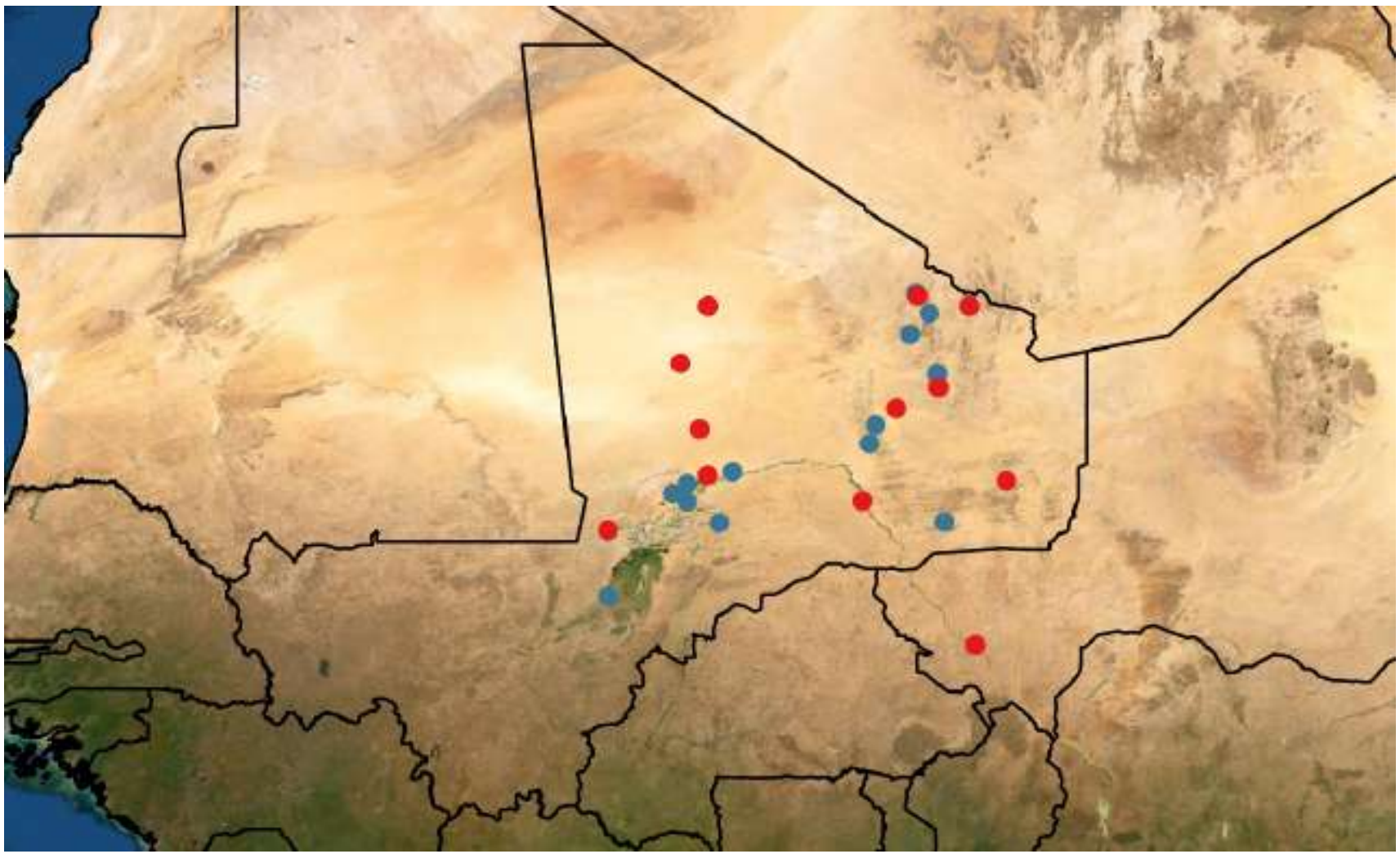
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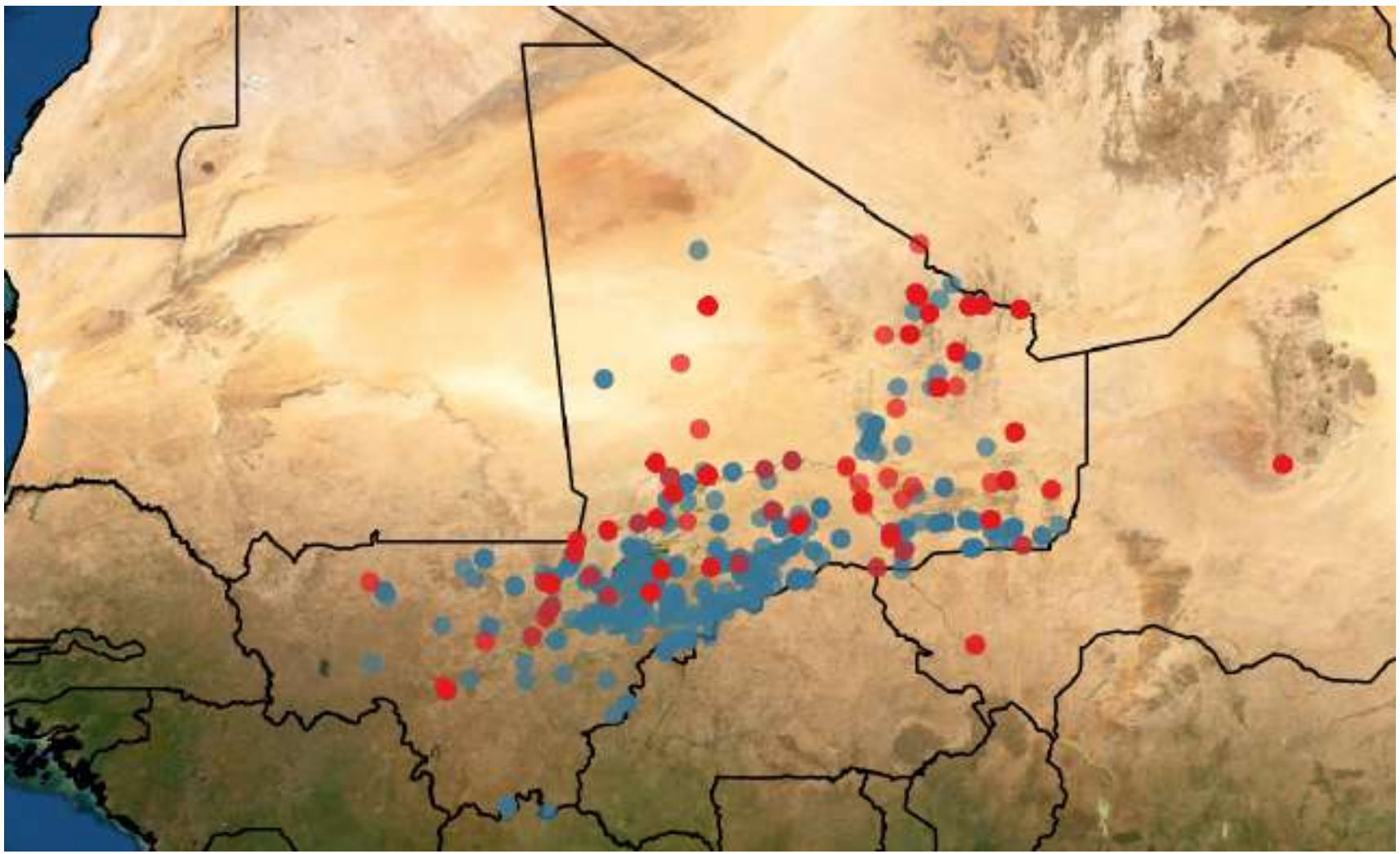
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Between Government of Mali and Coordination of Azawad Movements (CMA)



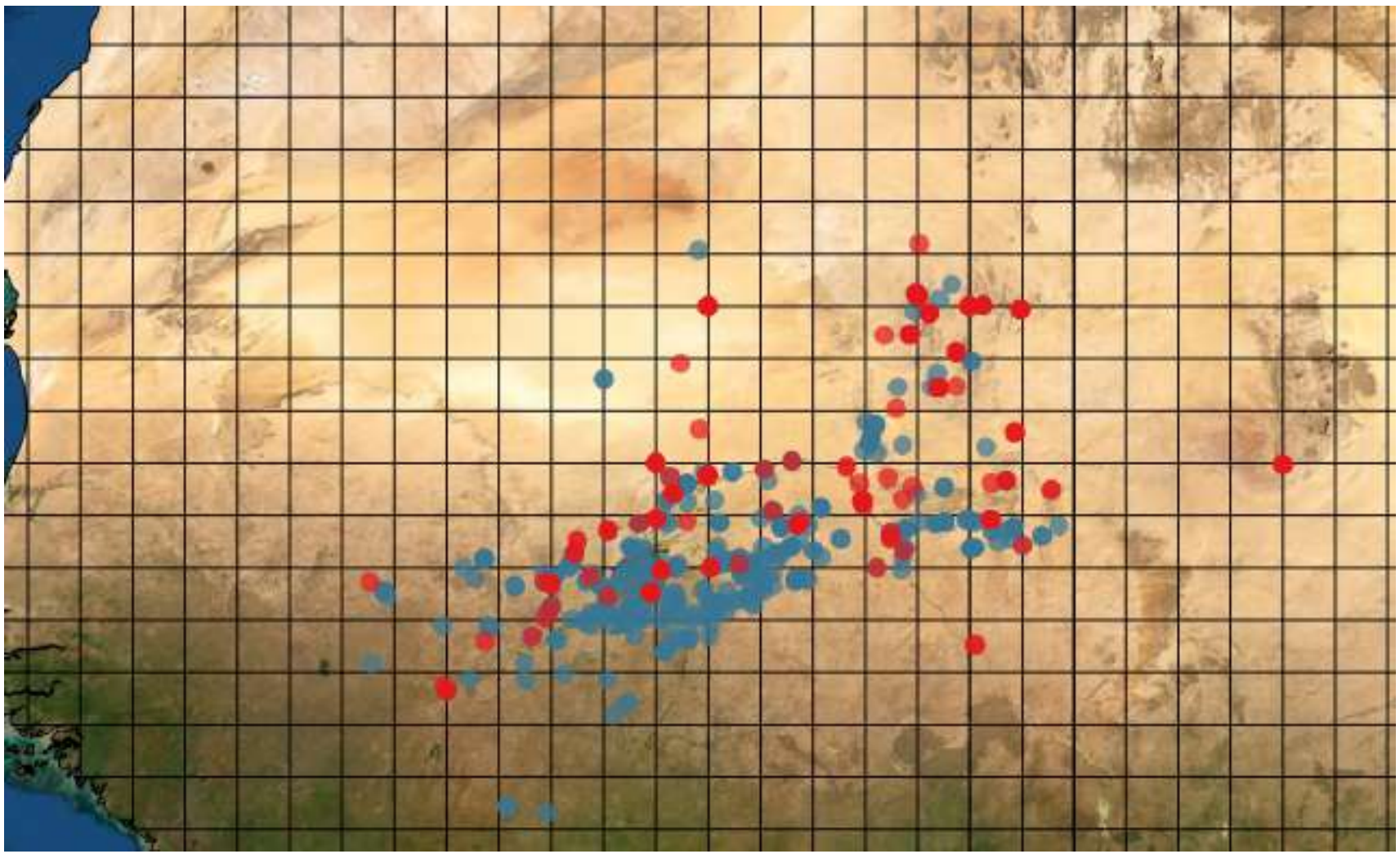
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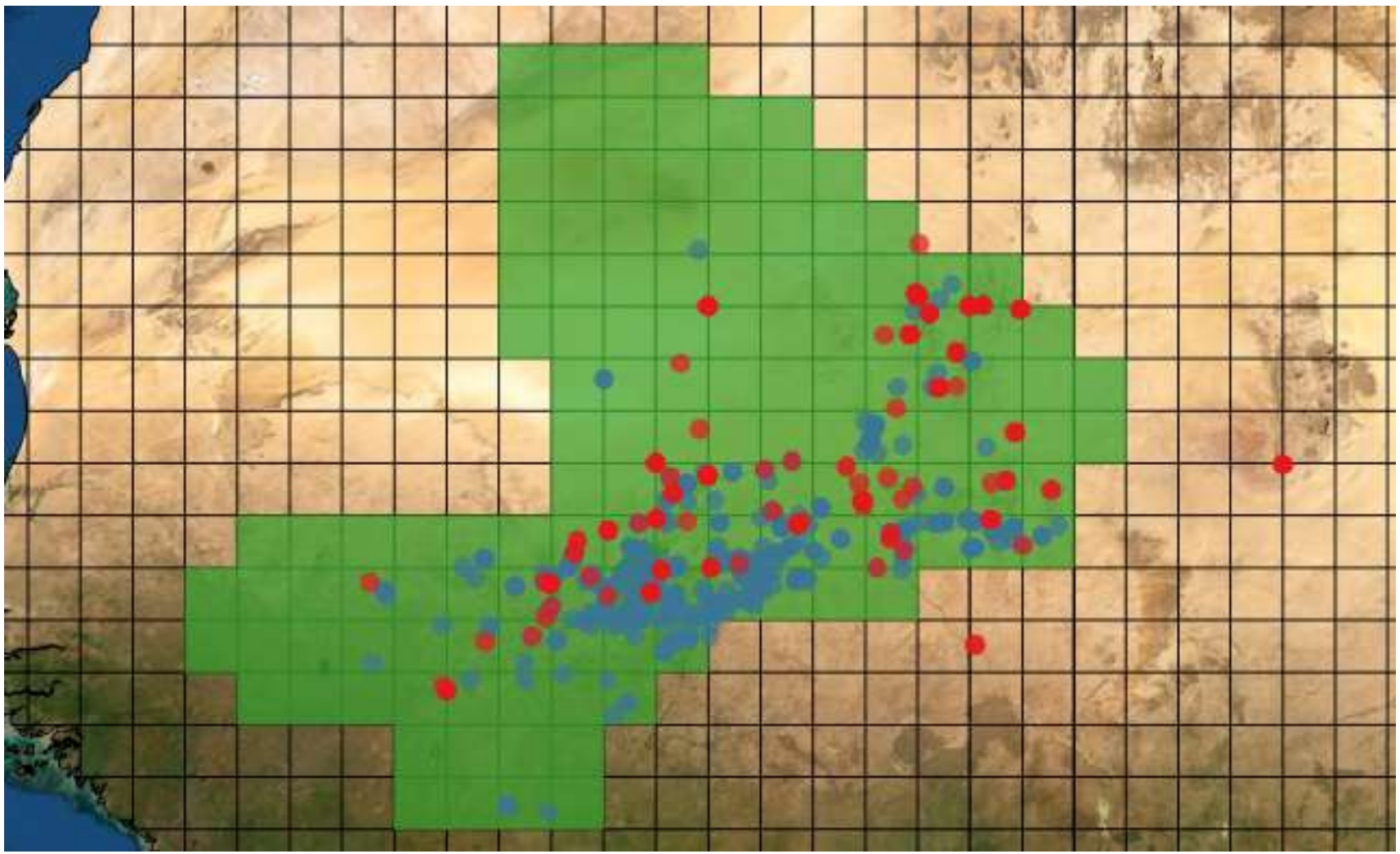
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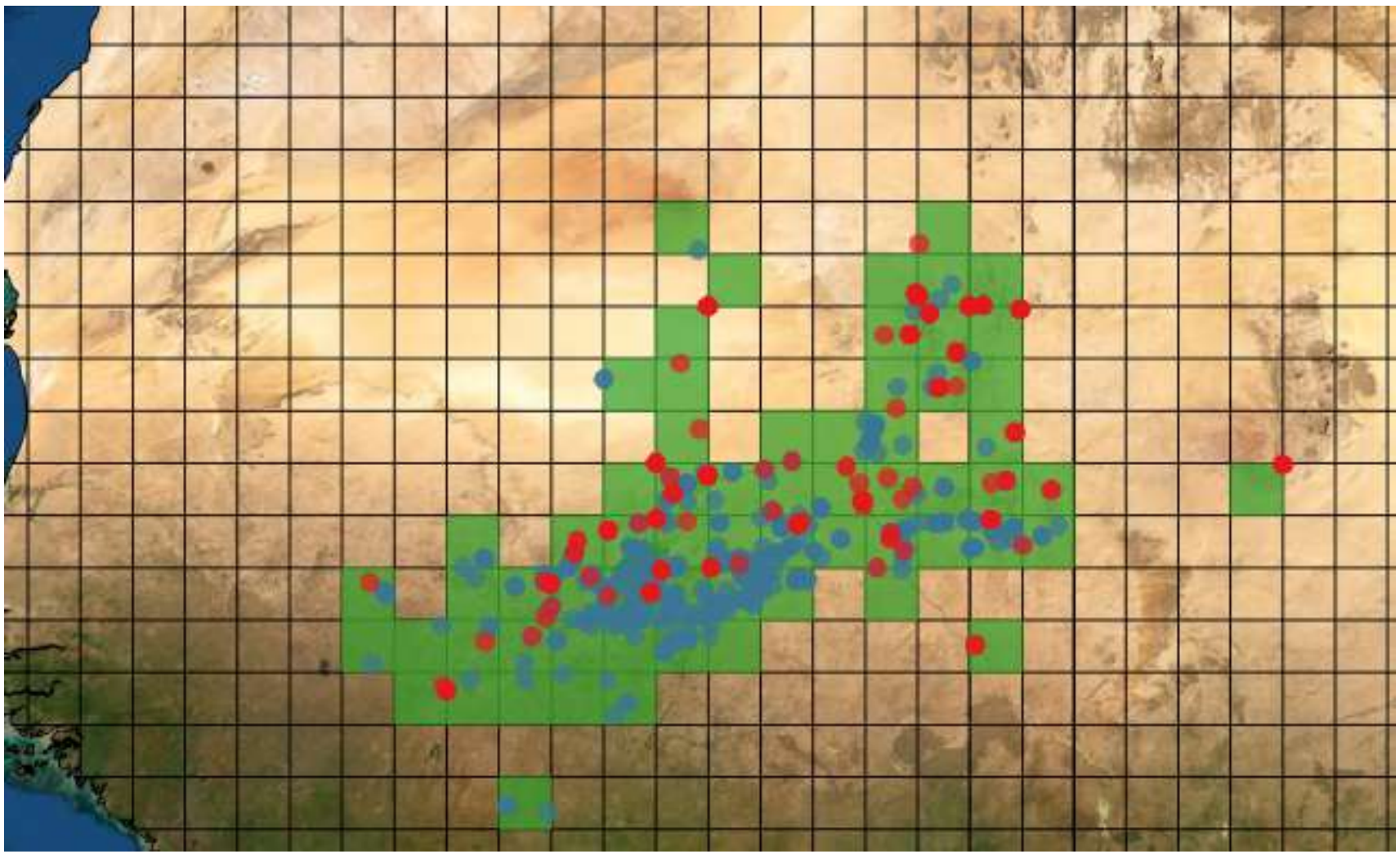
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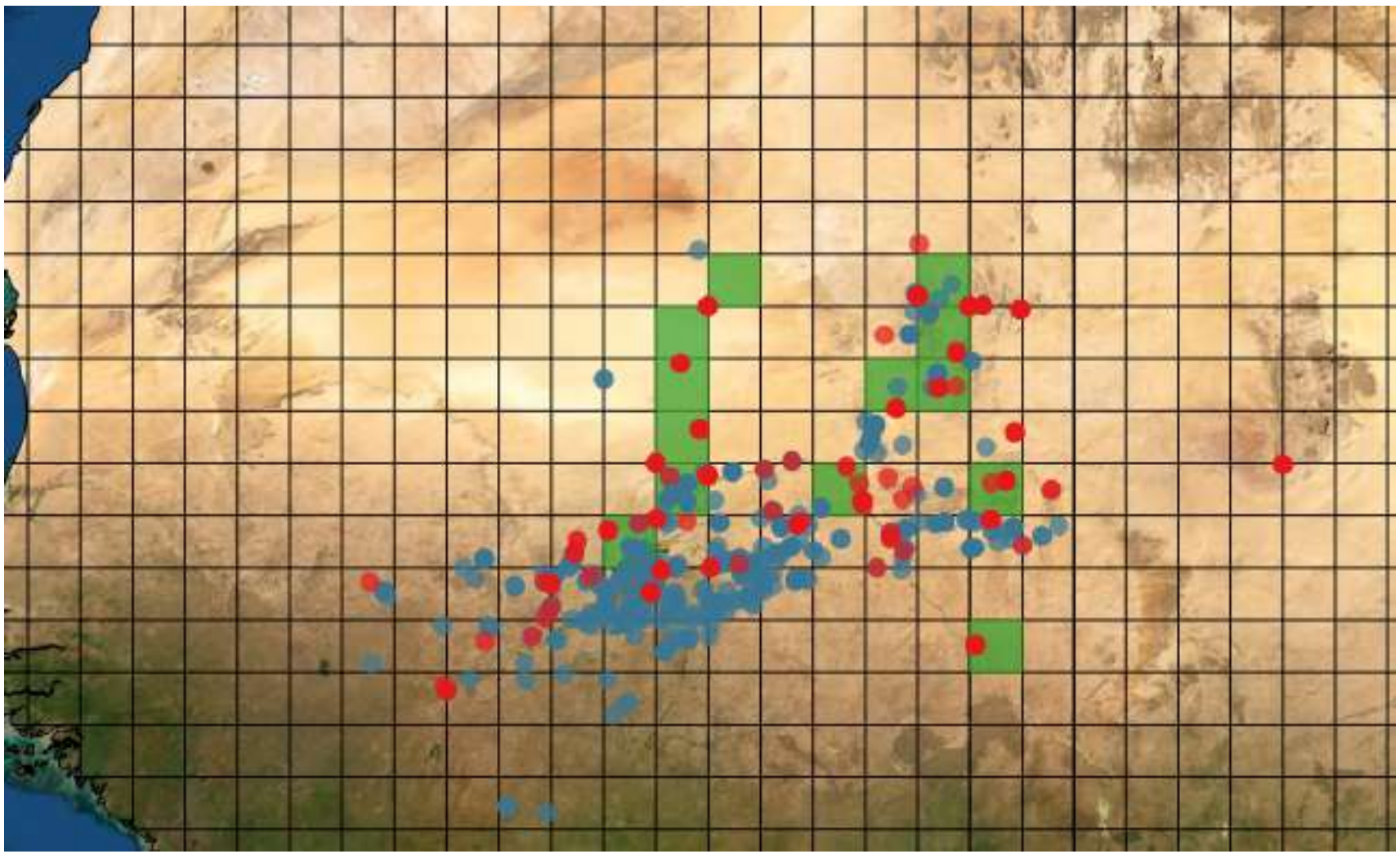
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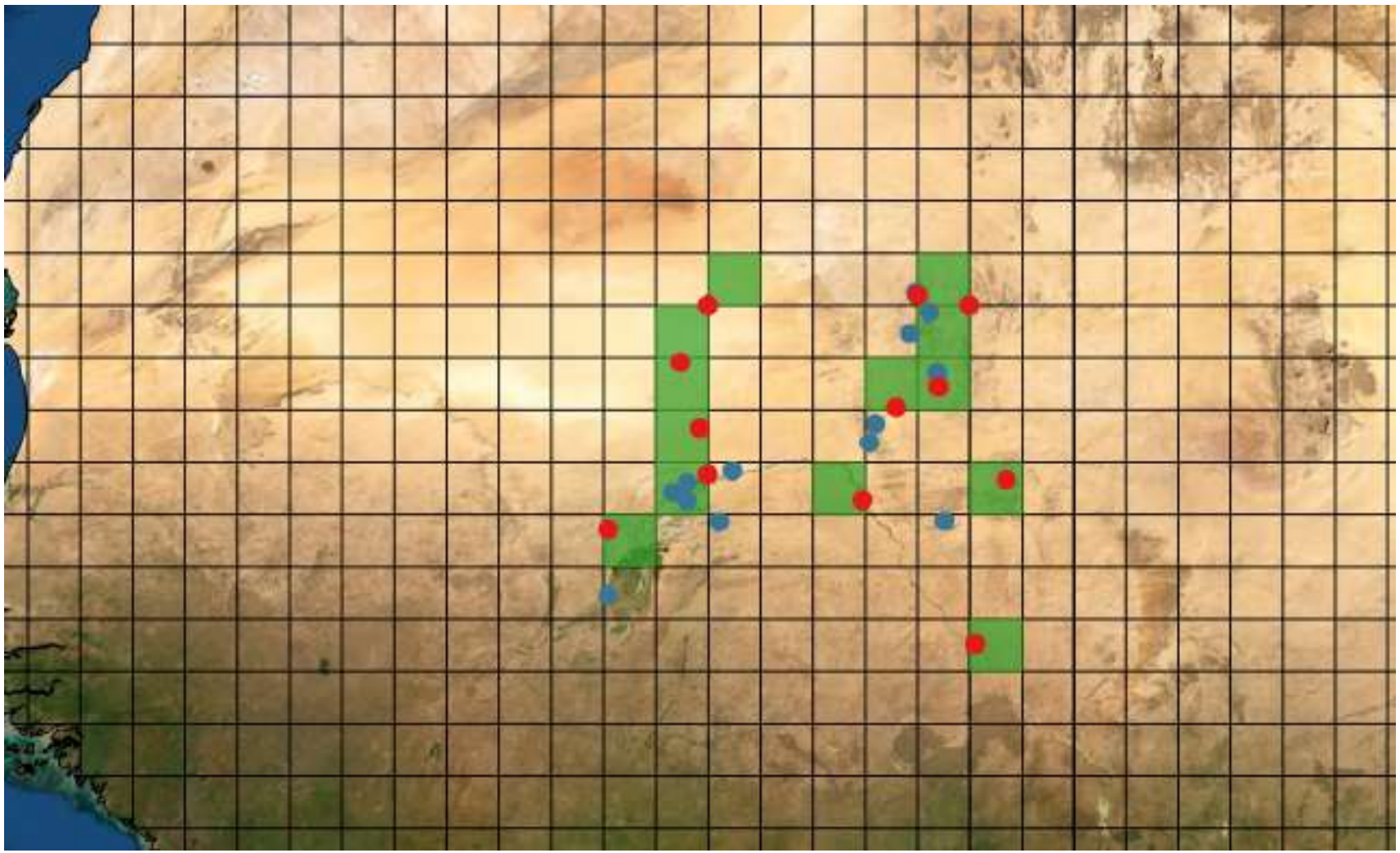
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Effect of ceasefires on economic well-being

