Civilian Targeting
The spatio-temporal diffusion of targeting civilians in Africa

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Motivation

- **Civilian populations are often targeted in armed conflicts.**

- **Ideally we would like to understand what causes civilian targeting.**

- **For now we will be reasonably content if we can pinpoint factors that are robustly correlated with civilian targeting.**

A Special Challenge

- **Correlates of civilian targeting could cluster in time and space.**

- **In particular, neighbouring actors may feed off each other**

Previous Work

- **Ample evidence of spatial contagion of armed conflict** *(Anselin and O'Loughlin, 1992; Most and Starr, 1980; Starr and Most, 1983; Ward and Gleditsch, 2002)*

- **Ethnic conflicts spread via demonstration effects** *(Lake and Rothchild, 1998)*

- **Increasing population and ethnic diversity increase risk of conflict** *(Elbadawi and Sambanis, 2002)*

- **Beardsley, Gleditsch and Lo (2015) use the UCDP GED Polygon dataset to study the conflict zone movement**

- **One-sided violence is a function of territory control** *(Kalyvas and Kocher, 2009)*

Hypotheses

- **Civilian targeting follows a spatio-temporal diffusion process as actors react to each other.**

- **Higher population density in a conflict zone increases the risk of intentional killing of civilians.**

- **Ethnic diversity increases likelihood of killing civilians.**

- **Actors are more likely to attack civilians in prolonged conflicts.**

- **Access to mineral resources in a conflict zone increases indiscriminate attacks.**

Data: Dependent Variable

- **CTI: the percent of all deaths associated with a conflict actor that come from one-sided attacks on unarmed civilians** *(Hicks et al., 2011)*

- **CTI takes value from 0 to 100**

- **Source: UCDP Geo-referenced Event Dataset**

- **Sample coverage: Africa, 1989-2010**

- **Number of actors: 358**
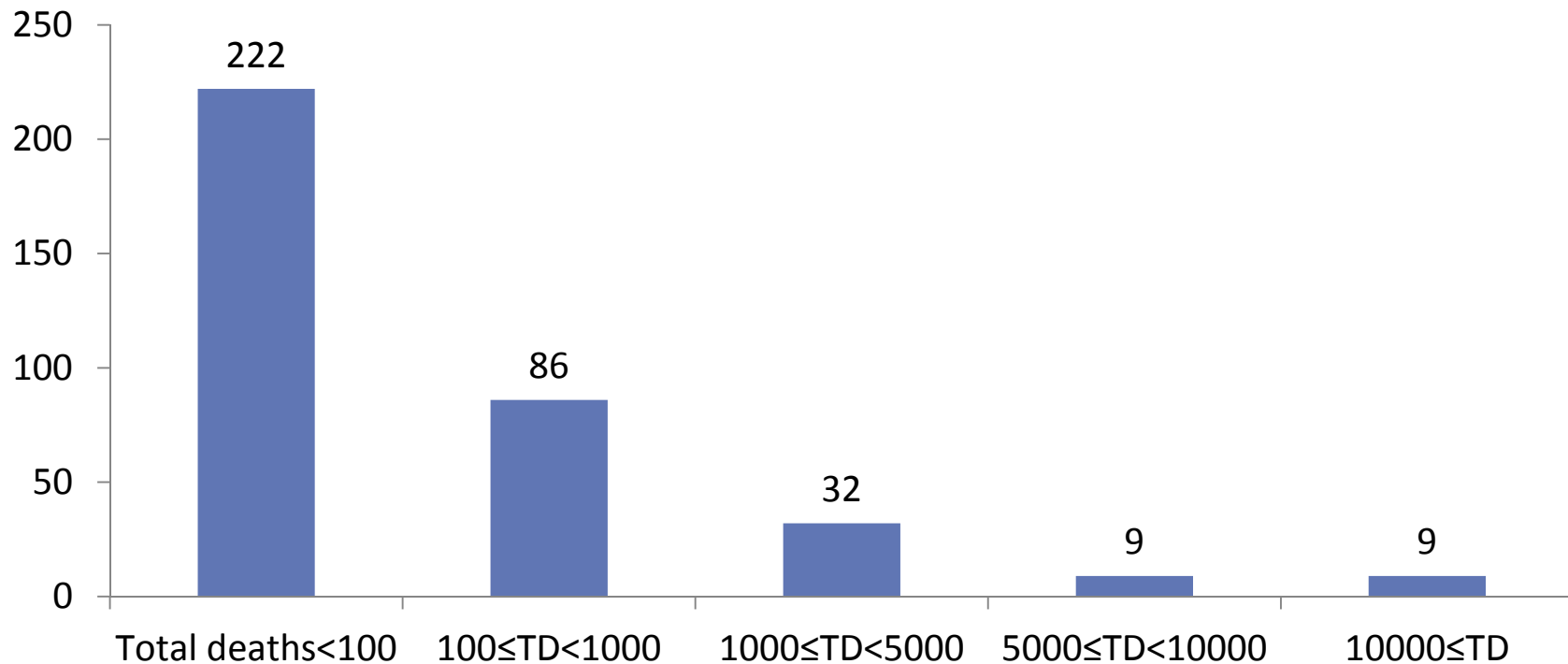 - **States: 36**
  - **Non-states: 322**