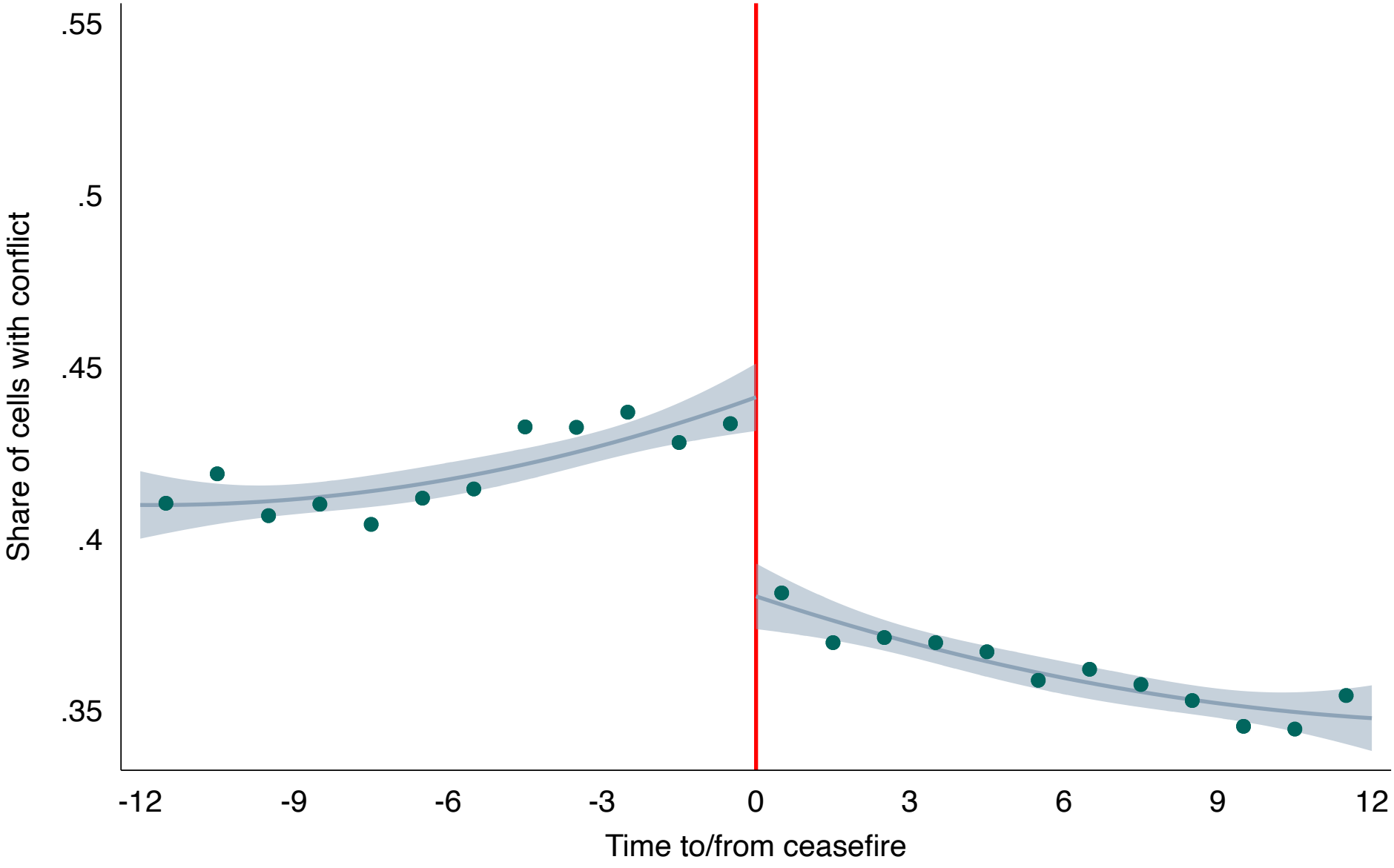
Fuzzy regression discontinuity in time

- Exploit the **temporal discontinuity at the time of the ceasefire ($t = 0$)**
  - Time is ceasefire-dependent – months of 30 days each on both sides:
  - at all months $t > 0$, the grid cell is treated
  - at all months $t < 0$, the grid cell is not treated
- **Fuzzy**: exploit the discontinuous reduction in conflict to estimate the impact on nightlight luminosity:

$$y_{ic,t} = \alpha + \beta\, c_{ic,t} + f(date_{ic,t}) + \epsilon_{ic,t} \tag{1}$$

where $c_{ic,t}$ is a dummy for the presence of conflict in cell i for ceasefire c at time t, instrumented by the post-ceasefire indicator

First stage: ceasefires and violence



▸ Estimates with ETH-PRIO ▸ Estimates with daily data

First stage: ceasefires and violence

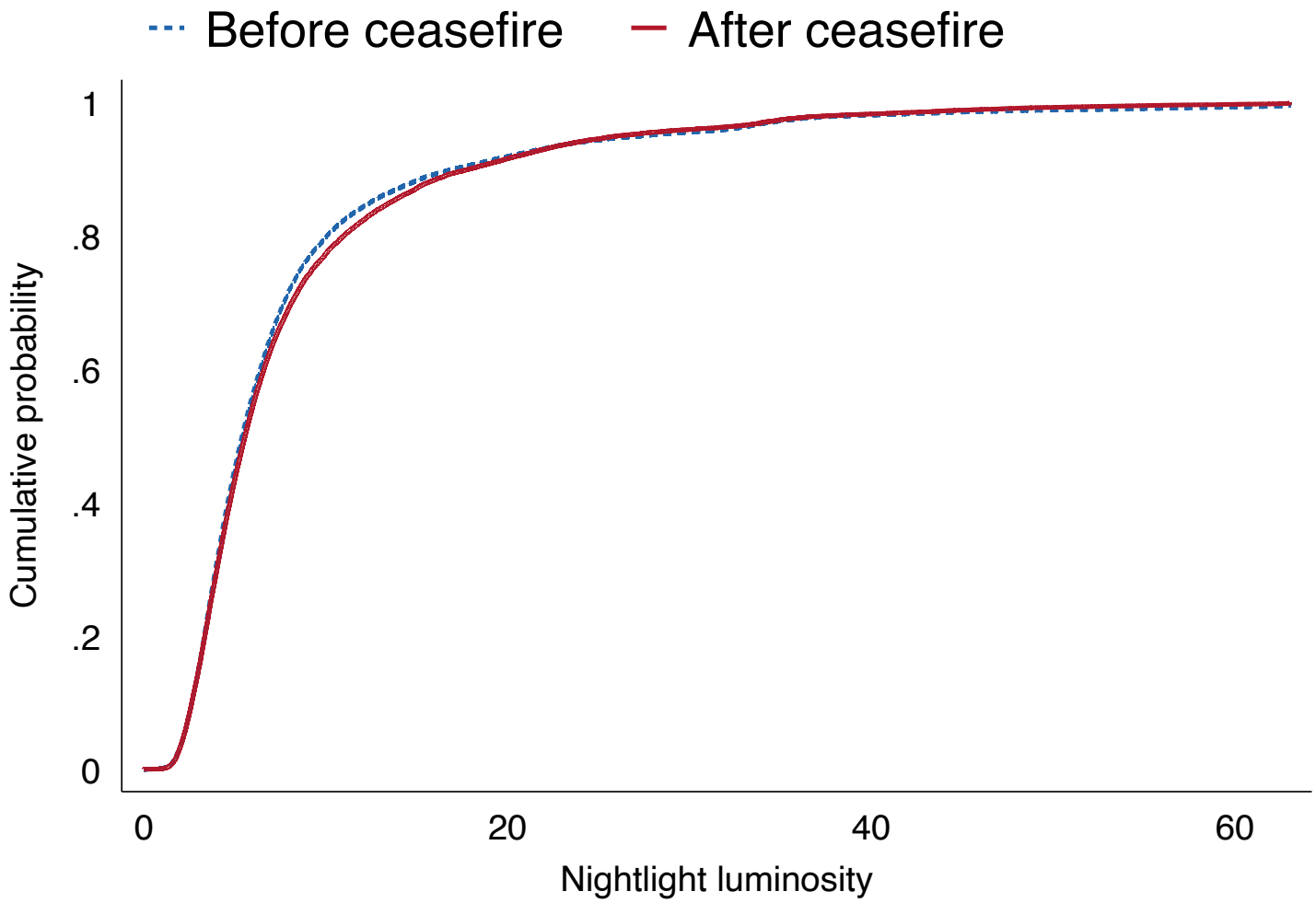
- Ceasefires ↓ violence by 5 ppts
- Robust to alternative specifications

Dependent variable:	Any violent event				
	(1)	(2)	(3)	(4)	(5)
Effect at ceasefire	-0.056	-0.056	-0.056	-0.051	-0.051
	(0.006)	(0.006)	(0.006)	(0.021)	(0.021)
	[0.000]	[0.000]	[0.000]	[0.013]	[0.013]
Mean (pre-ceasefire)	0.420	0.420	0.420	0.429	0.429
Kernel type	-	-	-	Triangular	Triangular
Bandwidth type	-	-	-	mserd	msetwo
Bandwidth (below)	12.000	12.000	12.000	6.070	6.366
Bandwidth (above)	12.000	12.000	12.000	6.070	6.330
Observations	179304	179304	179304	179304	179304

Note. **Violence is based on UCDP data. In columns (4) and (5), estimates are based on local polynomial RD point estimators with robust bias-corrected confidence intervals and inference procedures developed in Calonico, Cattaneo and Farrell (2020). Standard errors (in parentheses) are clustered at the month-ceasefire level. P-values are presented in brackets. The spatial unit of observation is the grid cell at the $1^\circ \times 1^\circ$ resolution. The temporal unit is the month (in 30 days) following the day of the ceasefire.**

Effect on nighlight luminosity

- Kolmogorov-Smirnov test for equality of distribution functions is rejected at p-val < 0.001



Effect on nightlight luminosity

The discontinuity in conflict leads to **increases in nightlight luminosity** $\Rightarrow$ 2% per 1 ppt decrease in conflict

Dependent variable:	**Average nightlight luminosity (log)**			
	(1)	(2)	(3)	(4)
Effect at ceasefire (1 ppt)	0.024	0.021	0.024	0.020
	(0.010)	(0.007)	(0.010)	(0.007)
	[0.019]	[0.004]	[0.019]	[0.004]
Mean (pre-ceasefire)	1.801	1.801	1.801	1.801
Kernel type	Triangular	Triangular	Epanechnikov	Epanechnikov
Bandwidth type	mserd	msetwo	mserd	msetwo
Bandwidth (below)	2.441	1.981	2.336	1.848
Bandwidth (above)	2.441	3.839	2.336	3.730
Observations	145216	145216	145216	145216

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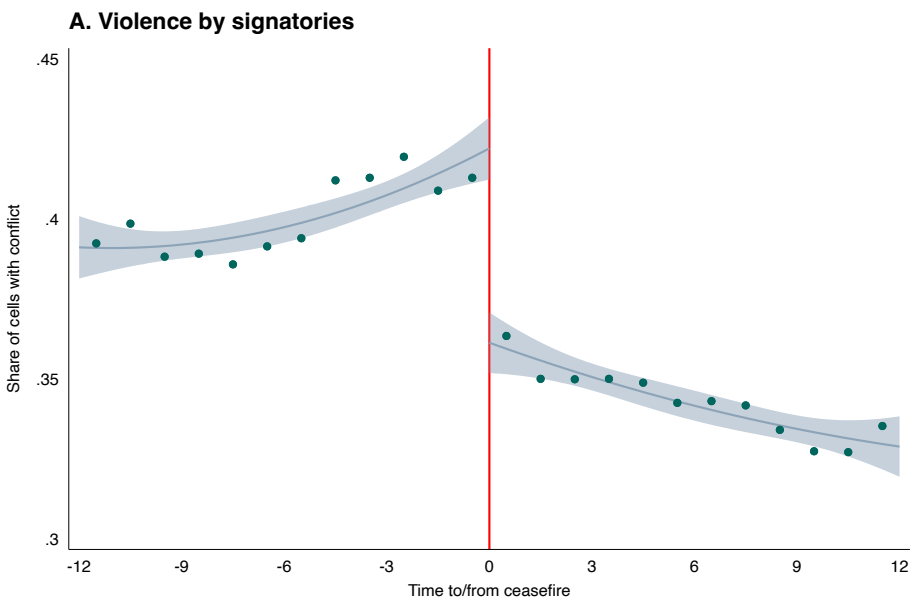
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2. The role of confounders
3. External intervention
4. Conflict relocation
5. Path to peace vs path to conflict

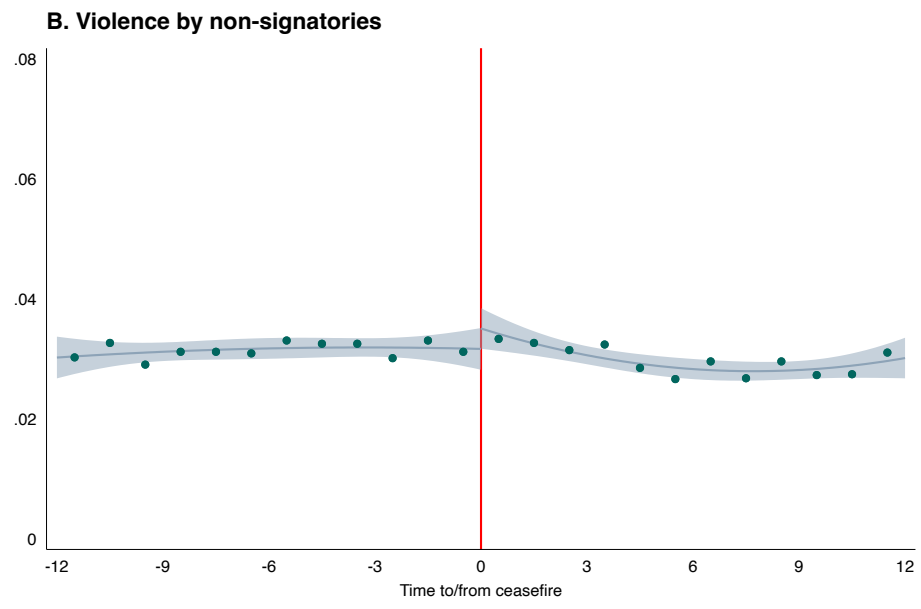
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Ceasefires and reductions in conflict

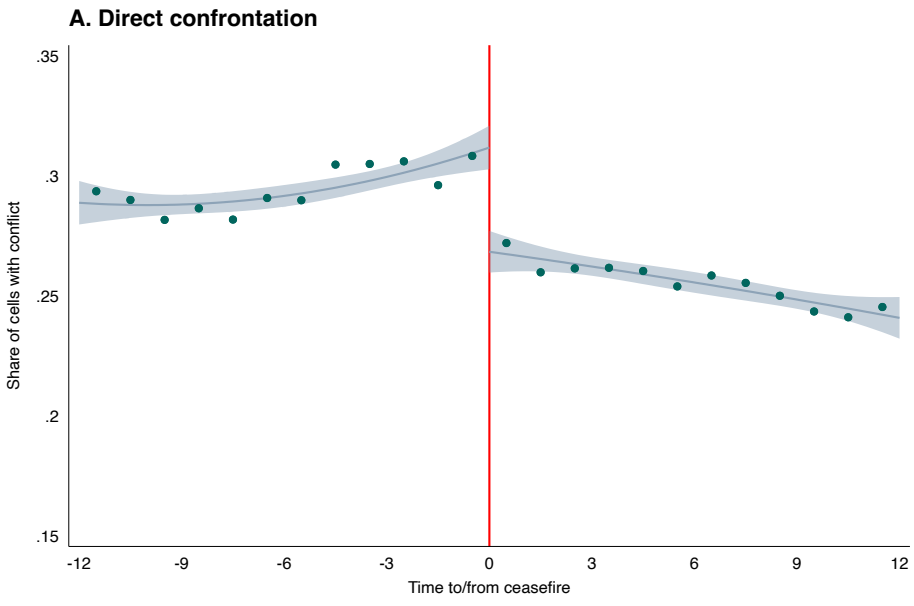
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2. Both **direct confrontations and unilateral violence** are reduced
3. Effectiveness is driven by **state-based conflict**

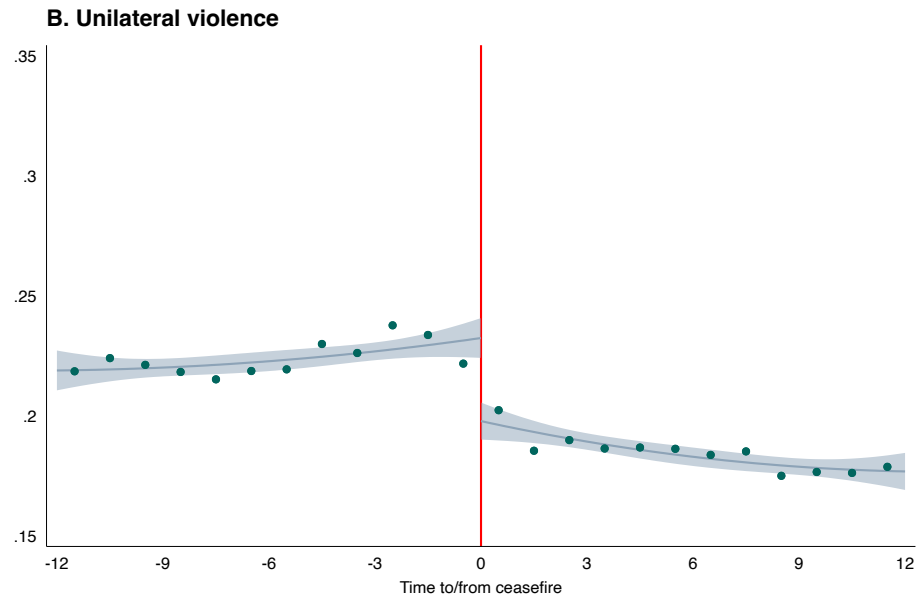




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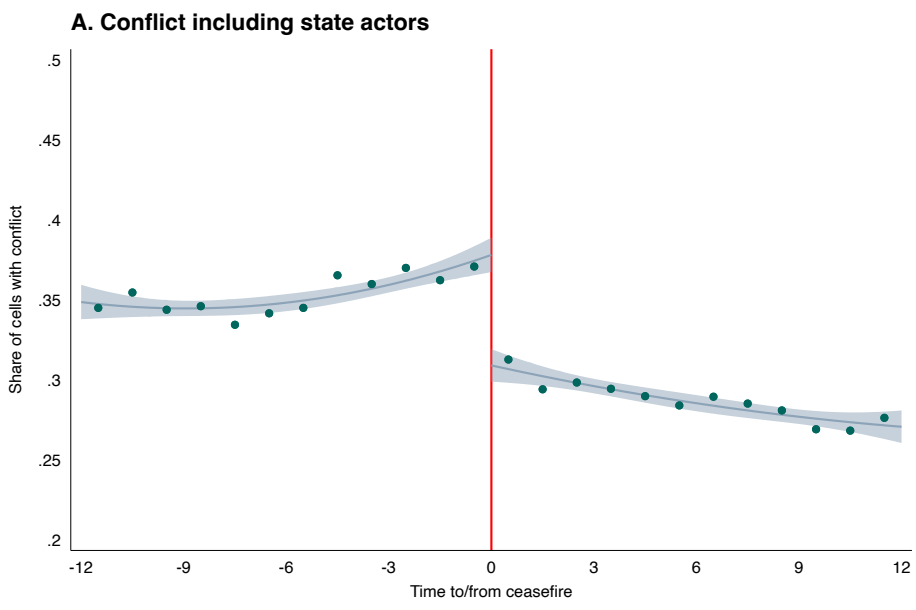
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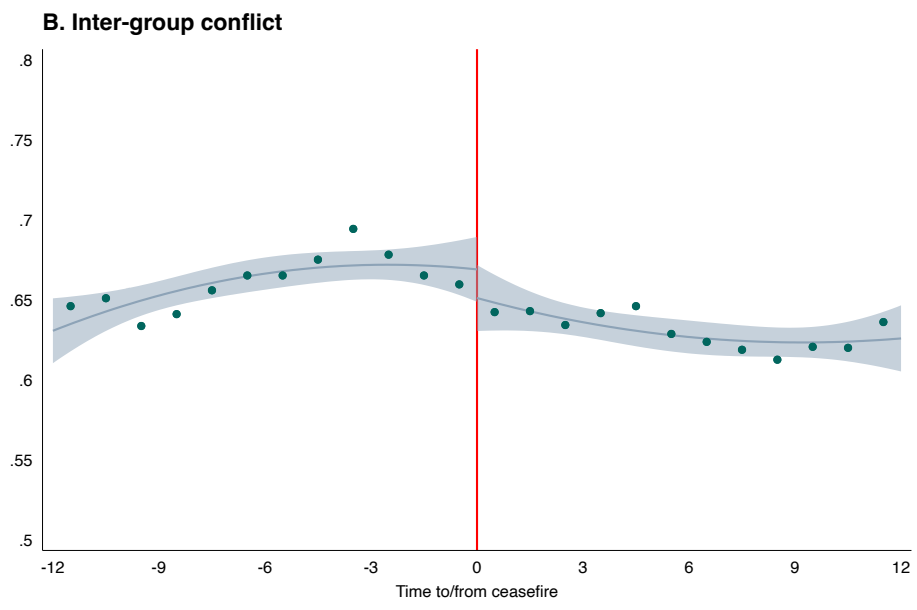