Actors by CTI
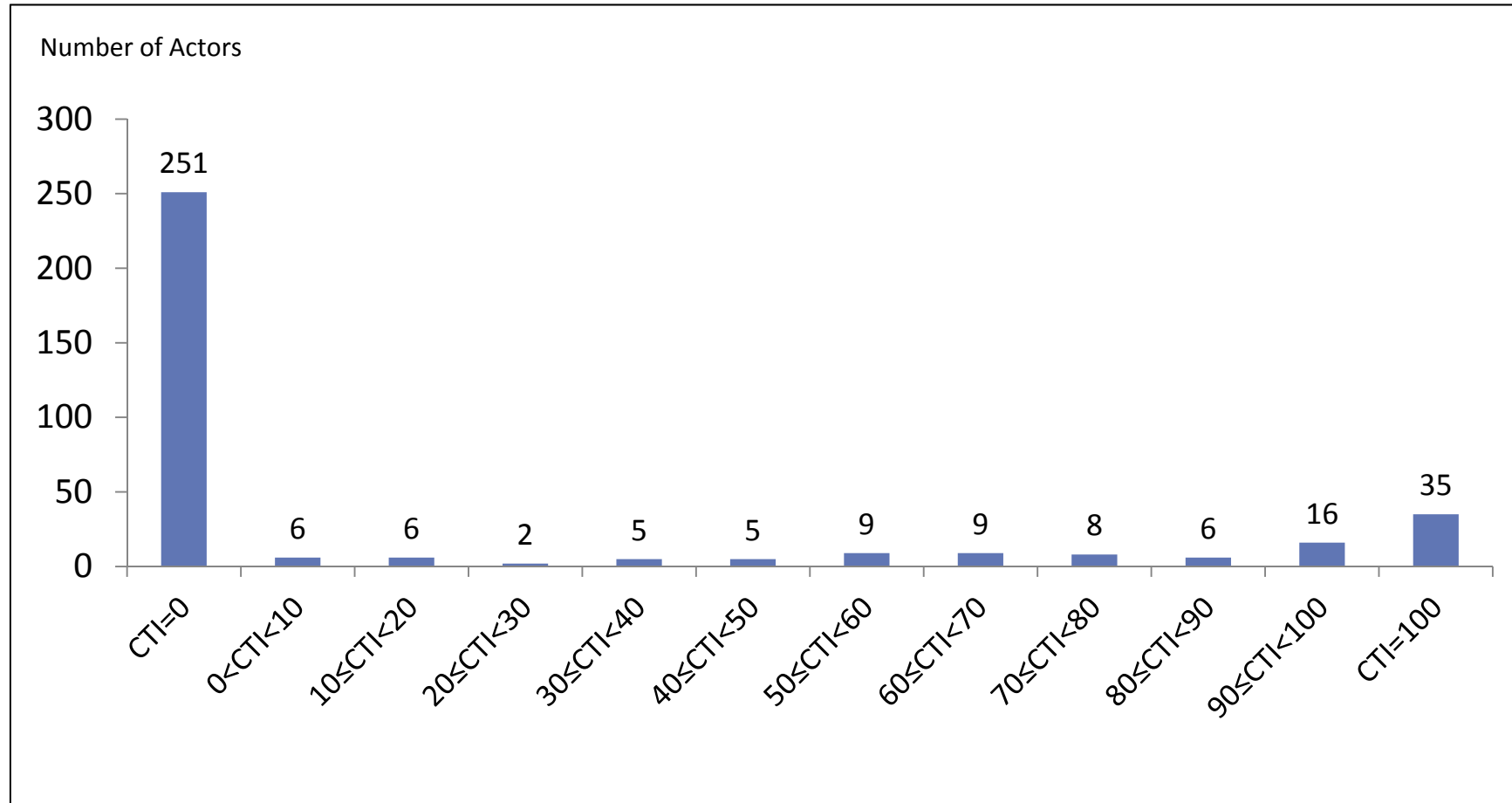
Number of Actors

- 251 out of 358 actors (70%) did not intentionally kill civilians
- 35 out of 358 actors (10%) used their lethal force against civilians only, rather than battling with other armed actors
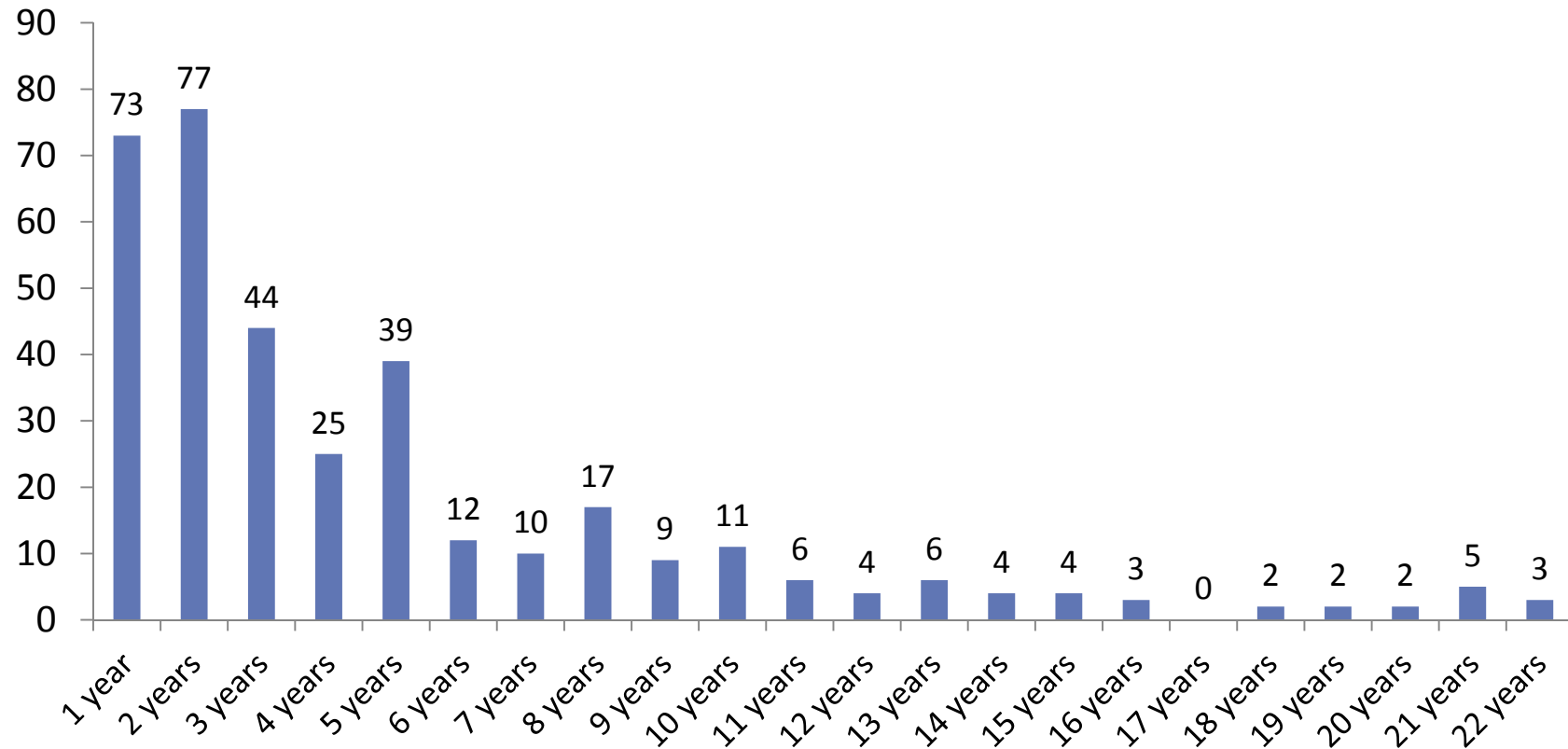
Actors by Total Deaths