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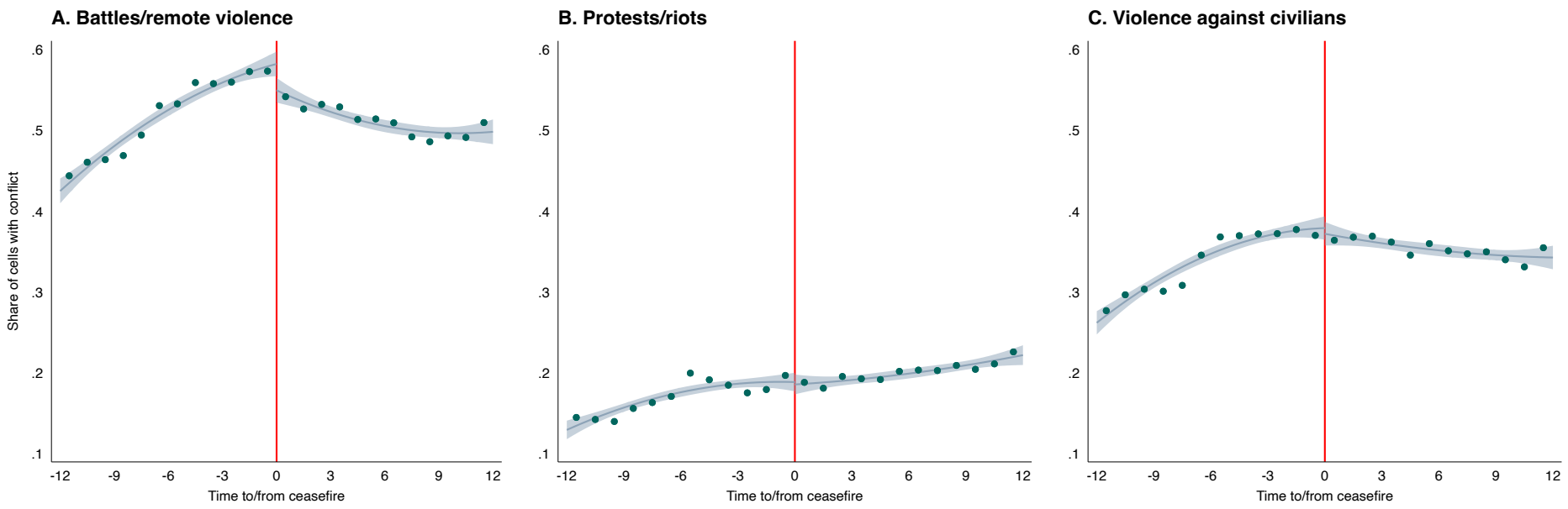




Effect of ceasefires on violence: ACLED

Supplement with **ACLED dataset** to understand the role of civilians

- Effect is driven by battles and by remove violence
- No effect on civilians

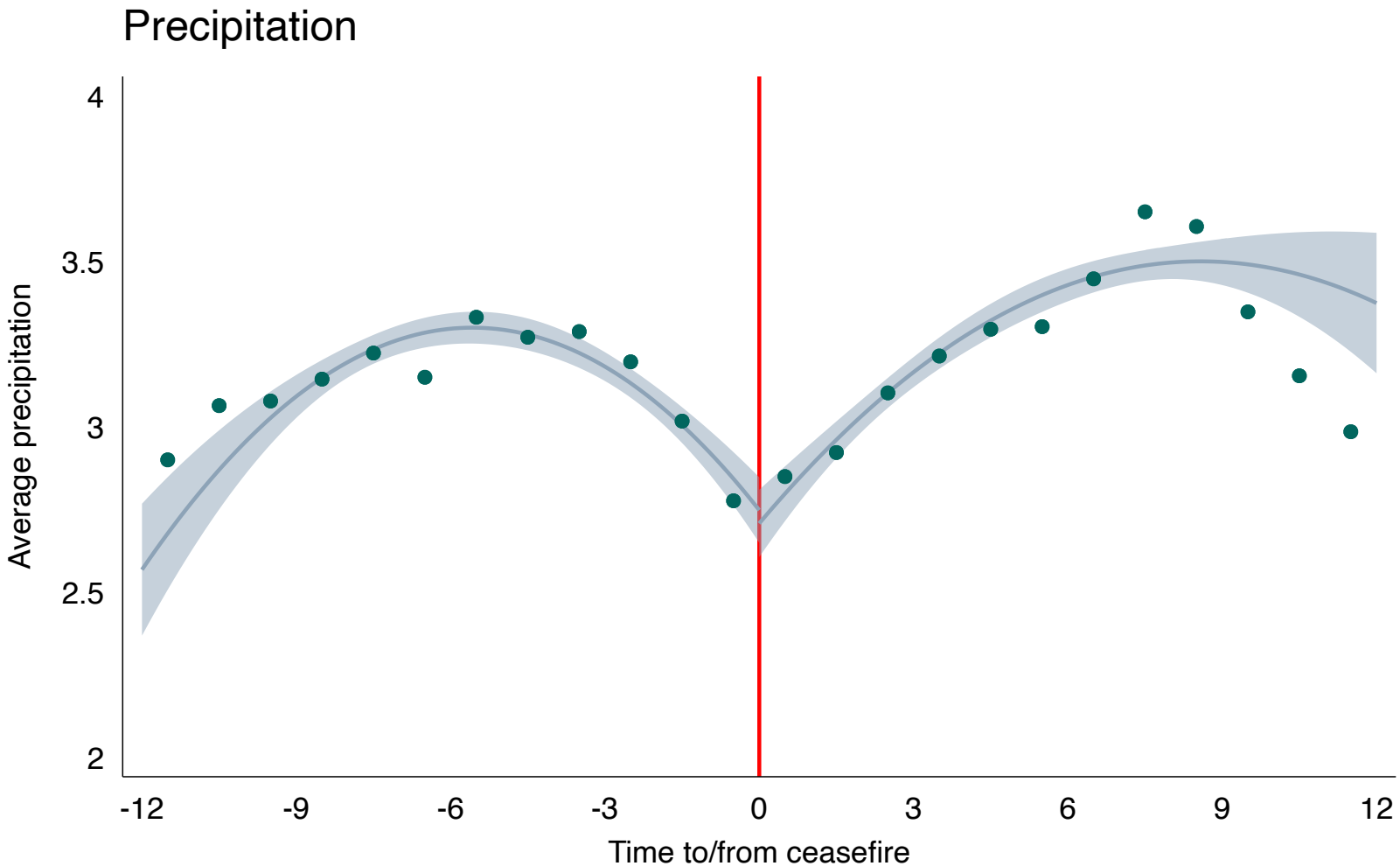


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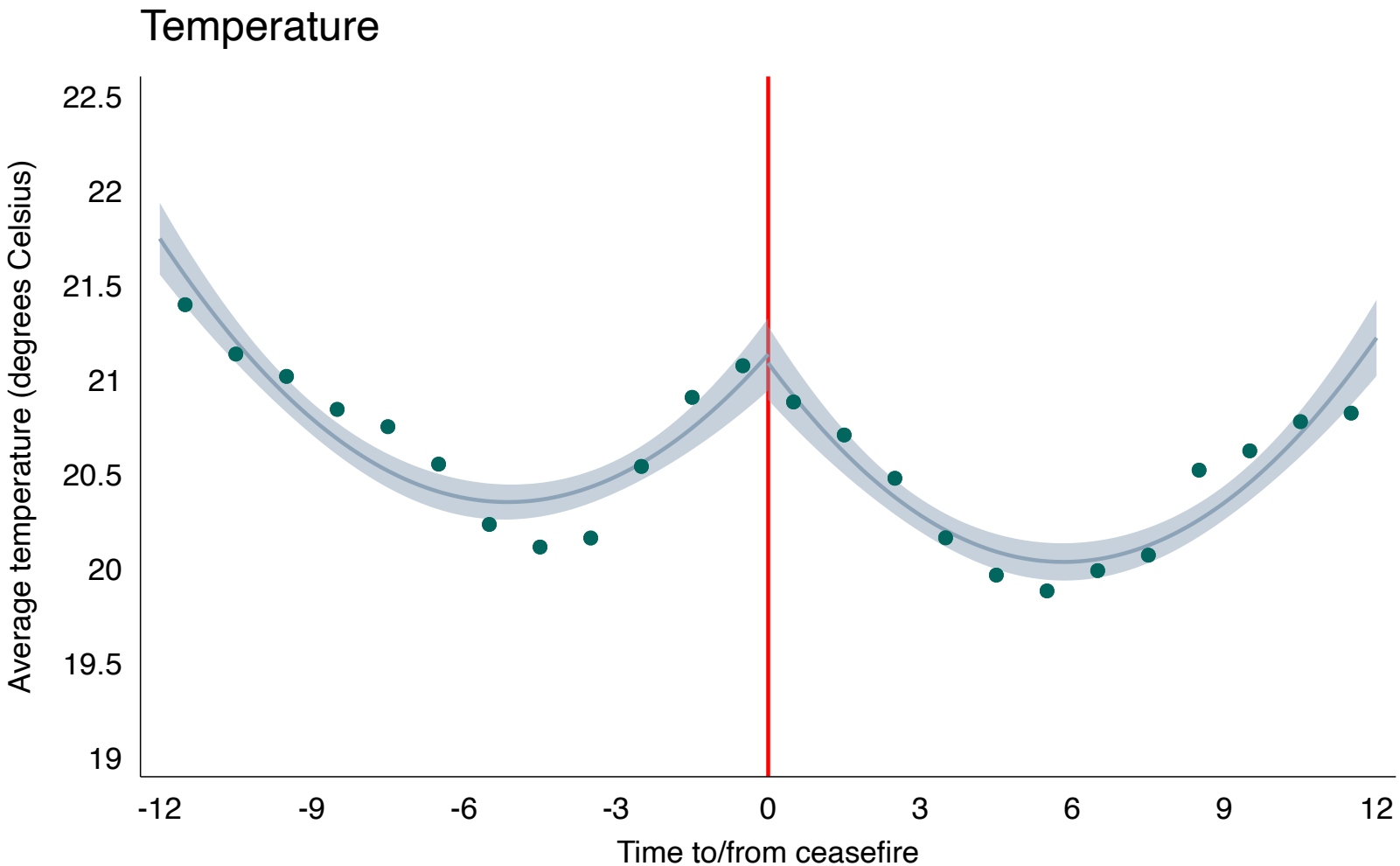
Focus on other drivers of conflict

- **Climate**: daily precipitation and temperature from ERA-5 dataset
- **Commodity value**: presence of commodity × international price



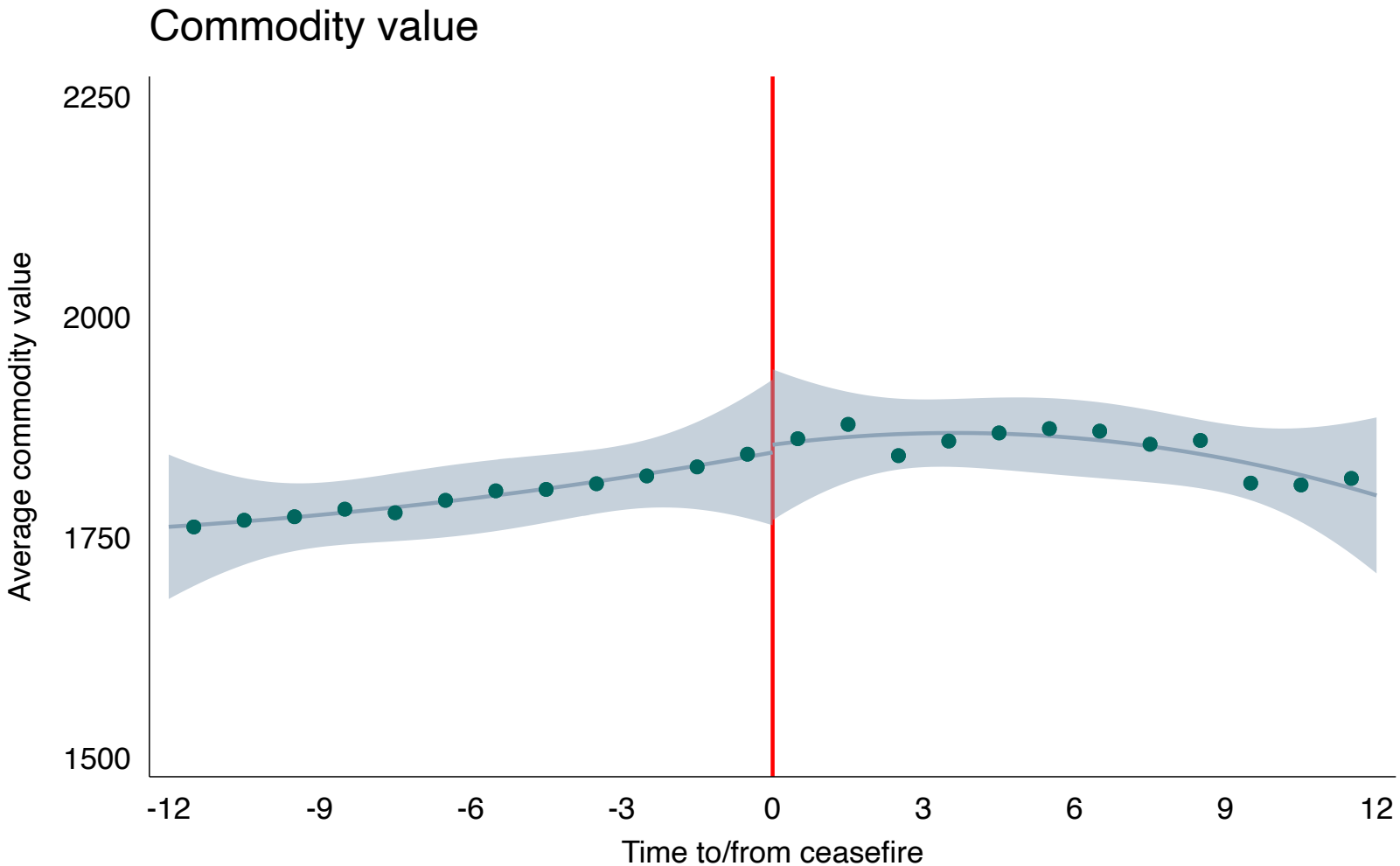
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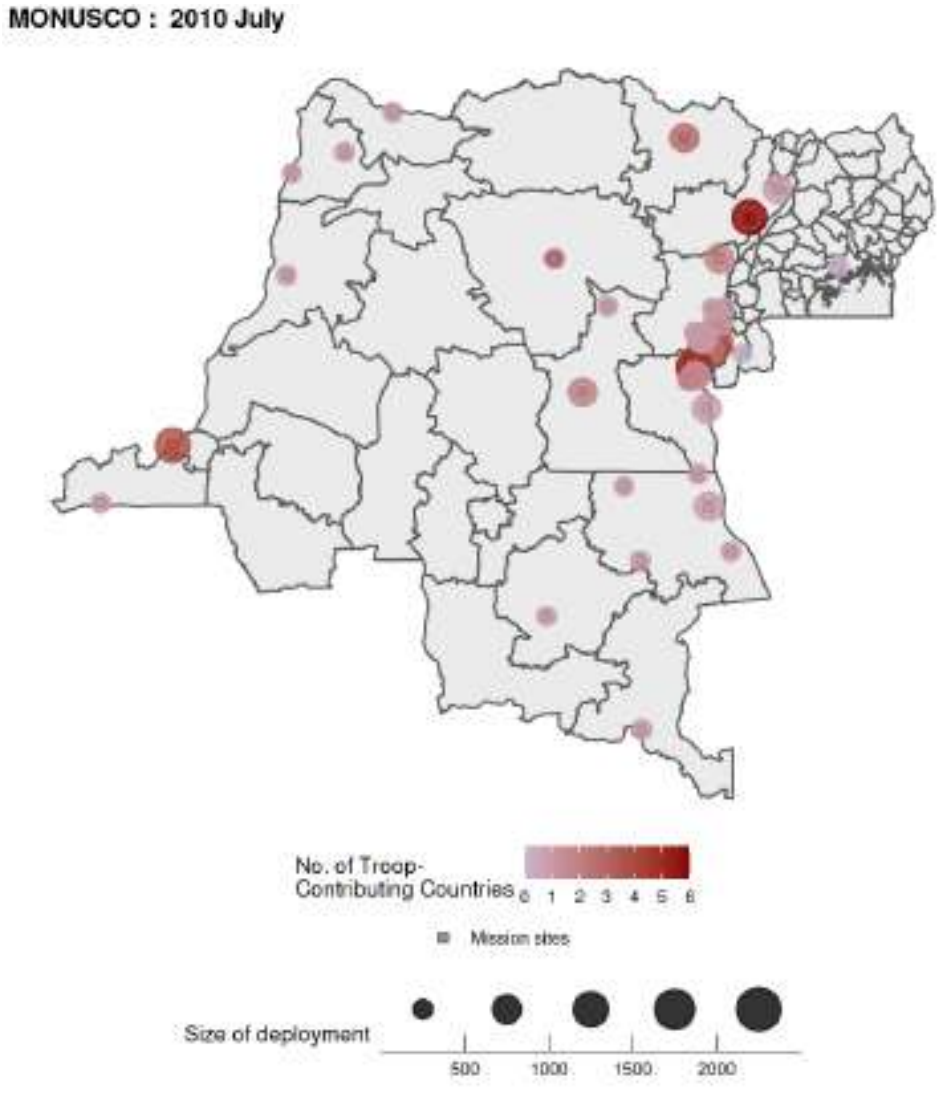
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External intervention

Deployment of peace corps is a source of nightlight emission around ceasefires?

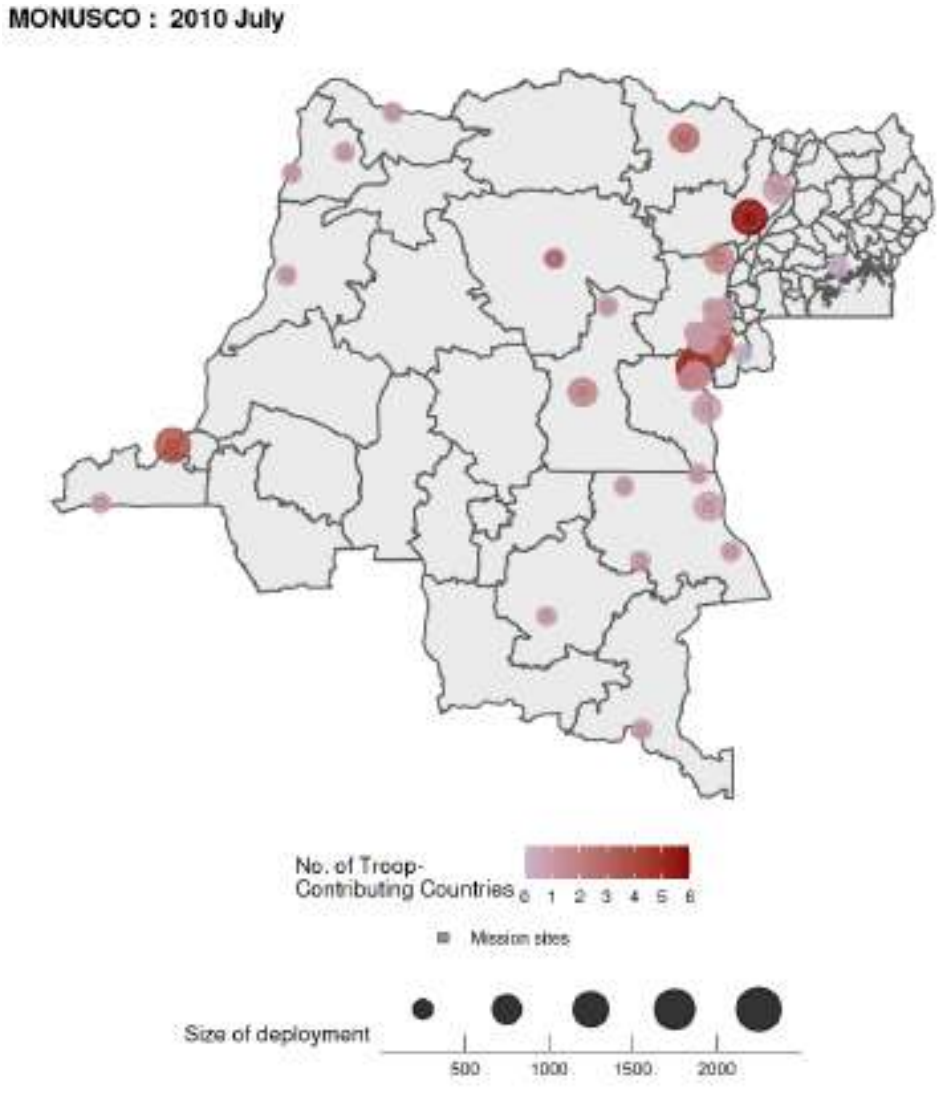
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  - Information on UN peacekeeping deployments at the local level in the period 1994–2020
- Build presence of peace missions and number of troops in our grid dataset
- FE estimates show no relation with nightlight luminosity:
  - peace mission $\Rightarrow$ 0.16%
  - $\uparrow$ 1000s troops $\Rightarrow$ -0.76%