Number of Actors
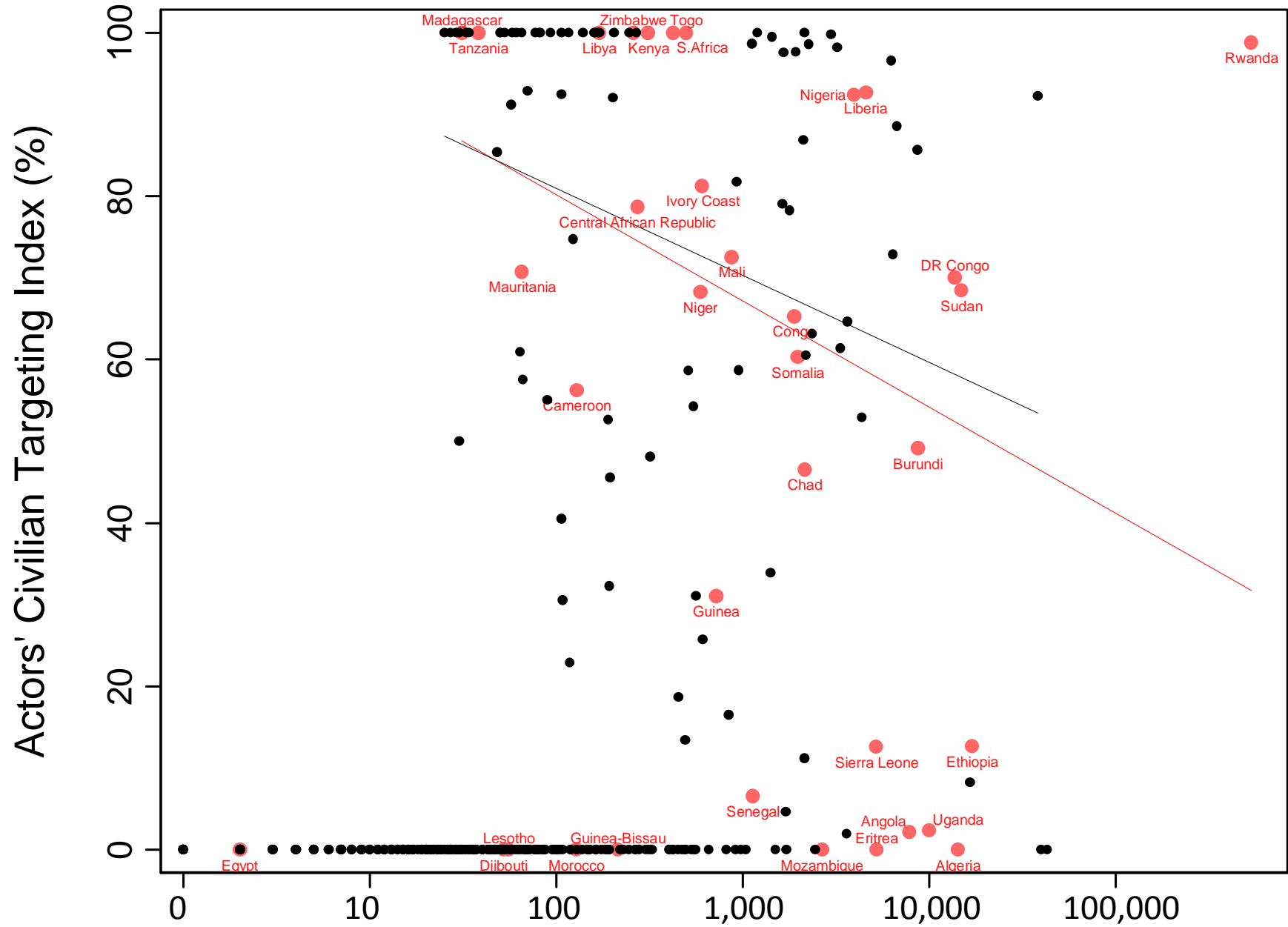

- 222 out of 358 actors (62%) are associated with less than 100 violent deaths (battle deaths + plus killing of unarmed civilians)
- Rwanda (not shown) is associated with 533,213 violent deaths (CTI of 98.8)