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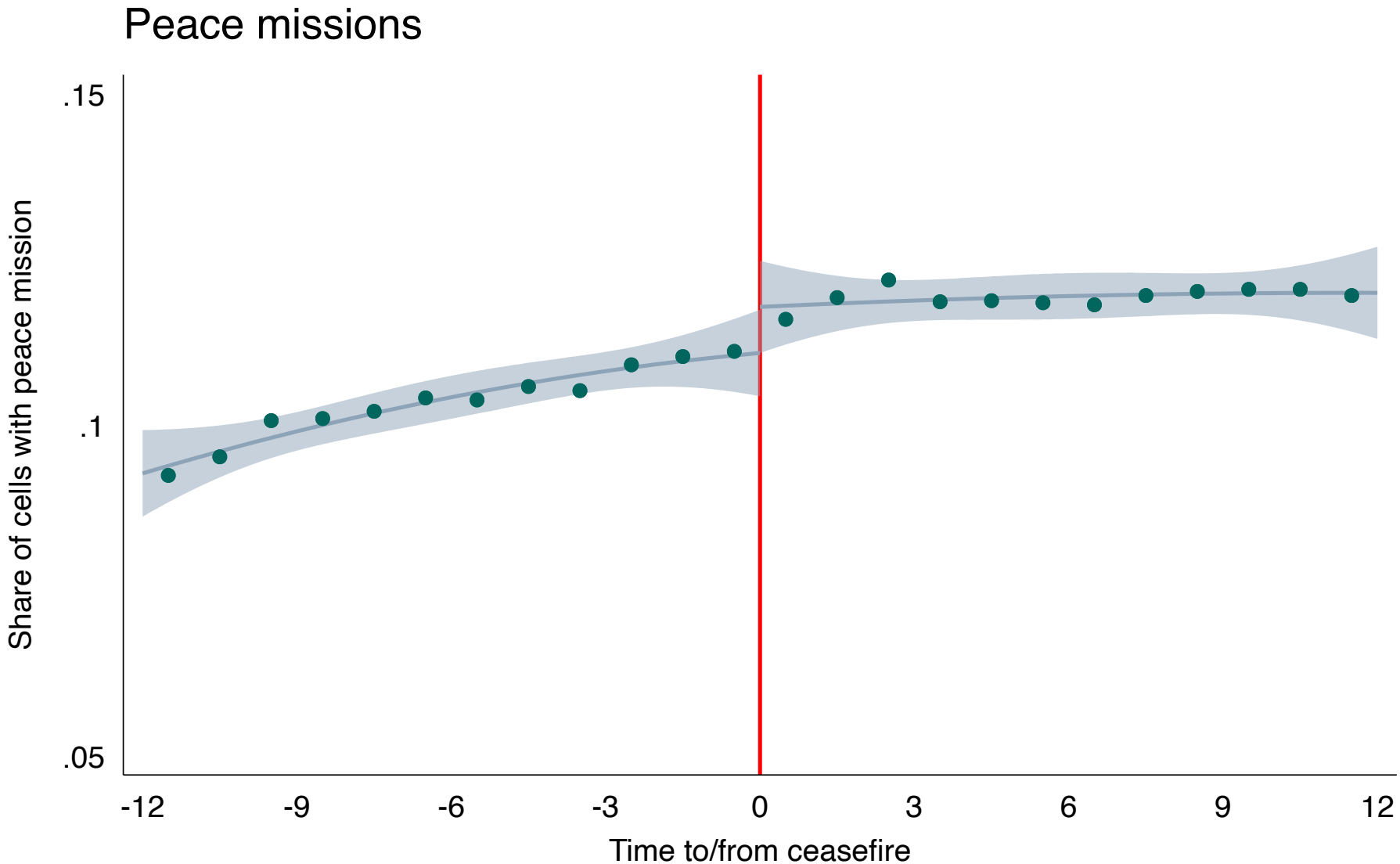
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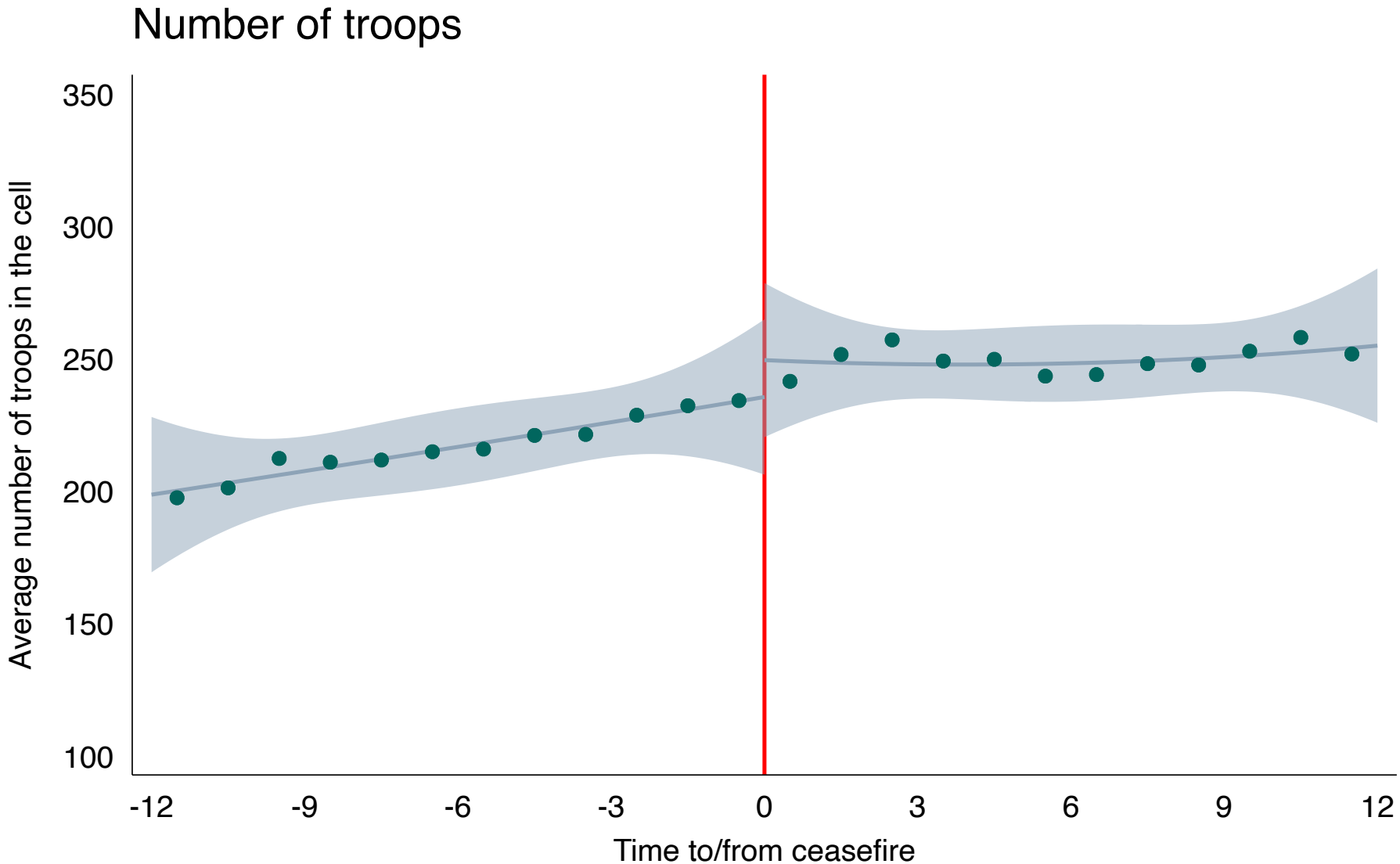
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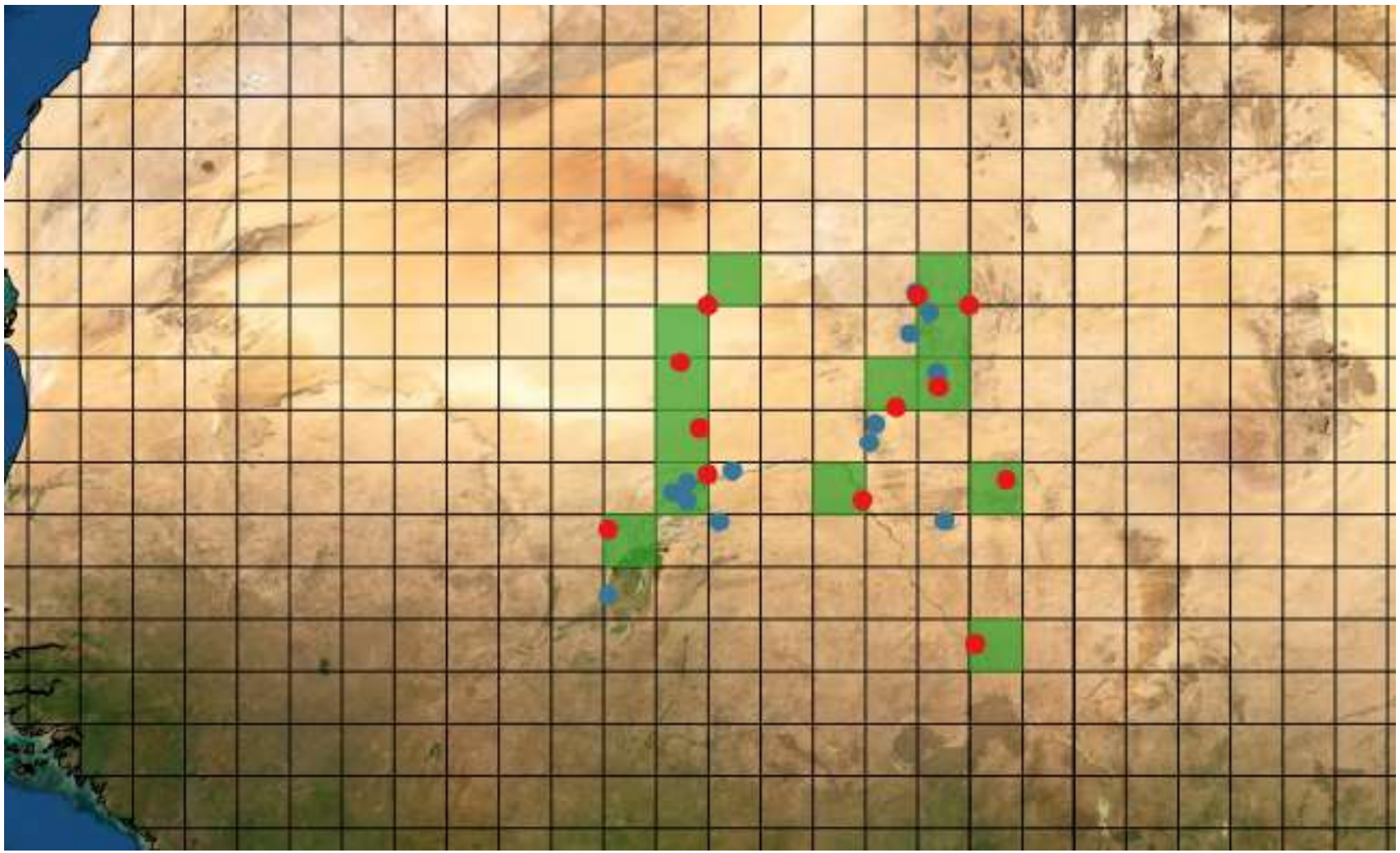


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4. **Conflict relocation**
5. Path to peace vs path to conflict

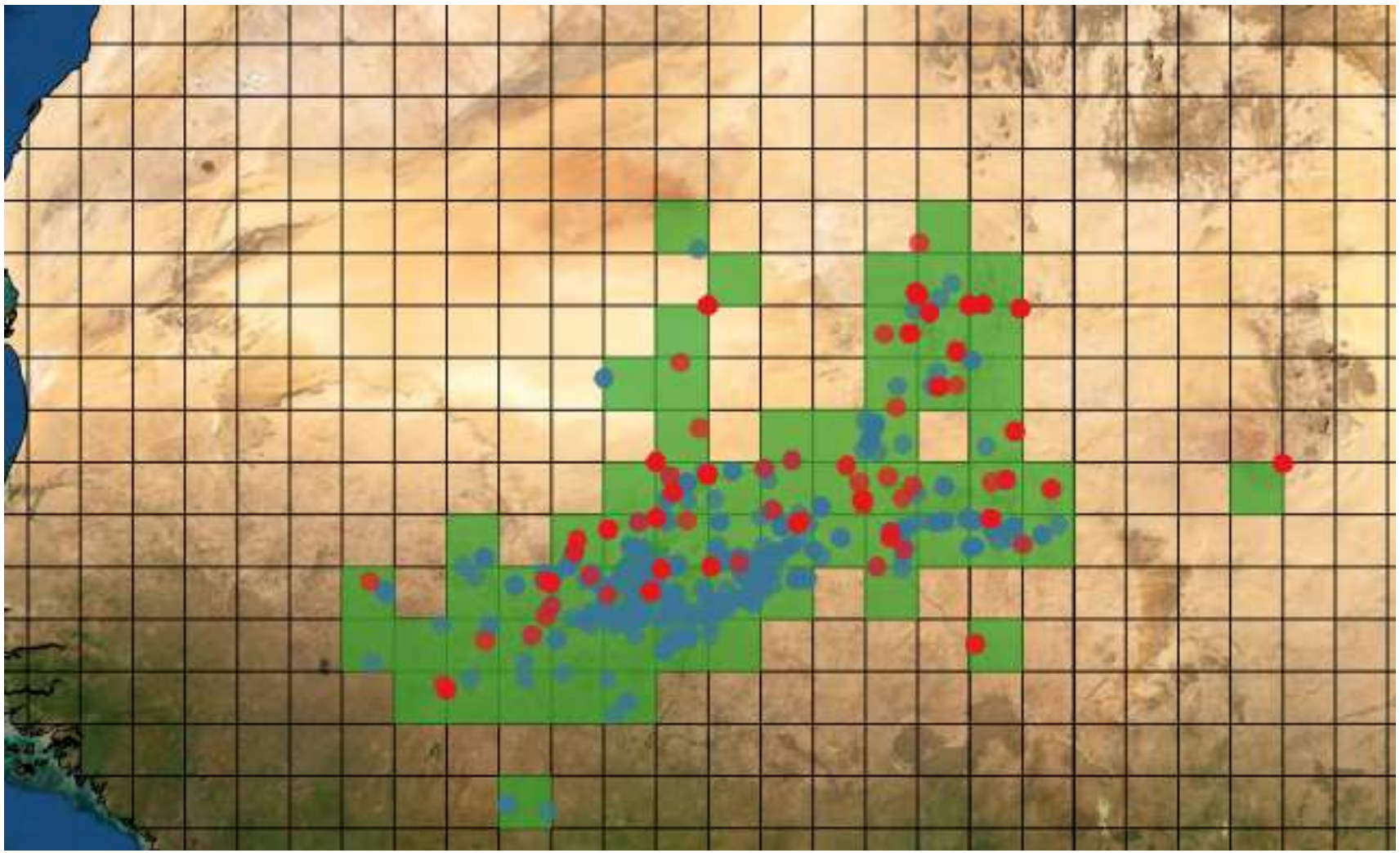
Example: Mali-Azawad accord de cessez-le-feu (May 23rd, 2014)

Between Government of Mali and Coordination of Azawad Movements (CMA)



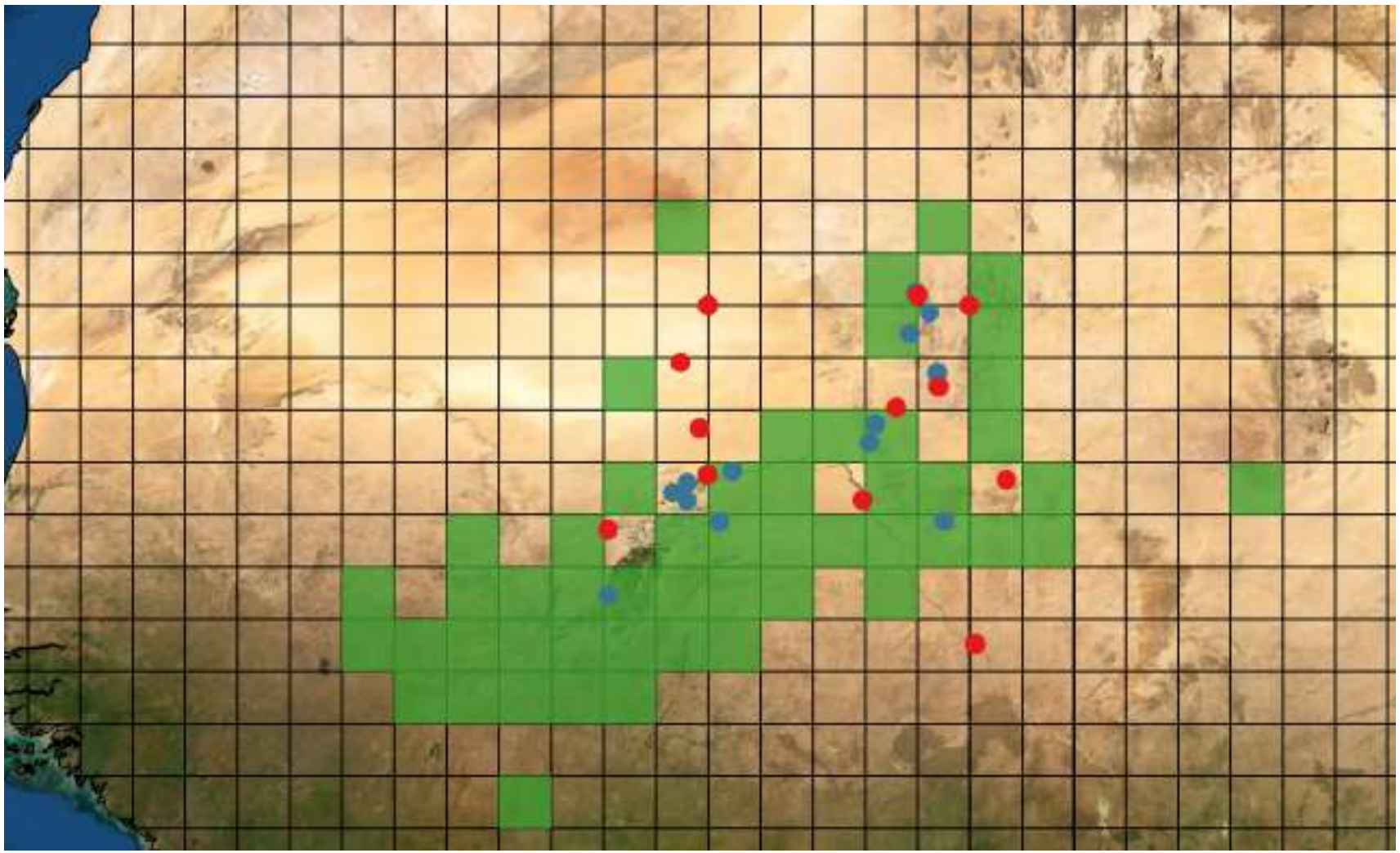
Example: Mali-Azawad accord de cessez-le-feu (May 23rd, 2014)

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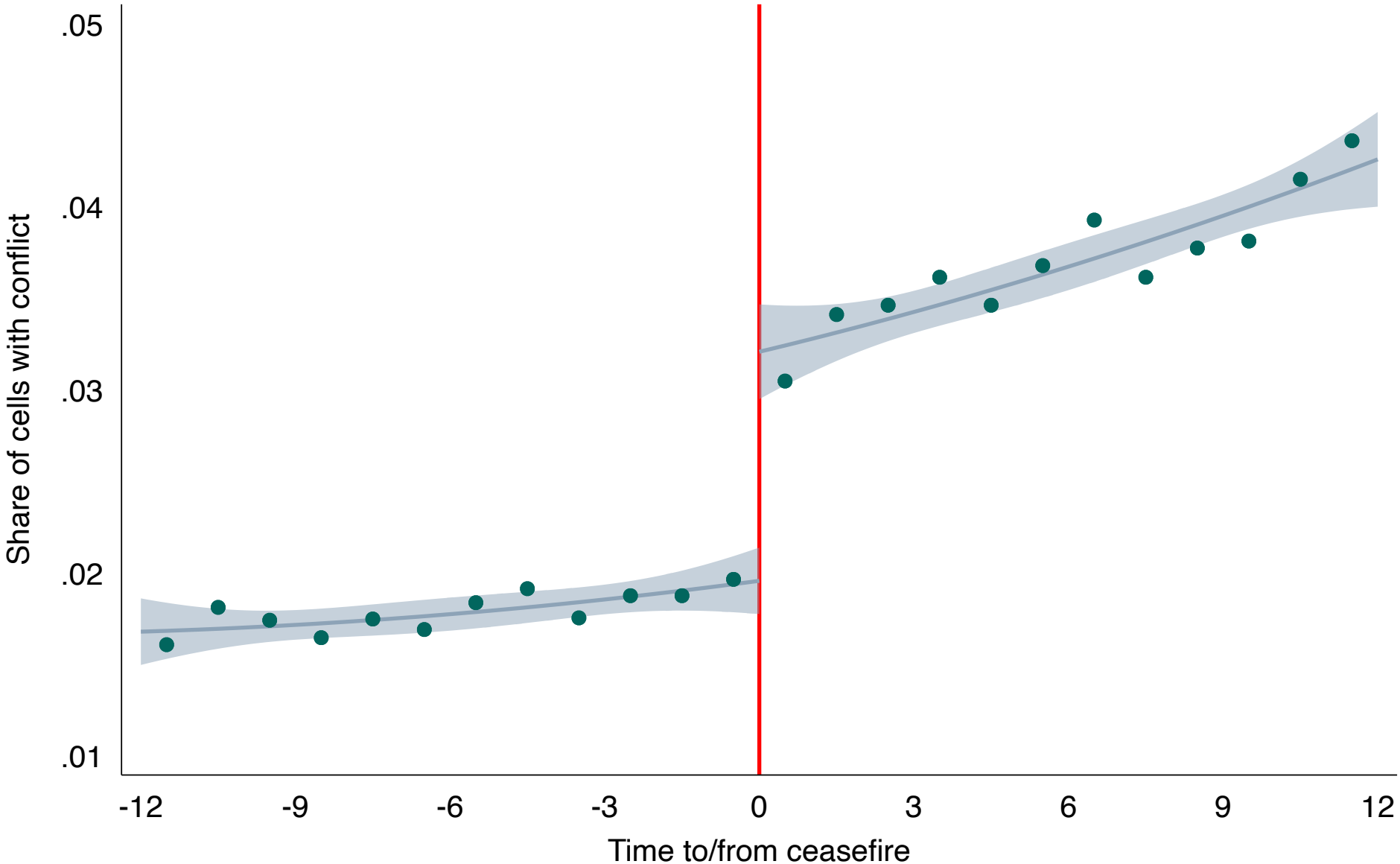


Example: Mali-Azawad accord de cessez-le-feu (May 23rd, 2014)

Between Government of Mali and Coordination of Azawad Movements (CMA)



First stage: ceasefires ↑ violence by 1 ppts



First stage: ceasefires ↑ violence by 1 ppts

Dependent variable:	Any violent event				
	(1)	(2)	(3)	(4)	(5)
Effect at ceasefire	0.012	0.012	0.012	0.012	0.012
	(0.001)	(0.001)	(0.001)	(0.007)	(0.007)
	[0.000]	[0.000]	[0.000]	[0.119]	[0.119]
Mean (pre-ceasefire)	0.018	0.018	0.018	0.018	0.018
Kernel type	-	-	-	Triangular	Triangular
Bandwidth type	-	-	-	mserd	msetwo
Bandwidth (below)	12.000	12.000	12.000	7.312	8.625
Bandwidth (above)	12.000	12.000	12.000	7.312	6.819
Observations	376488	376488	376488	376488	376488

Note. **Violence is based on UCDP data. In columns (4) and (5), estimates are based on local polynomial RD point estimators with robust bias-corrected confidence intervals and inference procedures developed in Calonico, Cattaneo and Farrell (2020). Standard errors (in parentheses) are clustered at the month-ceasefire level. P-values are presented in brackets. The spatial unit of observation is the grid cell at the $1^\circ \times 1^\circ$ resolution. The temporal unit is the month (in 30 days) following the day of the ceasefire.**