Actors by Duration of Conflict

Number of Actors

- 150 out of 358 actors (42%) involved in conflict 1-2 years
- 52 out of 358 actors (15%) involved in conflicts of 10 years or more

Areas of Actor Activity (1)

- **We turn to UCDP GED Polygon Dataset to construct polygons representing geographic areas of actor activity within each year**

- **A UCDP polygon covers "the smallest possible convex geographical area" encompassing conflict events in one dyad**
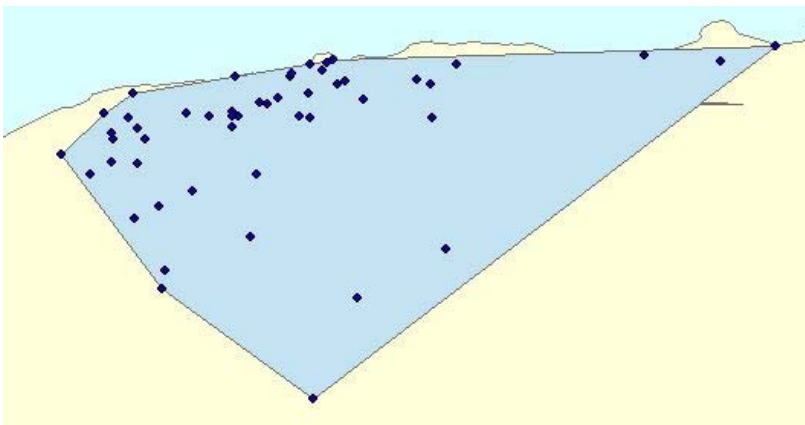
GIA (Armed Islamic Group) in 2002
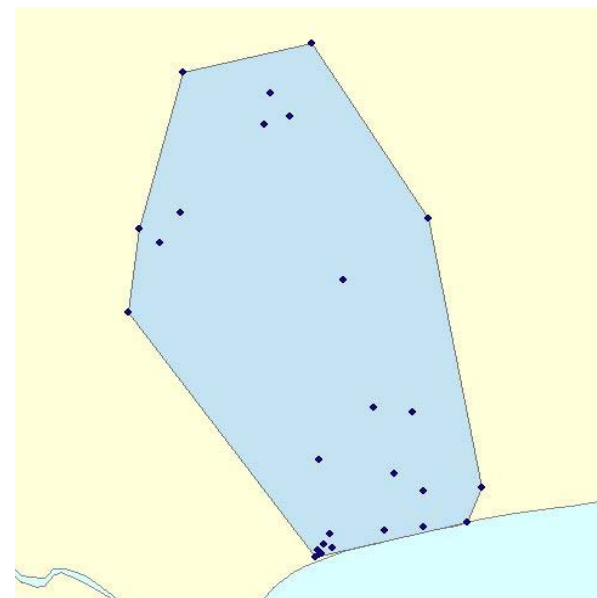
Government of Togo in 2005

Areas of Actor Activity (2)

- **Some actors are involved in more than one dyad simultaneously: we construct polygons representing all conflict activity of an actor**

- **Example:**

  Government of Liberia in 2001 was involved in two dyads represented by two polygons; we merge them to obtain one area

Two polygons → One polygon
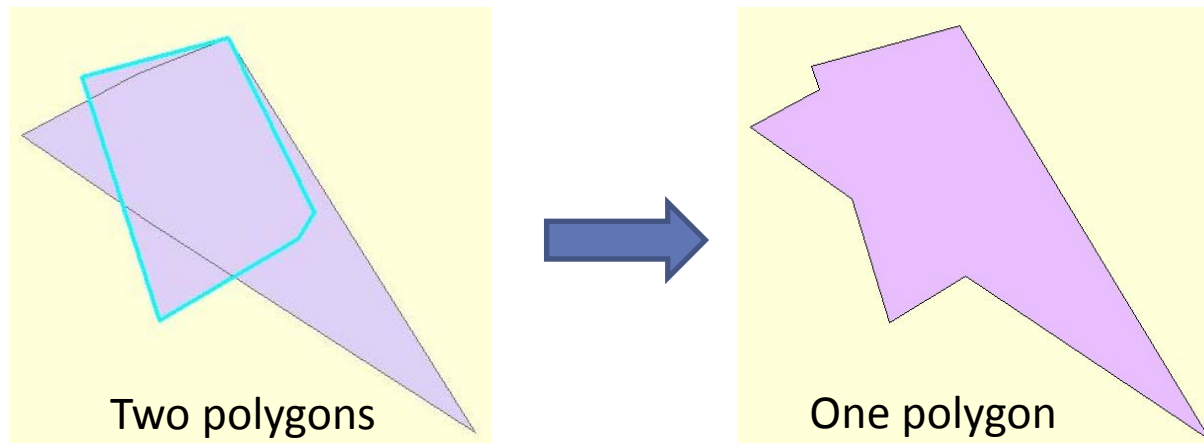
- **We drop split dyads from UCDP GED Polygon dataset (4.16% of all observations)**