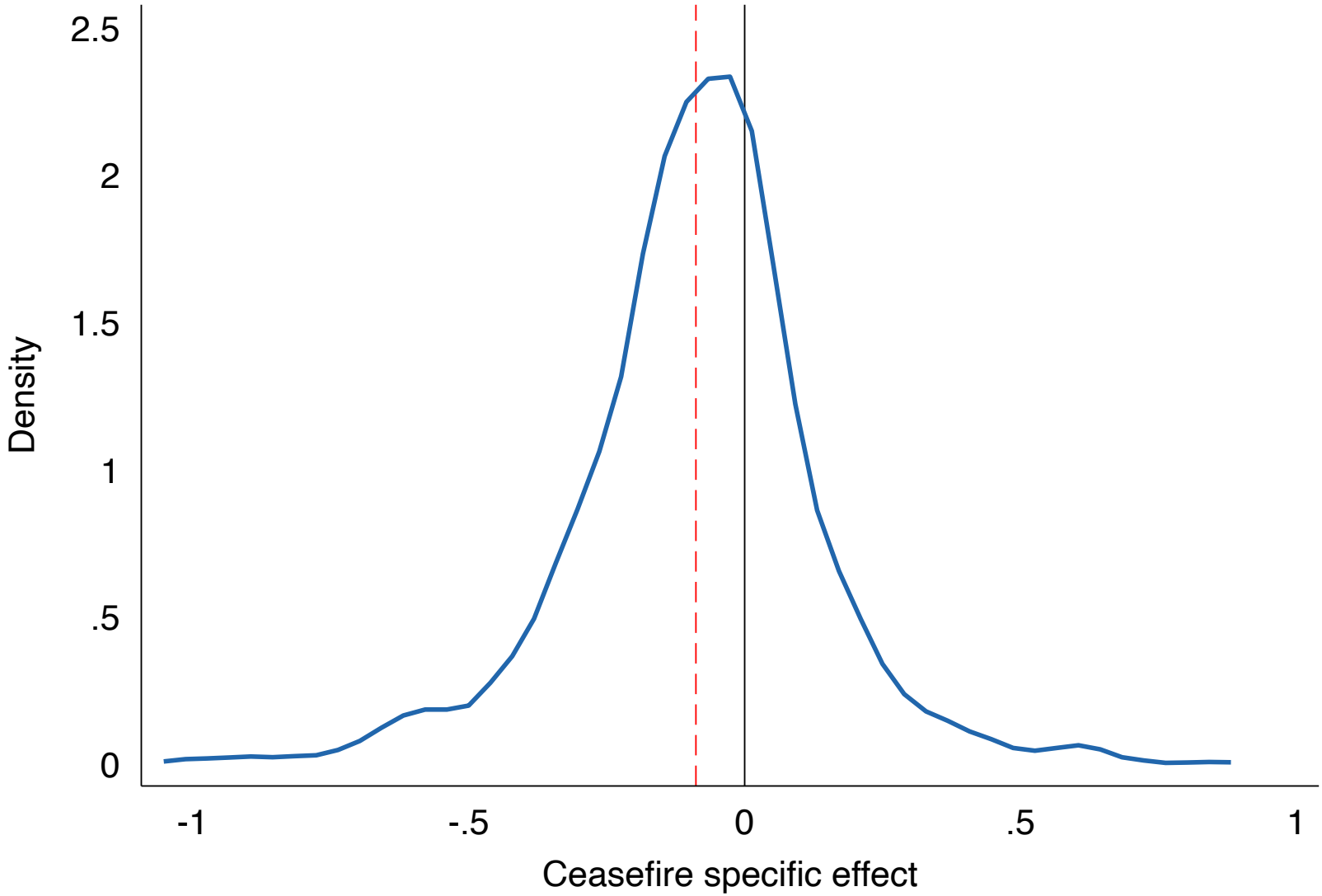
What drives these effects?

1. Characteristics driving effective ceasefires
2. The role of confounders
3. External intervention
4. Conflict relocation
5. **Path to peace vs path to conflict**

Heterogeneity in reduction in conflict

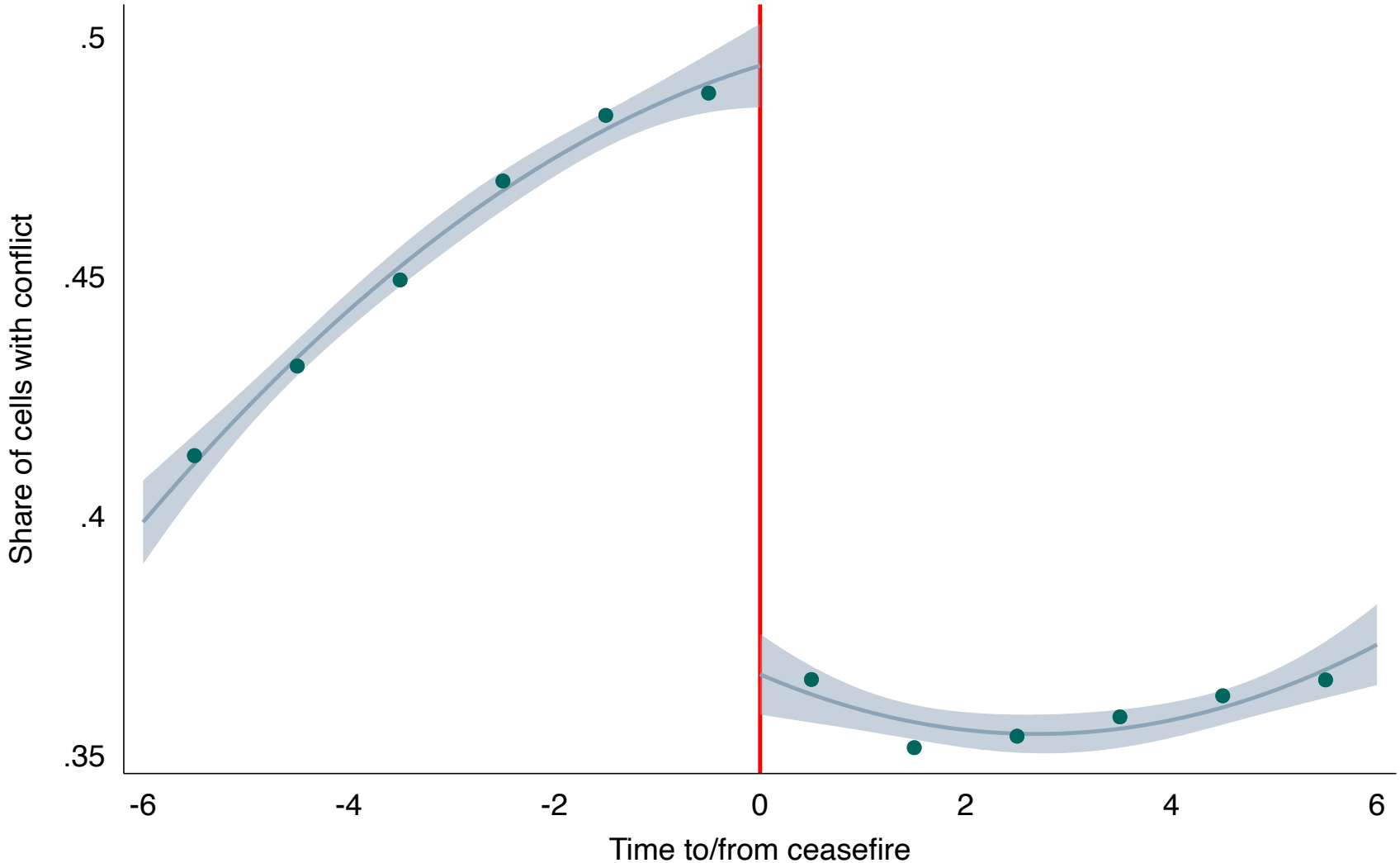
1. **Heterogeneity across ceasefires**
   - Estimate ceasefire-specific effects
2. **Heterogeneity across space**
   - Differentiate the effect by looking at all ceasefires

Heterogeneity across ceasefires

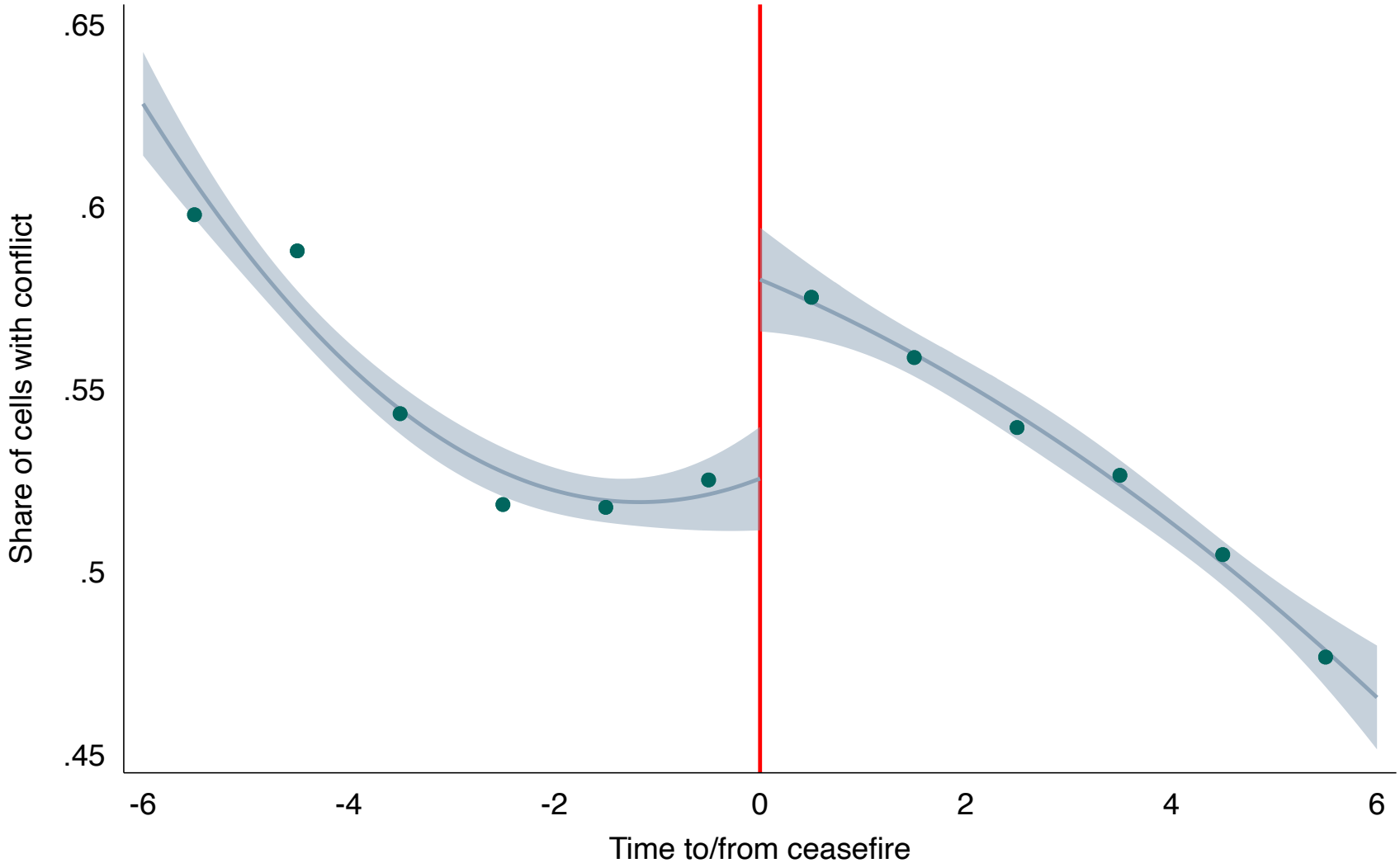


kernel = epanechnikov, bandwidth = 0.0337

Heterogeneity across ceasefires



Heterogeneity across ceasefires



Ceasefires and nightlight luminosity

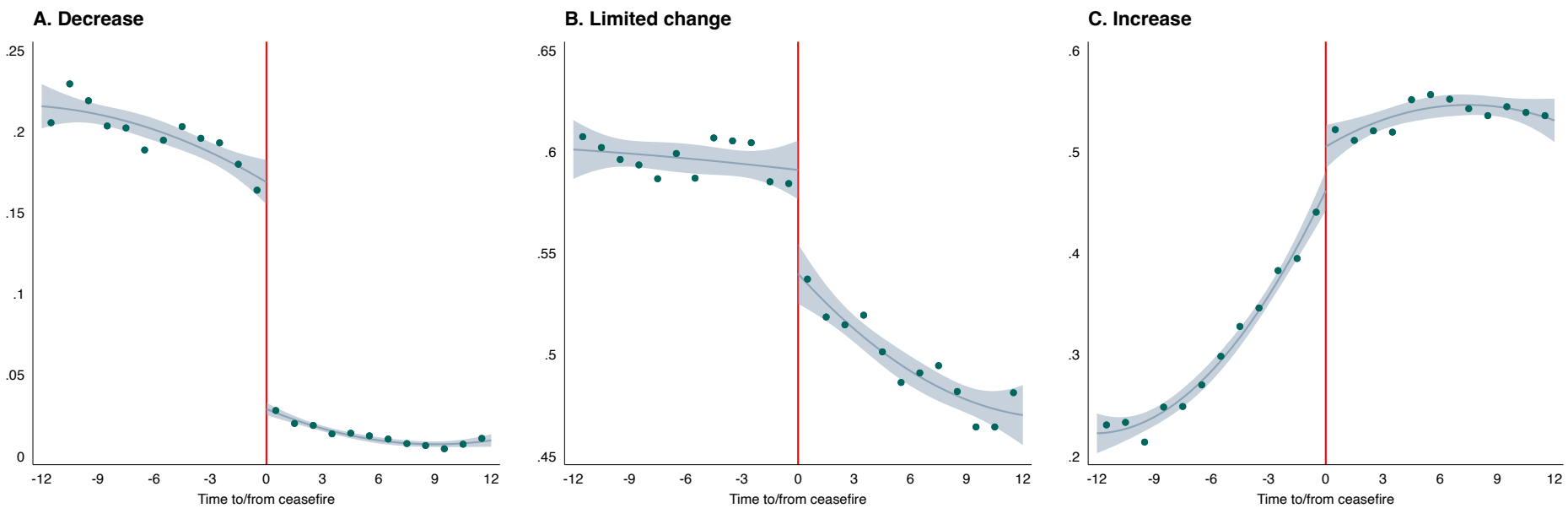
Focus on **ceasefires with reduction in conflicts**: discontinuity in conflict ⇒ 1.8% per 1 ppt decrease in conflict

Dependent variable:	Average nightlight luminosity (log)			
	(1)	(2)	(3)	(4)
Effect at ceasefire (1 ppt)	0.018	0.016	0.018	0.015
	(0.007)	(0.006)	(0.007)	(0.005)
	[0.012]	[0.004]	[0.012]	[0.004]
Robust 95% CI	[.008 ; .038]	[.01 ; .035]	[.008 ; .038]	[.009 ; .032]
Kernel type	Triangular	Triangular	Epanechnikov	Epanechnikov
Bandwidth type	mserd	msetwo	mserd	msetwo
Bandwidth (below)	2.417	2.343	2.306	2.514
Bandwidth (above)	2.417	3.335	2.306	3.052
Observations	105860	105860	105860	105860

Note. **Violence is based on UCDP data. Estimates are based on local polynomial RD point estimators with robust bias-corrected confidence intervals and inference procedures developed in Calonico, Cattaneo and Farrell (2020). Standard errors (in parentheses) are clustered at the month-ceasefire level. P-values are presented in brackets. The spatial unit of observation is the grid cell at the $1^\circ \times 1^\circ$ resolution. The temporal unit is the month (in 30 days) following the day of the ceasefire.**

Heterogeneity across space

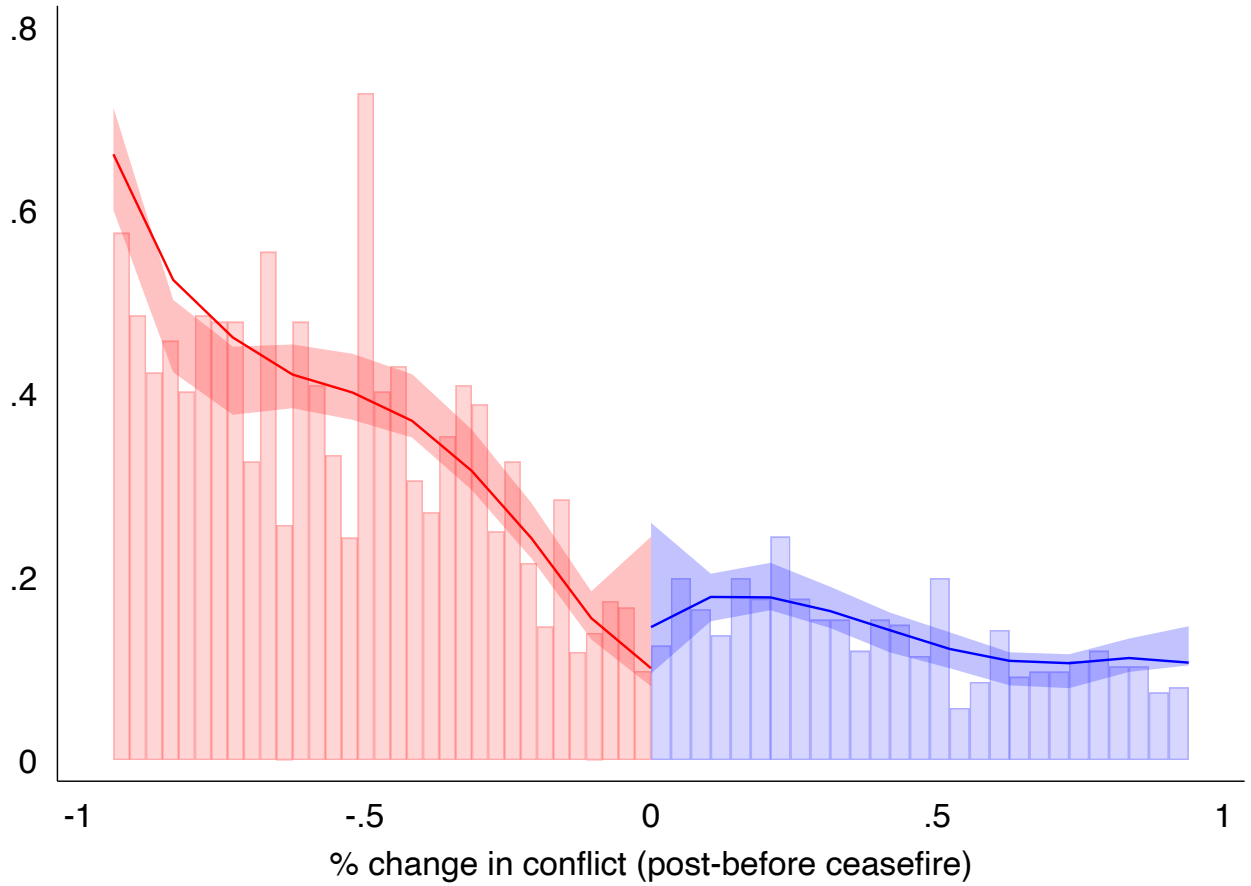
- Large **heterogeneity**
  - *Decrease*, *limited change*, and *increase* are the terciles in the pre-post % change in conflict



Path to peace vs path to conflict

Regression discontinuity at ceasefire level $\Rightarrow$ remove time variation

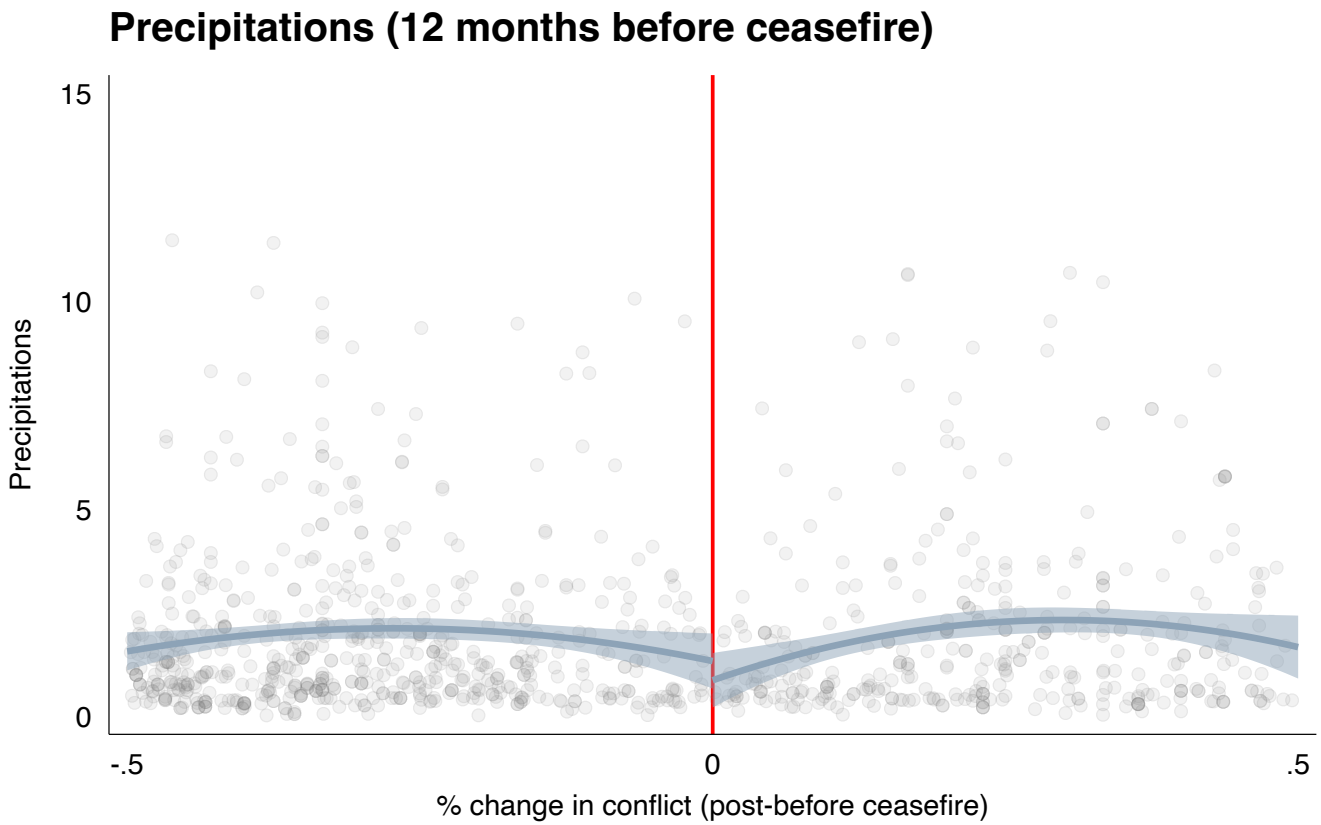
- **Running variable**: % change in fatalities from pre- to post-ceasefire
- **LATE at zero**: ceasefires lead no change in violence
- Robust to standard RD diagnostic test



Path to peace vs path to conflict

Regression discontinuity at ceasefire level $\Rightarrow$ remove time variation

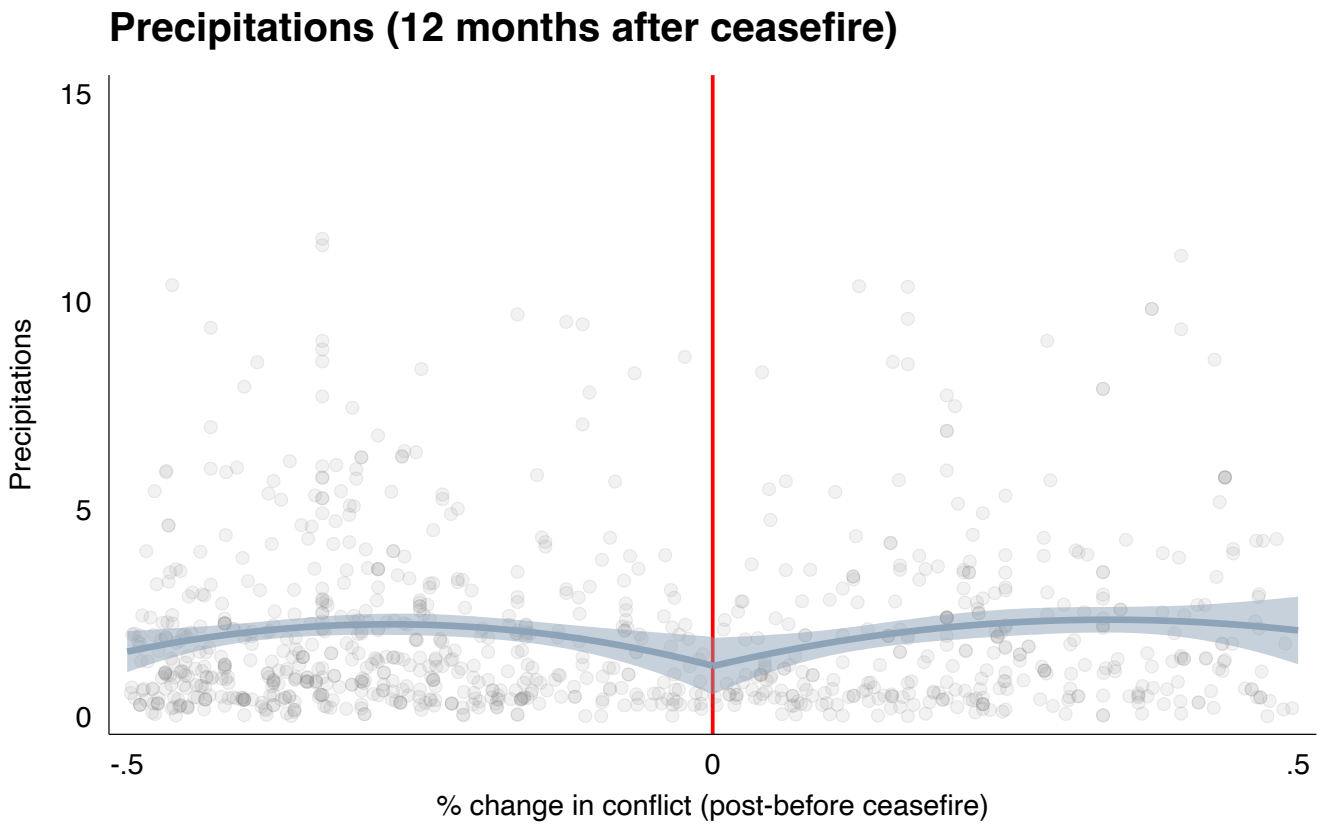
- **Running variable**: % change in fatalities from pre- to post-ceasefire
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Path to peace vs path to conflict

Regression discontinuity at ceasefire level $\Rightarrow$ remove time variation

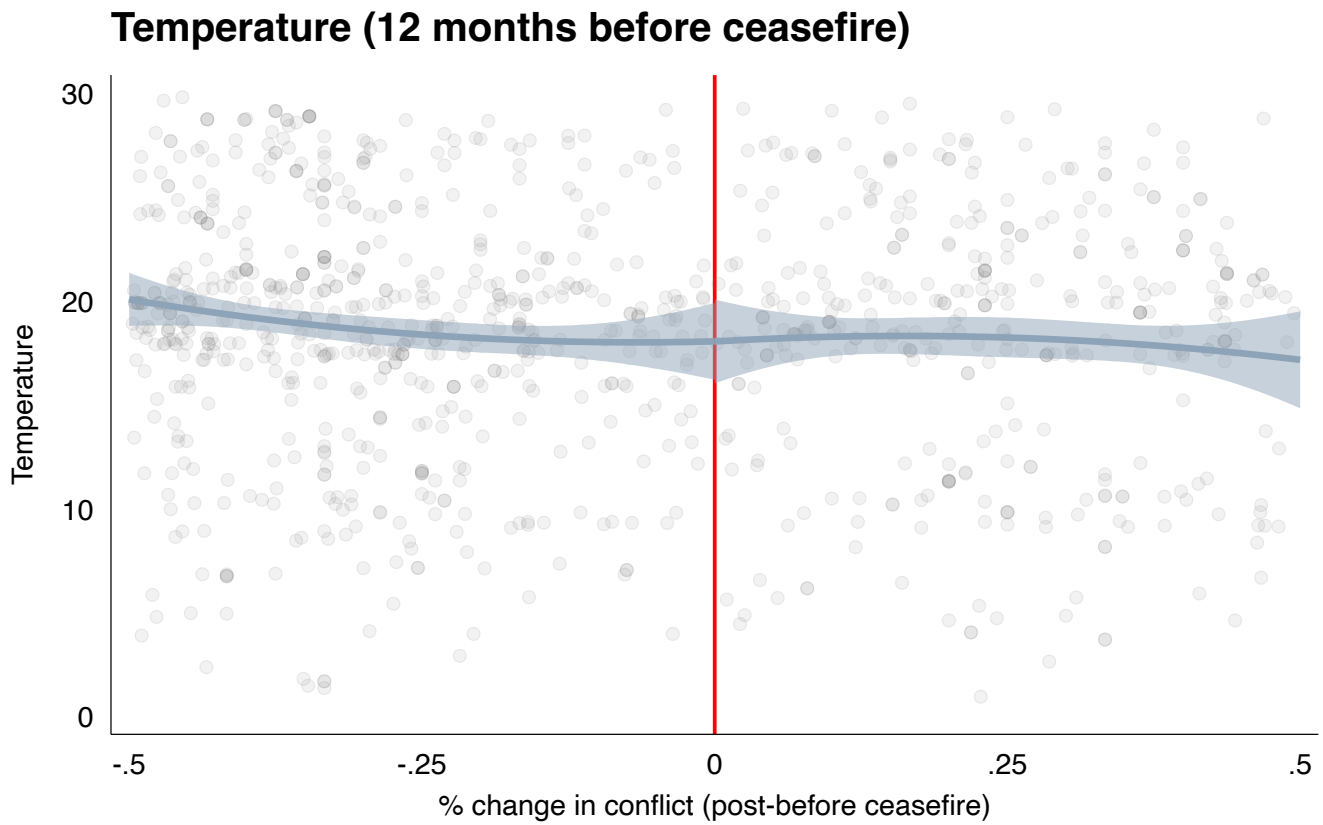
- **Running variable**: % change in fatalities from pre- to post-ceasefire
- **LATE at zero**: ceasefires lead no change in violence
- Robust to standard RD diagnostic test



Path to peace vs path to conflict

Regression discontinuity at ceasefire level $\Rightarrow$ remove time variation

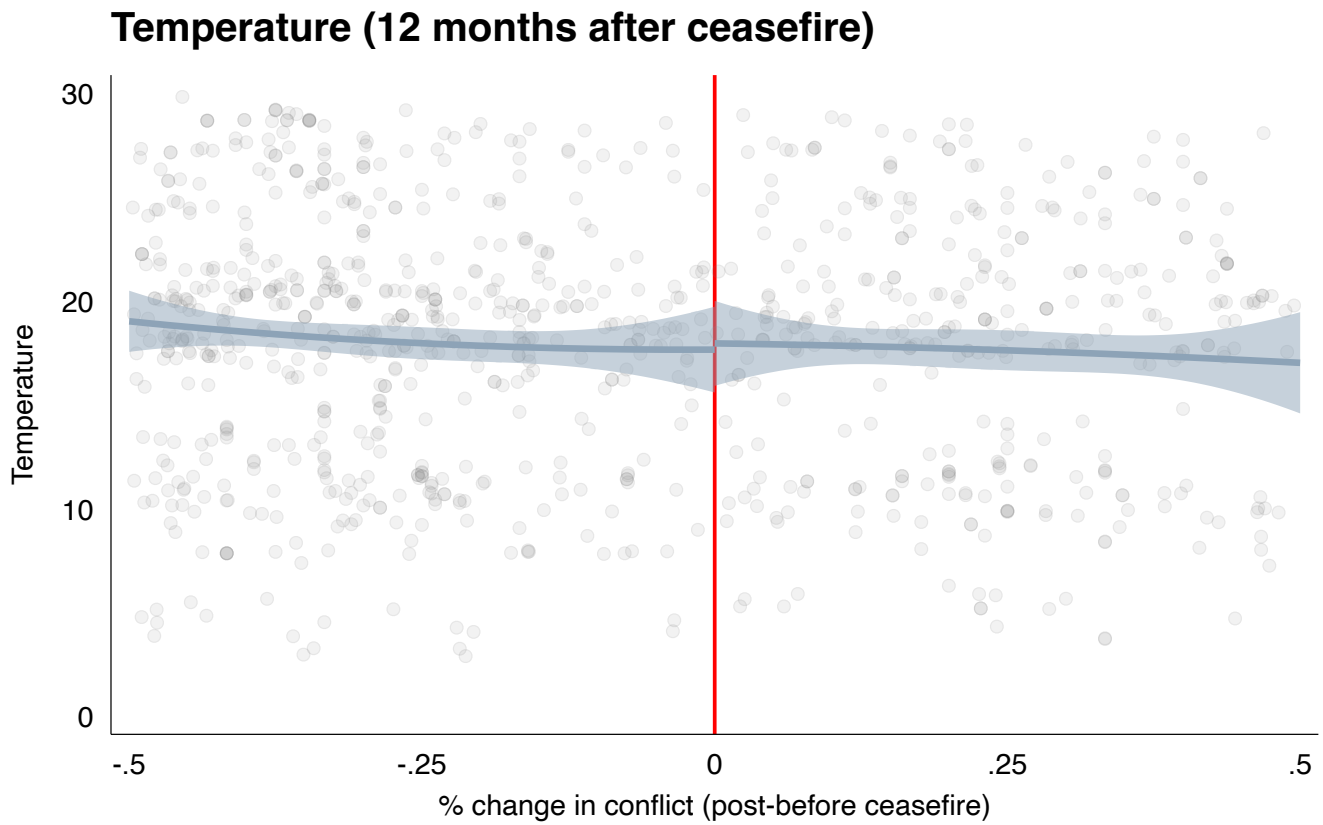
- **Running variable**: % change in fatalities from pre- to post-ceasefire
- **LATE at zero**: ceasefires lead no change in violence
- Robust to standard RD diagnostic test



Path to peace vs path to conflict

Regression discontinuity at ceasefire level $\Rightarrow$ remove time variation

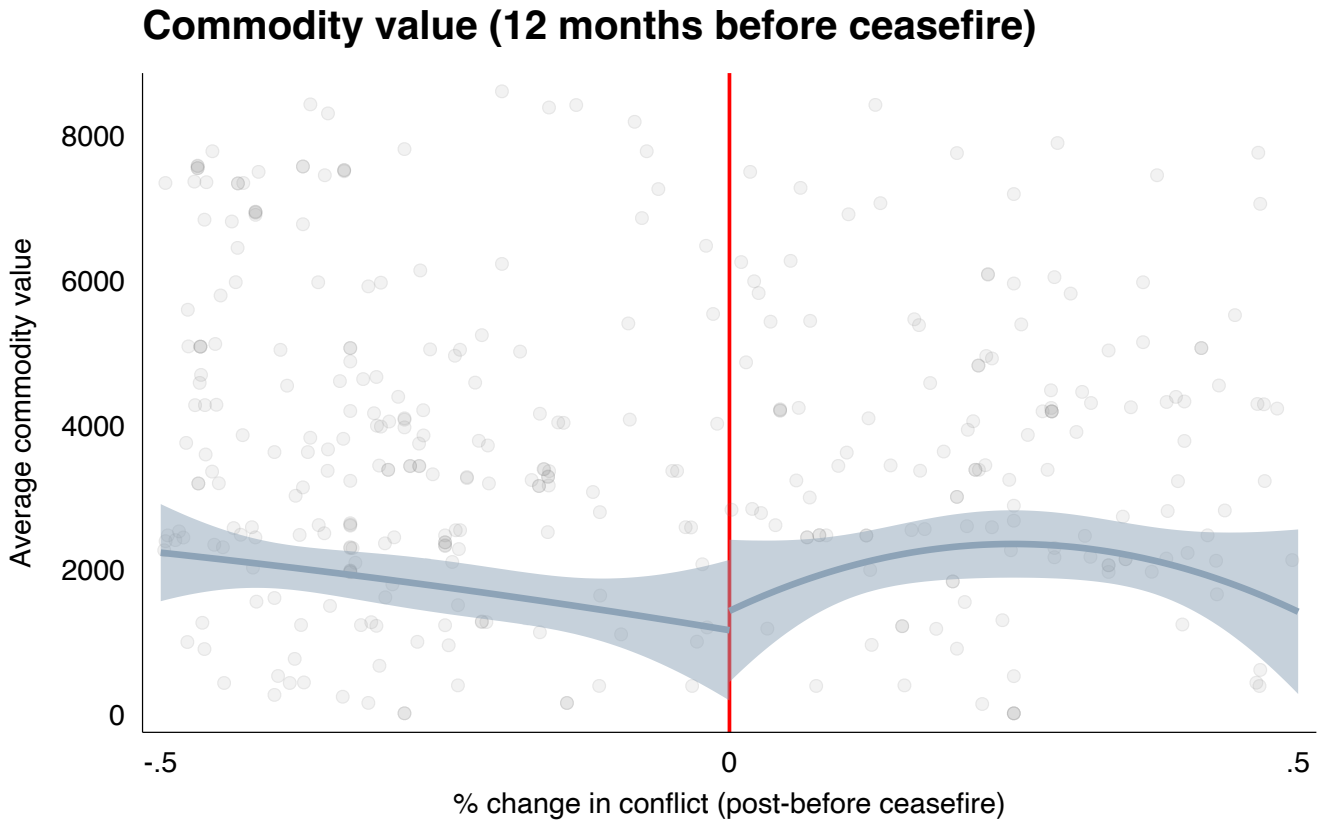
- **Running variable**: % change in fatalities from pre- to post-ceasefire
- **LATE at zero**: ceasefires lead no change in violence
- Robust to standard RD diagnostic test



Path to peace vs path to conflict

Regression discontinuity at ceasefire level $\Rightarrow$ remove time variation

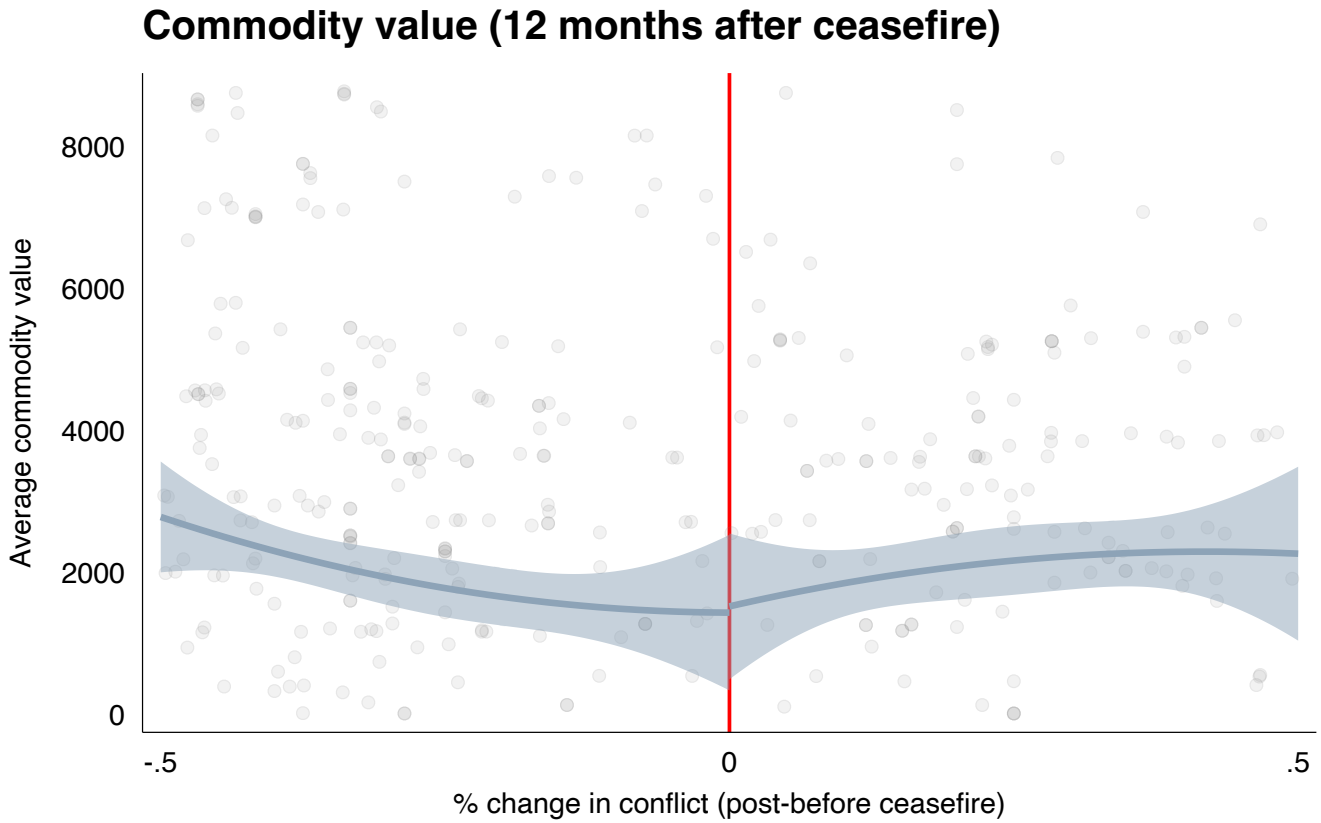
- **Running variable**: % change in fatalities from pre- to post-ceasefire
- **LATE at zero**: ceasefires lead no change in violence
- Robust to standard RD diagnostic test



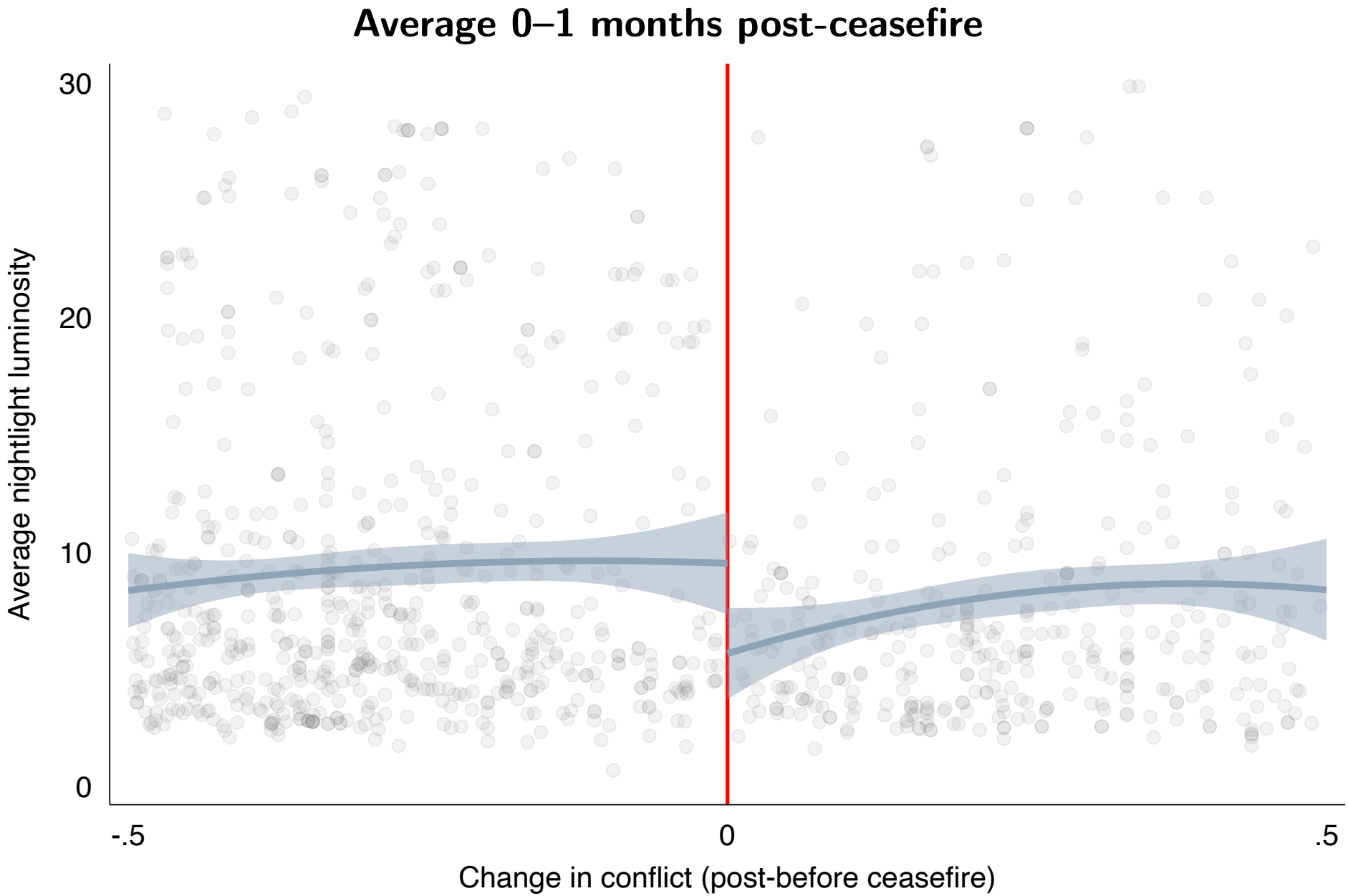
Path to peace vs path to conflict

Regression discontinuity at ceasefire level $\Rightarrow$ remove time variation

- **Running variable**: % change in fatalities from pre- to post-ceasefire
- **LATE at zero**: ceasefires lead no change in violence
- Robust to standard RD diagnostic test



Impact on nightlight luminosity



The effect of peace on economic development

Asymmetric effect at the time of the ceasefire $\approx$ 15% decrease in nightlight luminosity

Dependent variable:	**Average nightlight luminosity, by time post-ceasefire**			
	0–1 month	**0–6 months**	**0–9 months**	**0–12 months**
	(1)	(2)	(3)	(4)
RD estimate	-3.698	-1.850	-1.313	-1.204
	(0.940)	(0.882)	(0.591)	(0.591)
	[0.000]	[0.036]	[0.026]	[0.041]
Robust 95% CI	[-6.069 ; -1.704]	[-3.754 ; .39]	[-2.752 ; .024]	[-2.578 ; .21]
Kernel type	Triangular	Triangular	Triangular	Triangular
Bandwidth type	mserd	mserd	mserd	mserd
Bandwidth (below)	0.456	0.278	0.466	0.474
Bandwidth (above)	0.456	0.278	0.466	0.474
Observations	4757	4947	4982	5002

Note. Violence is based on UCDP data. Estimates are based on local polynomial RD point estimators with robust bias-corrected confidence intervals and inference procedures developed in Calonico, Cattaneo and Farrell (2020). Standard errors (in parentheses) are clustered at the month-ceasefire level. P-values are presented in brackets. The spatial unit of observation is the grid cell at the $1^\circ \times 1^\circ$ resolution. The temporal unit is the month (in 30 days) following the day of the ceasefire.