Data: Exogenous Variables

We use ArcGIS to construct polygon-specific variables describing:

- Area size of a polygon in square kilometres
- Average elevation above sea level (EROS 1996)
- Dummy indicating whether polygon transcends country borders
- Number of ethnic minorities: GeoEPR 2014
- Population density (UNEP/GRID)
- Presence of mineral resources and operations (U.S. Geological Survey, 2010)

Estimation Approach

- **spatio-temporal model to account for diffusion effects**

- **neighbouring observations from earlier period enter via a spatial lag operator**

- **the temporal lag gives actors opportunity to react to their counterparts elsewhere**

- **spatial lag in the error term to account for potential unobserved spatial patterns, heterogeneity or spatially correlated omitted variables (Elhorst, 2014)**

SAC / SARAR Model

$$cti_{it} = \alpha + \lambda W cti_{j,t-1} + X\beta + u_{it}$$
$$u_{it} = \rho W u_{j,t} + \epsilon_{it}$$
$$i \neq j$$

- $Wcti_{j,t-1}$ – spatially and temporally lagged CTI
- X – vector of exogenous regressors
- error term u_{it} can be decomposed:
  - Wu_{jt} – spatially correlated effects (spillover effects)
  - ε_{it} – unobserved local latent factors
- λ – measures spatio-temporal diffusion
- ρ – measures spatial spillovers from exogenous shocks

Constructing *W* matrix: Actor Dynamics

For each year we have a bunch of polygons - most actors are not active during every sample period
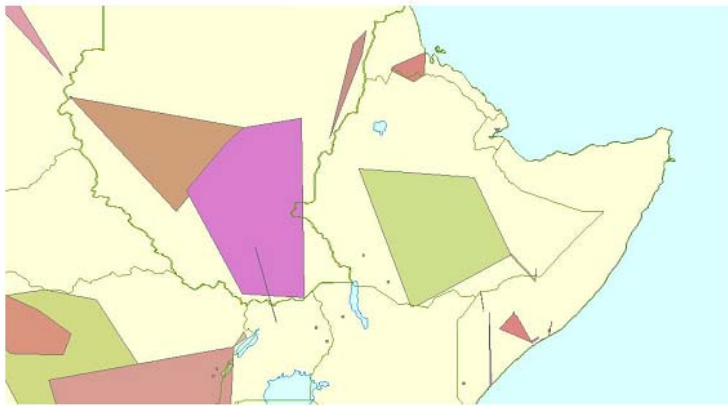
(a) 1999
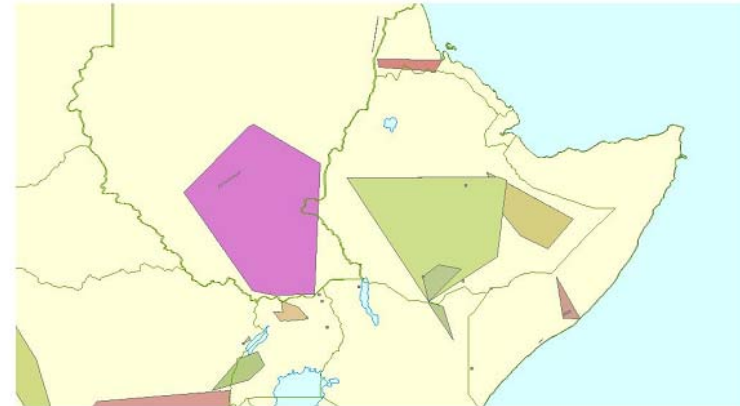
(b) 2000
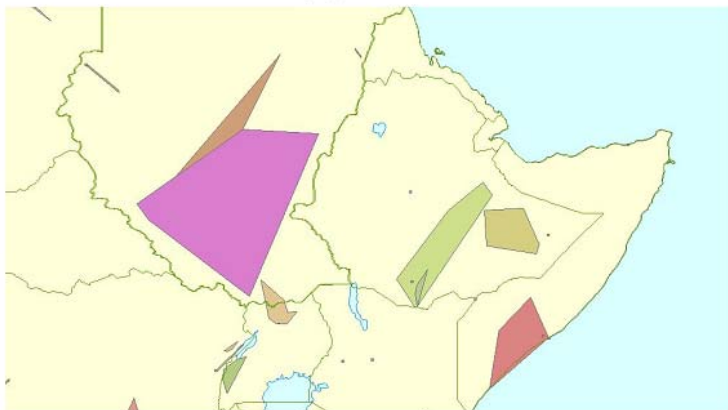
(c) 2001
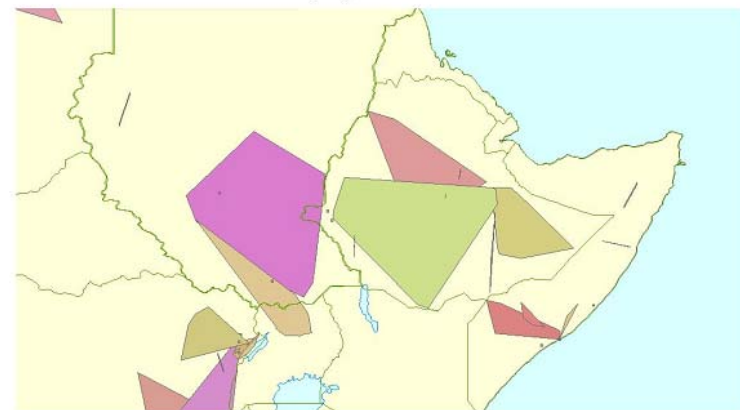
(d) 2002

Spatio-temporal weighting Matrix *W*

- **Cross-sections stacked over *T* time periods**
- **Temporal effects are one-directional and chronological**
- **It picks CTI of all other actors at a lag of *t*-1 and assigns weights based on inverse distance**
- **Initially we make the rows add up to 1 (row-standardization)**

Time		1	1	1	2	2	2	3	3	3
	Actor	A	B	C	A	B	C	A	B	C
1	A	0	0	0	0	0	0	0	0	0
1	B	0	0	0	0	0	0	0	0	0
1	C	0	0	0	0	0	0	0	0	0
2	A	0	w	w	0	0	0	0	0	0
2	B	w	0	w	0	0	0	0	0	0
2	C	w	w	0	0	0	0	0	0	0
3	A	0	0	0	0	w	w	0	0	0
3	B	0	0	0	w	0	w	0	0	0
3	C	0	0	0	w	w	0	0	0	0

| | All actors | |
| | MLE | GS2SLS |
	(1)	(2)
Population density (log)	3.016*** (3.59)	2.949*** (3.44)
Minorities	0.889** (2.49)	0.875** (2.44)
Area (sq.km, log)	1.167* (1.80)	1.194* (1.84)
Elevation (log)	0.540 (0.46)	0.573 (0.49)
State	7.213** (2.16)	6.953** (2.13)
Years since outbreak	0.362 (1.16)	0.374 (1.20)
Cross-border	2.335 (0.73)	2.307 (0.72)
Resources	2.527 (0.65)	2.535 (0.65)
Constant	-11.13 (-1.22)	-12.32 (-1.27)
$\hat{\lambda}$	0.248*** (2.76)	0.284** (2.04)
$\hat{\rho}$	-0.0685 (-1.17)	-0.0588 (-1.02)
$\hat{\sigma}^2$	1512.1*** (21.15)	
N	896	896