Conclusion

- We provide **causal evidence of the effect of peace on development**
  1. Quantitatively examine the **effects of ceasefires on violence**
     - Studying the determinants of the success of such peace agreements
  2. Evidence of the **effect of peace on economic development**
     - Economic impacts at the time of the ceasefire
     - Asymmetric effects depending on successful or unsuccessful ceasefires

Descriptives: ceasefires

Back

	Mean	Std. dev.	Percentiles			N
			1st	Median	99th	
	(1)	(2)	(3)	(4)	(5)	(6)
Number PAX signatories	2.48	2.04	1	2	11.27	374
Number UCDP signatories	1.87	1.01	0	2	5	374
Number UCDP state actors	0.87	0.67	0	1	2.27	374
Number UCDP non-state actors	1	0.92	0	1	4.27	374
Length text (pages)	2.68	3.92	1	2	15.81	374

Descriptives: conflict

Back

	Mean	Std. dev.	Percentiles			N
			1st	Median	99th	
	(1)	(2)	(3)	(4)	(5)	(6)
Any event (signatory)	0.37	0.48	0.00	0.00	1.00	179,304
Any violent event (other actors)	0.03	0.17	0.00	0.00	1.00	179,304
Violent events (signatory)	5.99	26.09	0.00	0.00	120.00	179,304
Violent events (other actors)	0.10	0.88	0.00	0.00	3.00	179,304
Any fatality (signatory)	0.36	0.48	0.00	0.00	1.00	179,304
Any fatality (other actors)	0.03	0.17	0.00	0.00	1.00	179,304
Fatalities (signatory)	37.54	436.82	0.00	0.00	655.00	179,304
Fatalities (other actors)	0.83	12.03	0.00	0.00	20.00	179,304
Any state-based violence	0.32	0.47	0.00	0.00	1.00	179,304
Any non-state violence	0.10	0.31	0.00	0.00	1.00	179,304
Any one-sided violence	0.13	0.33	0.00	0.00	1.00	179,304
Any event (signatory, unilateral)	0.20	0.40	0.00	0.00	1.00	179,304
Any event (signatory, confrontation)	0.27	0.45	0.00	0.00	1.00	179,304

Provision of ceasefires

Back

Heterogeneity in the effect of ceasefires might be due to heterogeneity in provisions

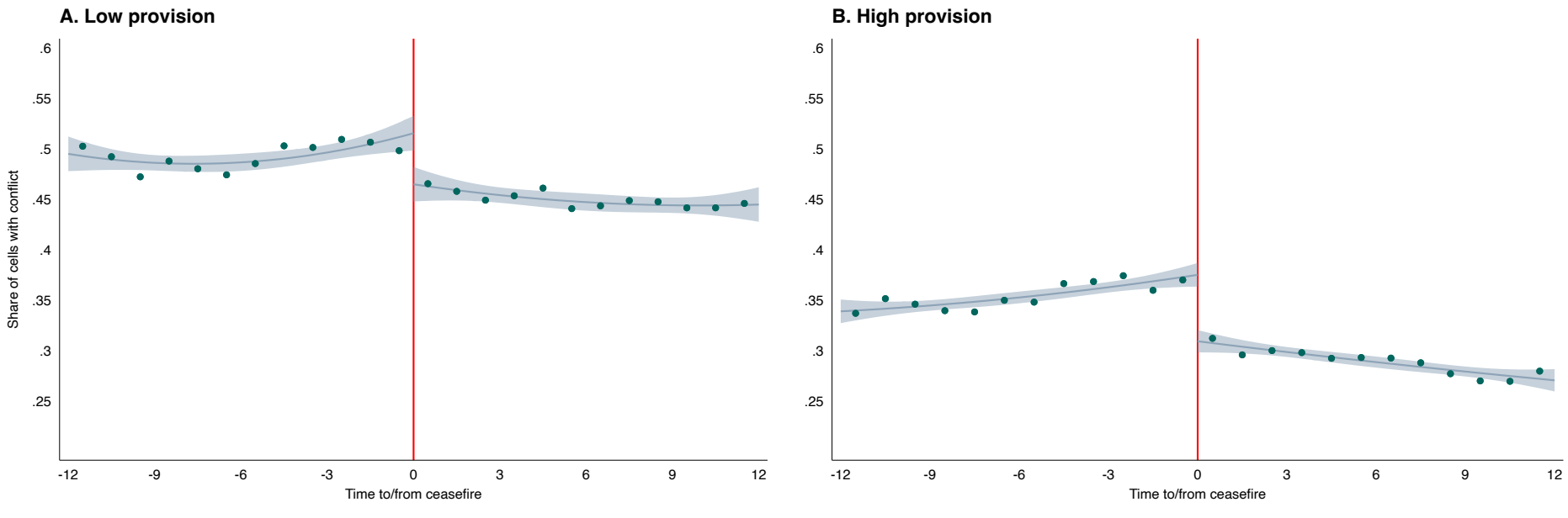
[Collier et al., 2004; Cunningham et al., 2009; Cunningham, 2013; Berman et al., 2017]

	Mean	Std. dev.	Percentiles			N
			1st	Median	99th	
	(1)	(2)	(3)	(4)	(5)	(6)
Year of ceasefire	2,004.92	10.04	1,990.00	2,005.50	2,020.00	374
Development: cursory mention	0.20	0.40	0.00	0.00	1.00	374
Development: some details on reconstruction	0.07	0.26	0.00	0.00	1.00	374
Development: reconstruction plans	0.02	0.13	0.00	0.00	1.00	374
Reference to refugees: only mentioned	0.11	0.32	0.00	0.00	1.00	374
Reference to refugees: some provisions	0.05	0.23	0.00	0.00	1.00	374
Reference to refugees: substantive	0.03	0.16	0.00	0.00	1.00	374
Mention of media: rhetorical	0.14	0.35	0.00	0.00	1.00	374
Mention of media: substantive	0.05	0.23	0.00	0.00	1.00	374
Mention of media: detailed substantive	0.04	0.20	0.00	0.00	1.00	374
Provisions for DDR: general reference	0.11	0.32	0.00	0.00	1.00	374
Provisions for DDR: mechanism less enforceable	0.09	0.28	0.00	0.00	1.00	374
Provisions for DDR: mechanisms enforceable	0.03	0.18	0.00	0.00	1.00	374
Police: general reference	0.11	0.31	0.00	0.00	1.00	374
Police: mechanism less enforceable	0.03	0.18	0.00	0.00	1.00	374
Police: mechanism enforceable	0.00	0.05	0.00	0.00	1.00	374
Release of prisoners: brief	0.11	0.32	0.00	0.00	1.00	374
Release of prisoners: mechanism	0.13	0.34	0.00	0.00	1.00	374
Release of prisoners: detailed	0.05	0.21	0.00	0.00	1.00	374
Military powersharing: mentioned	0.06	0.24	0.00	0.00	1.00	374
Military powersharing: some details	0.04	0.19	0.00	0.00	1.00	374
Military powersharing: plenty of details	0.03	0.18	0.00	0.00	1.00	374

Provision of ceasefires and conflict

Build a **provision index** based on principal component analysis

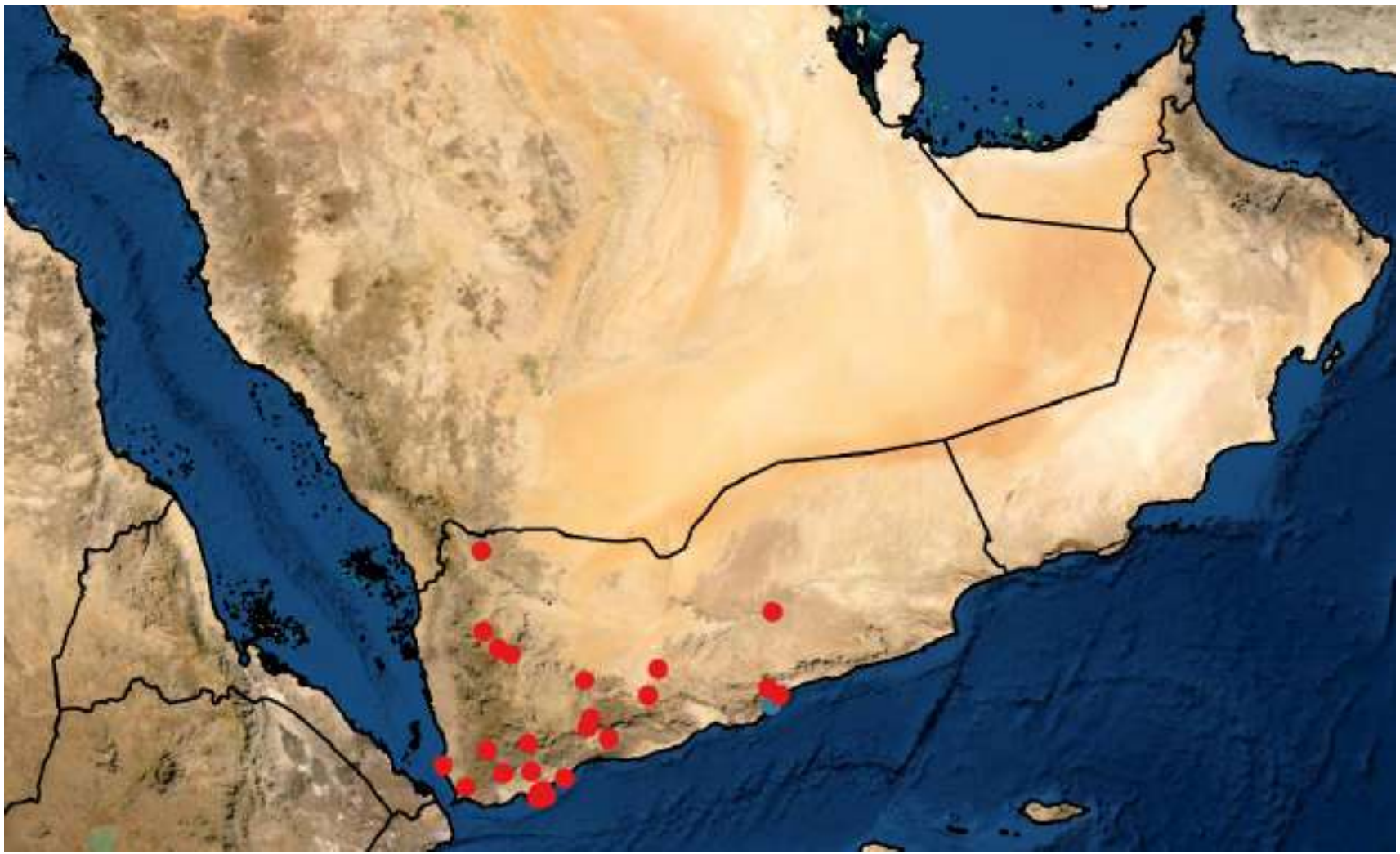
- *Low* indicates the first tercile of the distribution of the index, *high* indicates the second and third tercile



Example: Agreement on a Ceasefire in the Republic of Yemen (June 30th, 1994)

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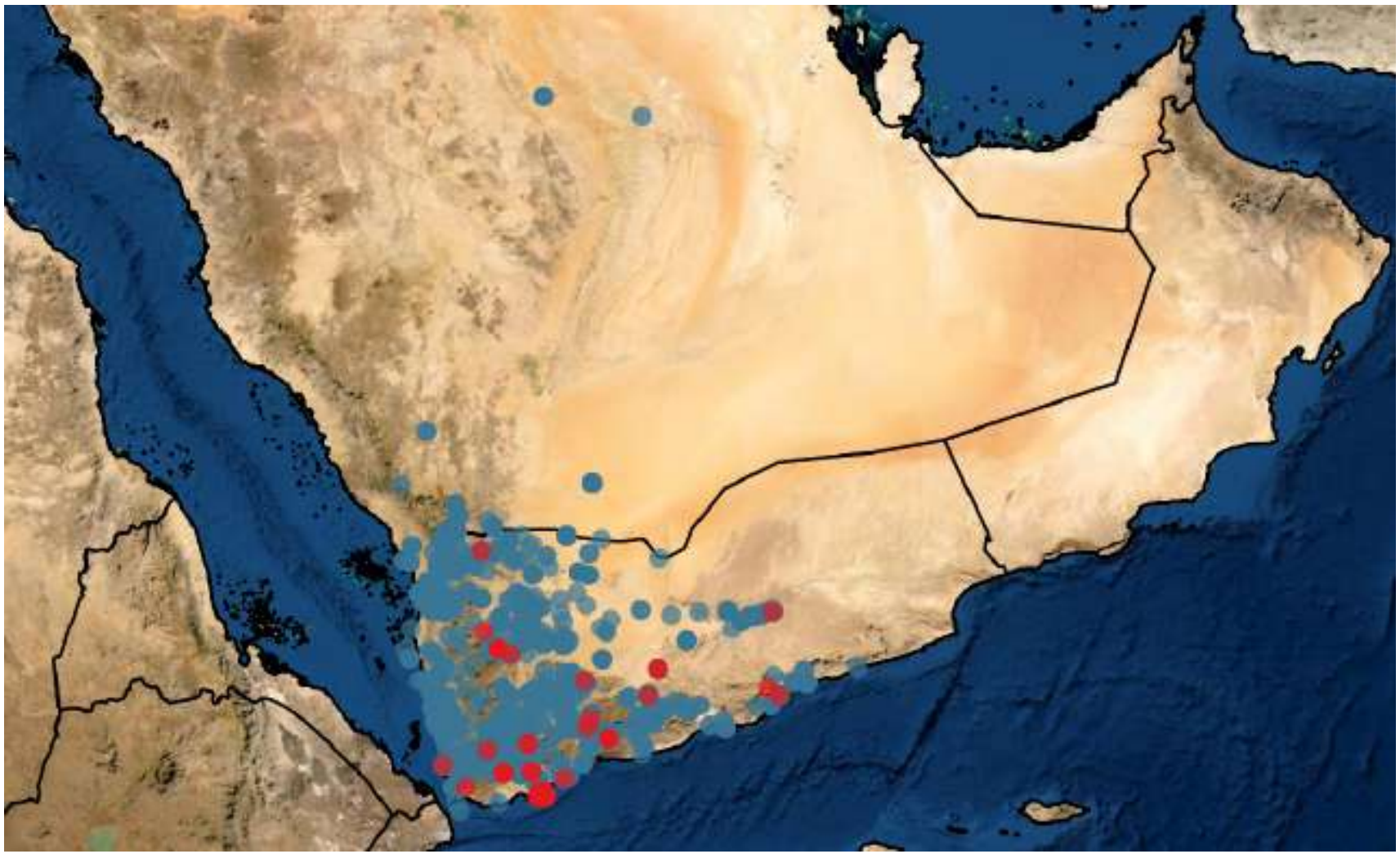
Between Government of North Yemen and Democratic Republic of Yemen



Example: Agreement on a Ceasefire in the Republic of Yemen (June 30th, 1994)

Back

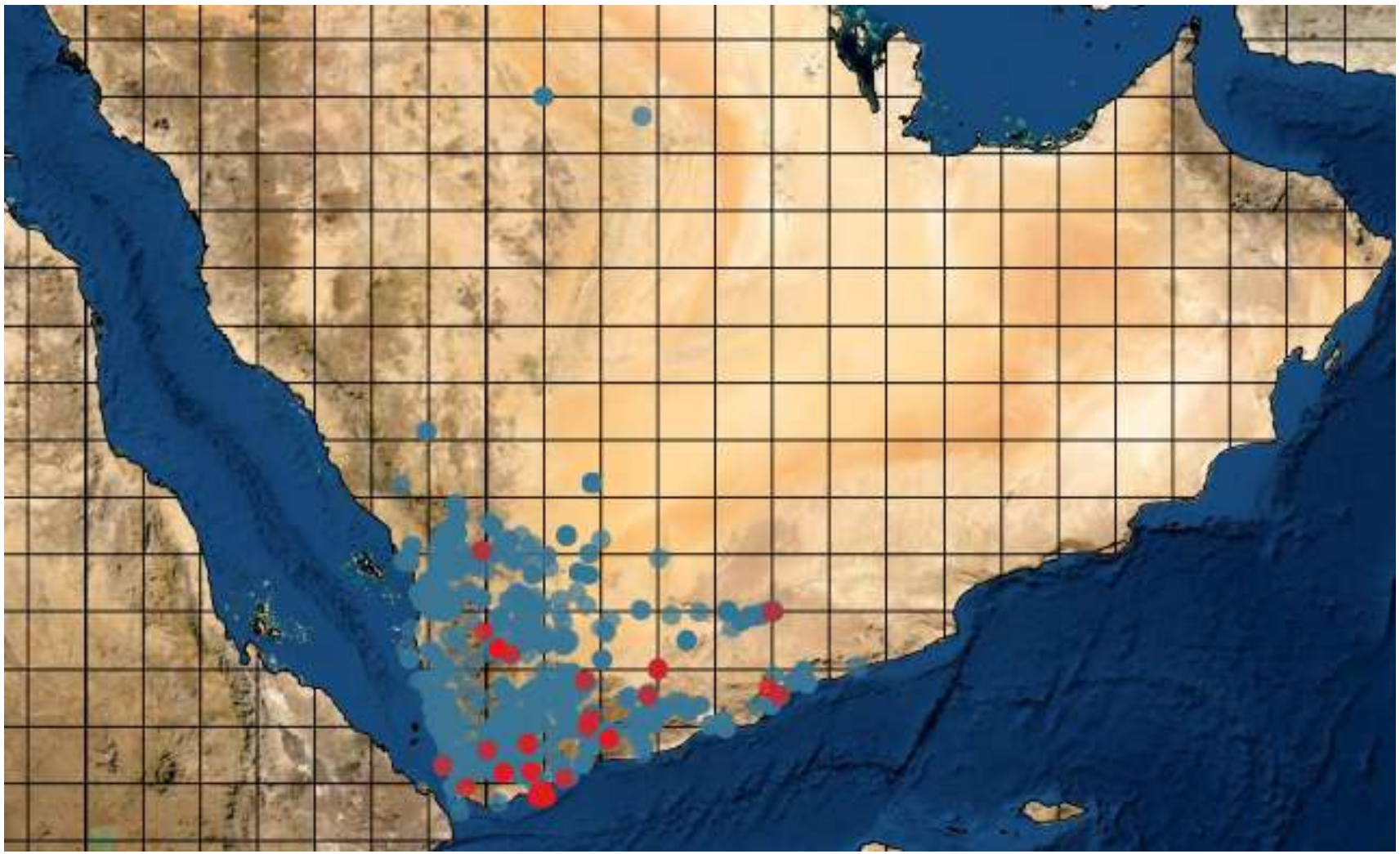
Between Government of North Yemen and Democratic Republic of Yemen



Example: Agreement on a Ceasefire in the Republic of Yemen (June 30th, 1994)

Back

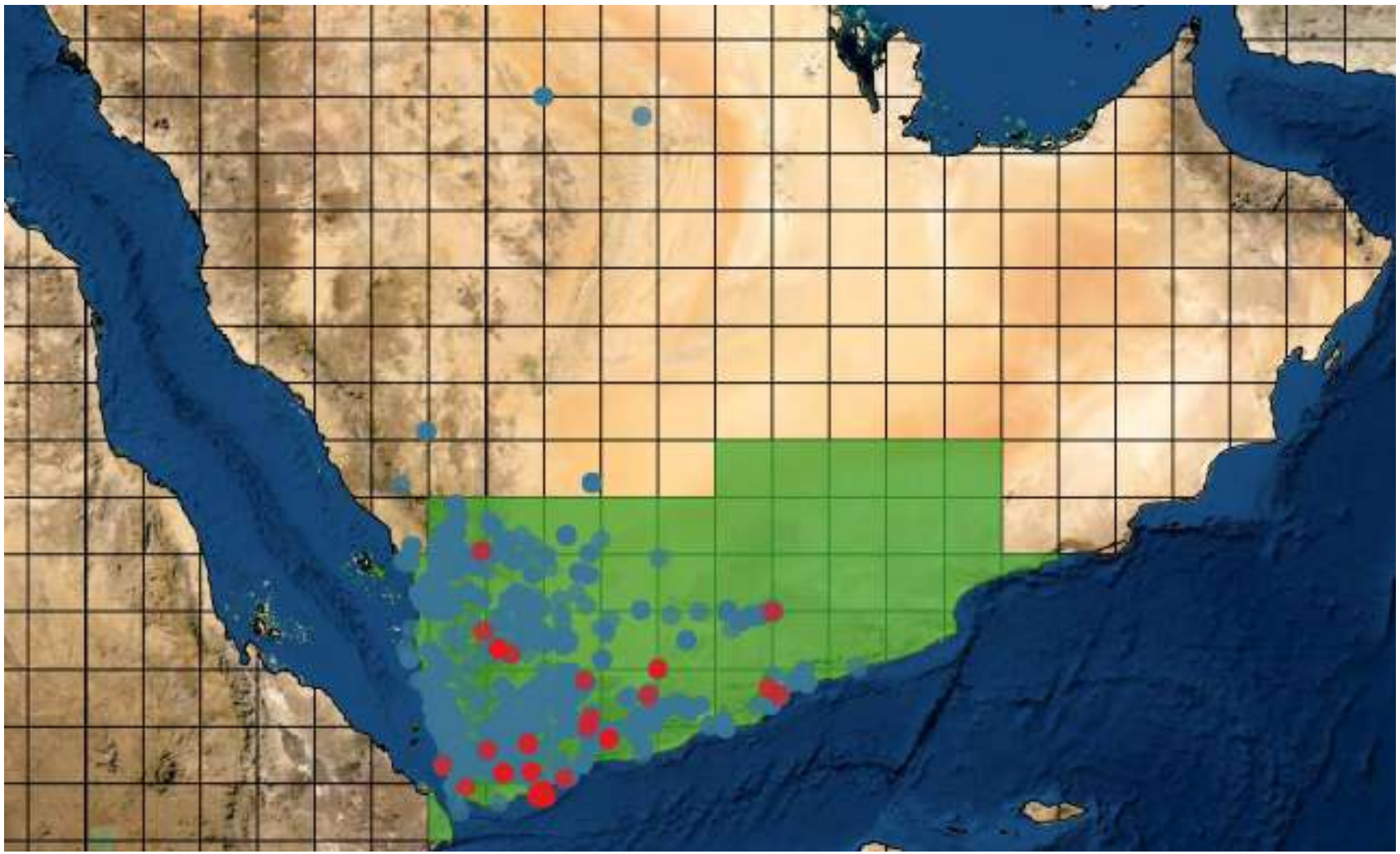
Between Government of North Yemen and Democratic Republic of Yemen



Example: Agreement on a Ceasefire in the Republic of Yemen (June 30th, 1994)

Back

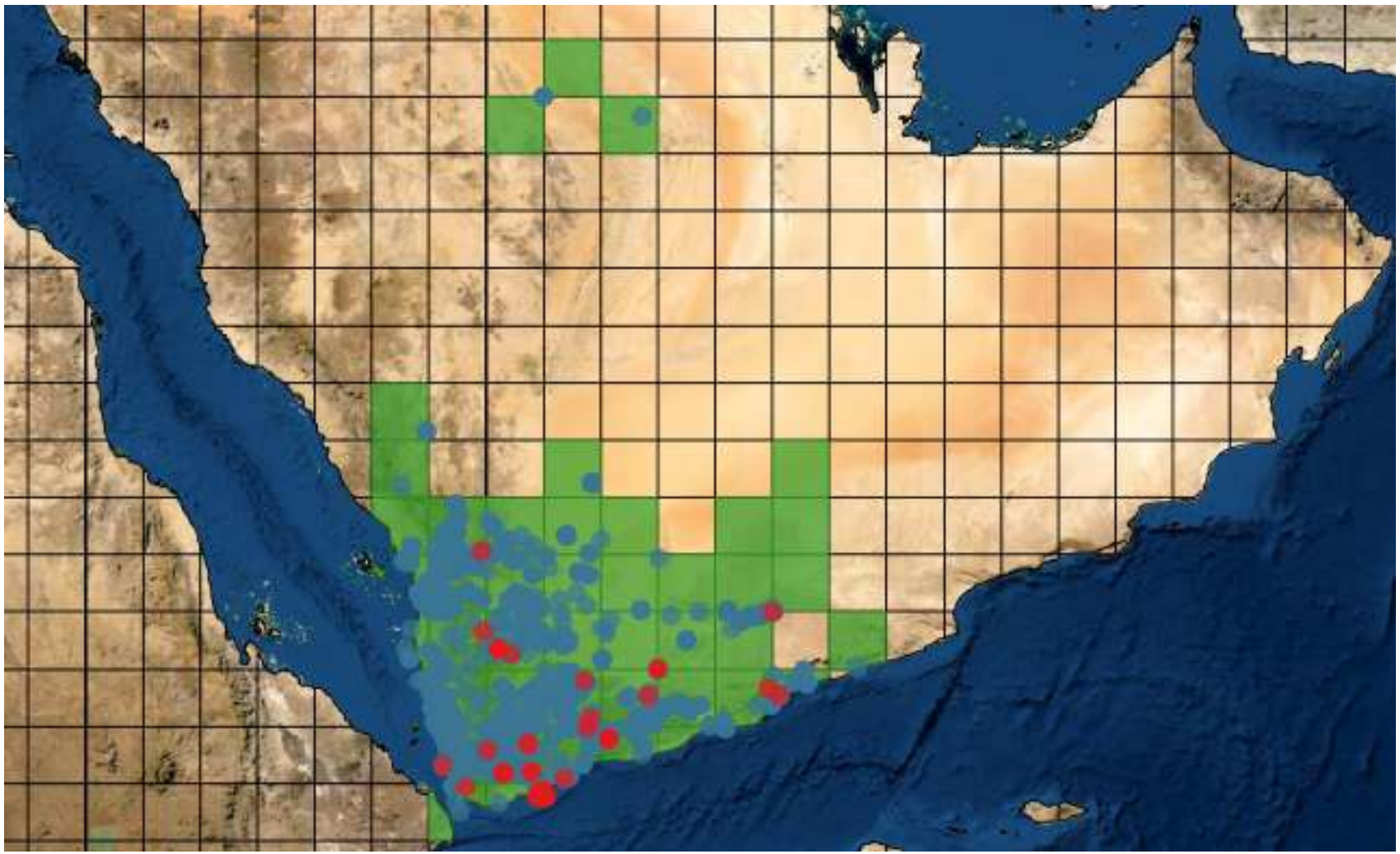
Between Government of North Yemen and Democratic Republic of Yemen



Example: Agreement on a Ceasefire in the Republic of Yemen (June 30th, 1994)

Back

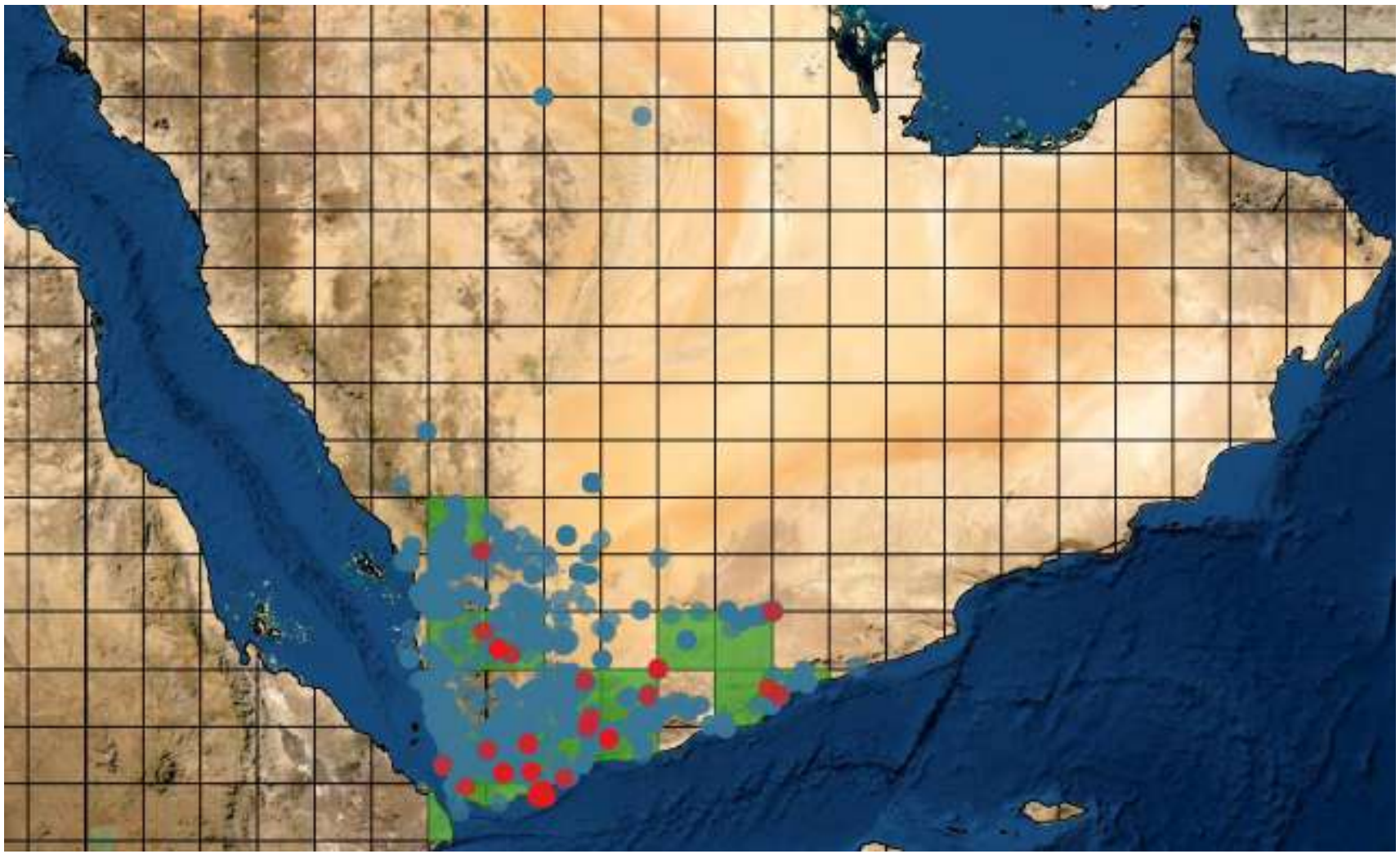
Between Government of North Yemen and Democratic Republic of Yemen



Example: Agreement on a Ceasefire in the Republic of Yemen (June 30th, 1994)

Back

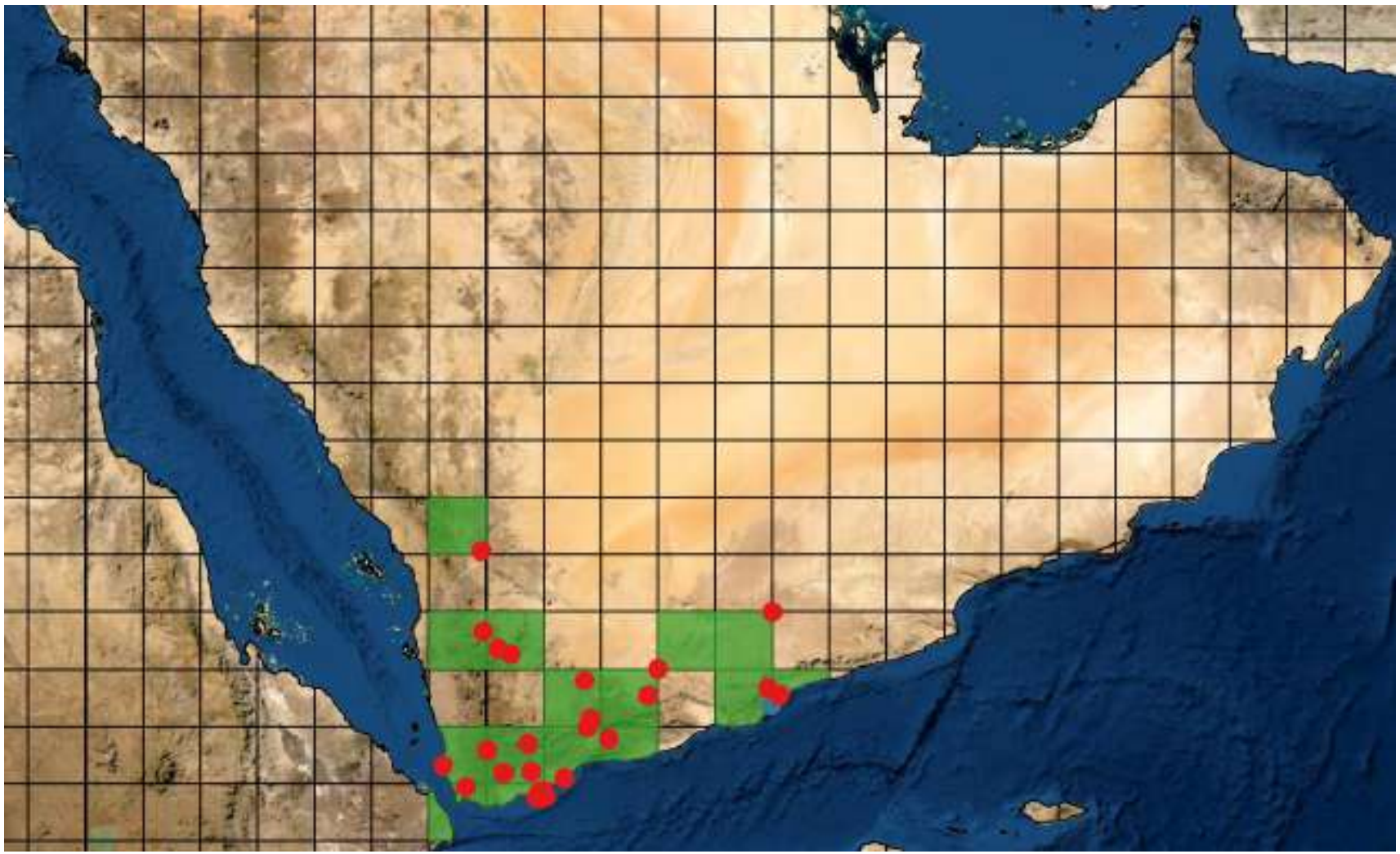
Between Government of North Yemen and Democratic Republic of Yemen



Example: Agreement on a Ceasefire in the Republic of Yemen (June 30th, 1994)

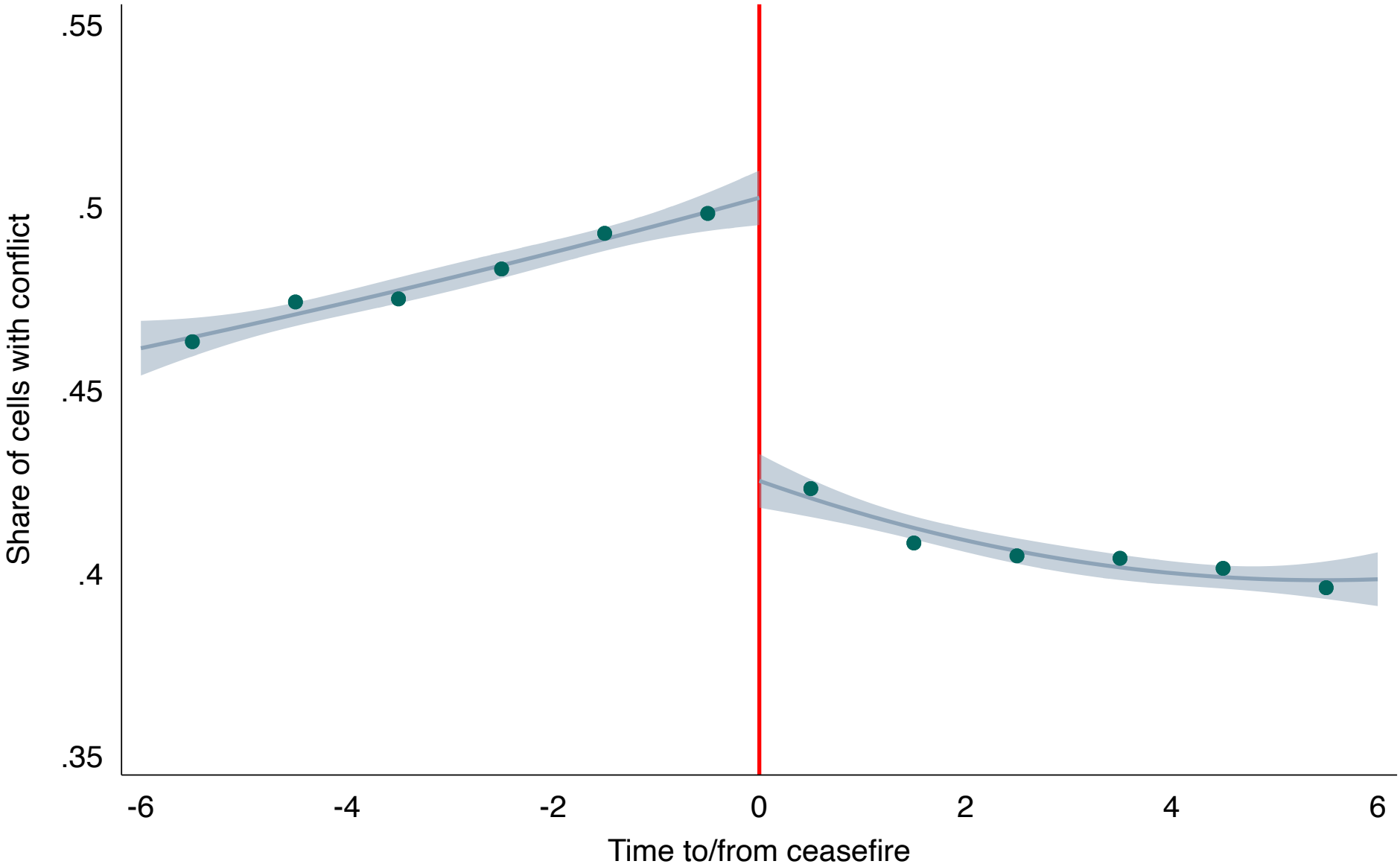
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Between Government of North Yemen and Democratic Republic of Yemen



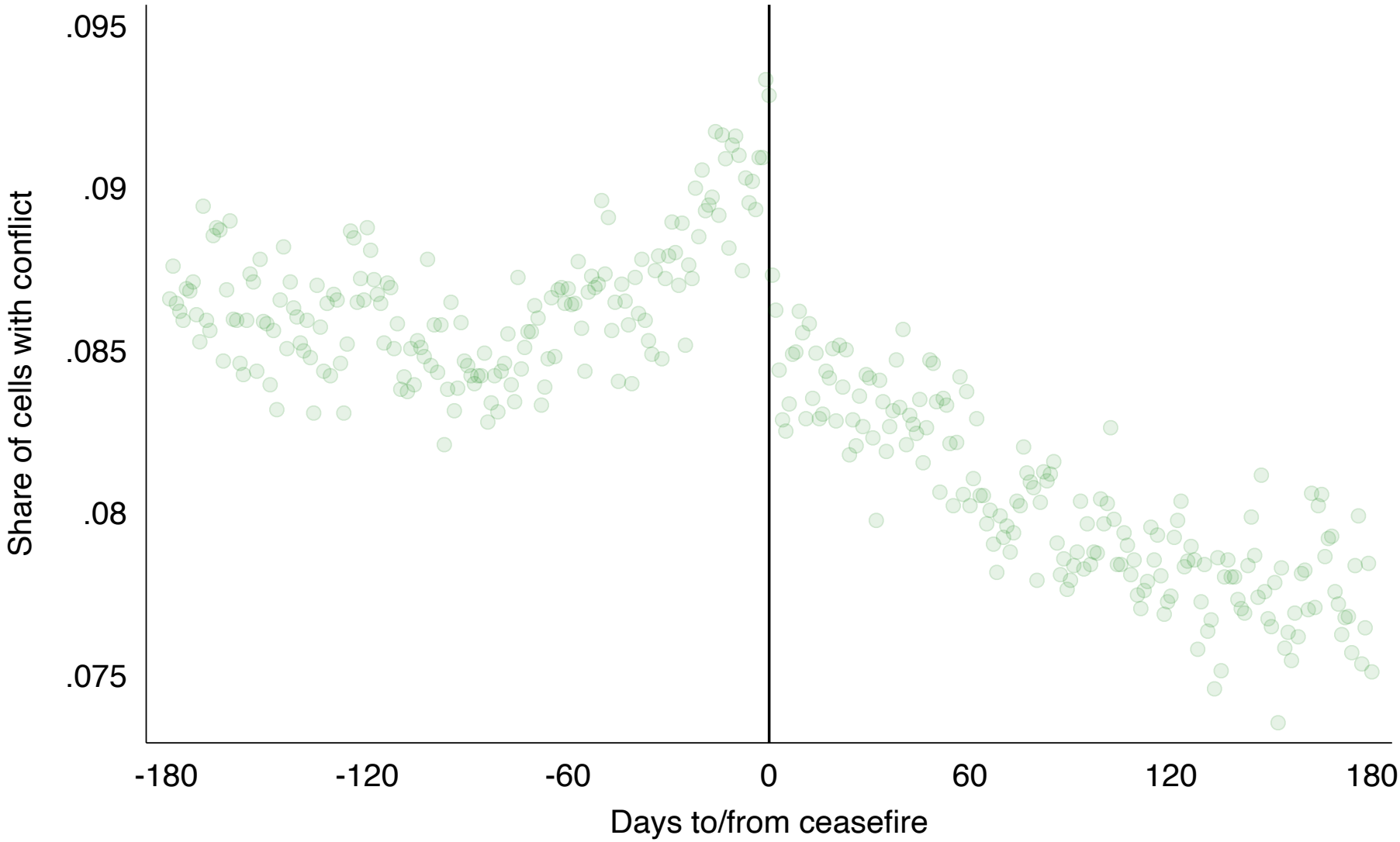
First stage: ceasefires and violence

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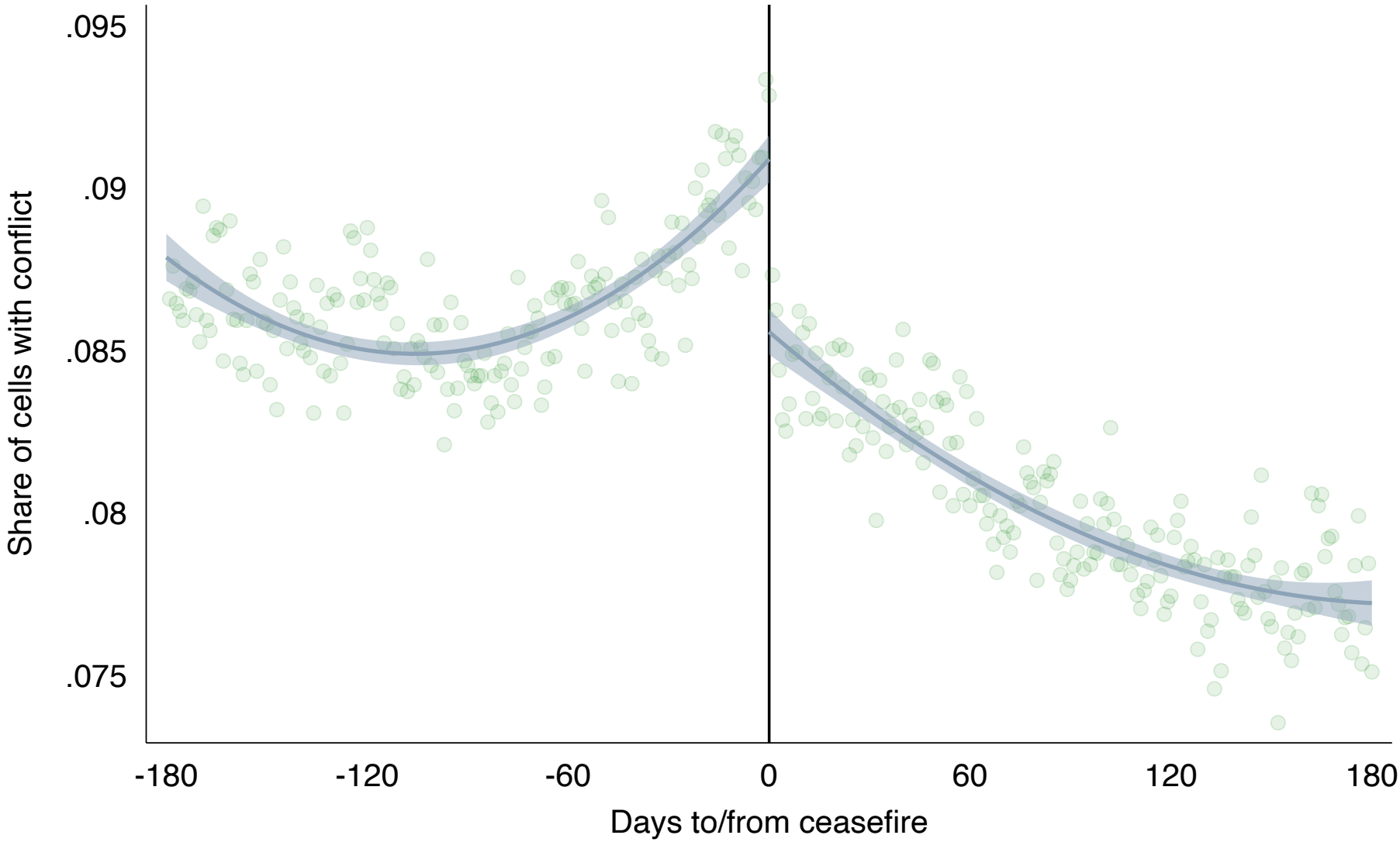
First stage (daily): ceasefires and violence

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First stage (daily): ceasefires and violence

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Disstribution of nightlight luminosity

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