All actors

The CTI is the dependent variable

t statistics are in parentheses

	State		Non-state	
	MLE (3)	GS2SLS (4)	MLE (5)	GS2SLS (6)
Population density(log)	0.517 (0.28)	0.342 (0.18)	3.332*** (3.74)	3.401*** (3.73)
Minorities	1.197** (2.21)	1.296** (2.40)	0.619 (1.26)	0.592 (1.20)
Area (sq.km, log)	-1.033 (-0.78)	-0.914 (-0.68)	1.411* (1.95)	1.390* (1.91)
Elevation (log)	-0.278 (-0.11)	-0.217 (-0.09)	1.612 (1.29)	1.514 (1.18)
Years since outbreak	-1.092** (-2.57)	-1.029** (-2.50)	2.429*** (5.33)	2.454*** (5.36)
Cross-border	-8.435 (-1.27)	-9.764 (-1.46)	3.386 (0.97)	3.419 (0.97)
Resources	17.61*** (2.75)	18.05*** (2.78)	-5.561 (-1.15)	-4.943 (-1.02)
Constant	55.42*** (2.88)	37.67* (1.92)	-32.49*** (-3.30)	-28.84*** (-2.79)
$\hat{\lambda}$	-0.0900 (-0.52)	0.316* (1.86)	0.531*** (5.97)	0.404*** (3.12)
$\hat{\rho}$	-0.0581 (-0.42)	-0.171 (-1.49)	-0.0448 (-0.59)	0.0124 (0.17)
$\hat{\sigma}^2$	1658.2*** (11.35)		1270.3*** (17.86)	
N	258	258	638	638

State and non-state actors

The CTI is the dependent variable

t statistics are in parentheses

Mineral resources

The CTI is the dependent variable

t statistics are in parentheses

	Petrol (1)	Coal (2)	Gold (3)	Diamond (4)	Copper (5)	All (6)
Population density(log)	3.150*** (3.77)	3.076*** (3.66)	2.963*** (3.54)	3.055*** (3.64)	3.055*** (3.65)	3.102*** (3.70)
Minorities	1.337*** (3.55)	0.991*** (2.82)	0.699* (1.91)	0.928** (2.57)	0.776** (2.19)	0.965** (2.42)
Area (sq.km, log)	1.518** (2.46)	1.534** (2.45)	1.195* (1.94)	1.289** (2.06)	1.275** (2.08)	1.588** (2.53)
Elevation (log)	0.0959 (0.08)	0.765 (0.66)	0.446 (0.39)	0.634 (0.55)	0.593 (0.51)	0.0205 (0.02)
State	7.325** (2.21)	7.123** (2.15)	7.385** (2.22)	7.410** (2.22)	6.451* (1.93)	6.127* (1.86)
Years since outbreak	0.301 (0.98)	0.229 (0.73)	0.370 (1.20)	0.335 (1.08)	0.391 (1.26)	0.296 (0.95)
Cross-border	2.582 (0.81)	2.703 (0.84)	2.220 (0.70)	2.390 (0.75)	2.679 (0.84)	2.934 (0.92)
Petrol	-12.34*** (-2.79)					-11.12** (-2.26)
Coal		-14.27** (-2.17)				-14.57** (-2.15)
Gold			10.86** (2.05)			9.763* (1.70)
Diamond				0.449 (0.08)		1.716 (0.25)
Copper					31.78** (2.49)	29.22** (2.21)
Constant	-10.84 (-1.24)	-14.25 (-1.62)	-10.48 (-1.19)	-12.62 (-1.43)	-11.79 (-1.35)	-9.295 (-1.04)
$\hat{\lambda}$	0.231** (2.57)	0.231** (2.54)	0.258*** (2.88)	0.251*** (2.79)	0.241*** (2.67)	0.212** (2.32)
$\hat{\rho}$	-0.0707 (-1.20)	-0.0547 (-0.92)	-0.0761 (-1.30)	-0.0703 (-1.19)	-0.0606 (-1.03)	-0.0515 (-0.85)
$\hat{\sigma}^2$	1499.7*** (21.15)	1505.3*** (21.16)	1505.4*** (21.15)	1512.7*** (21.15)	1502.6*** (21.16)	1477.6*** (21.16)
N	896	896	896	896	896	896

Mineral resources– number of sites

The CTI is the dependent variable

t statistics are in parentheses

	Petrol (1)	Coal (2)	Gold (3)	Diamond (4)	Copper (5)	All (6)
Population density(log)	3.180*** (3.80)	3.020*** (3.60)	2.994*** (3.57)	3.002*** (3.57)	3.057*** (3.65)	3.128*** (3.74)
Minorities	1.298*** (3.49)	0.892** (2.52)	0.849** (2.36)	0.956*** (2.73)	0.865** (2.43)	1.181*** (3.11)
Area (sq.km, log)	1.532** (2.48)	1.269** (2.06)	1.249** (2.03)	1.373** (2.20)	1.299** (2.11)	1.458** (2.35)
Elevation (log)	0.316 (0.27)	0.585 (0.51)	0.554 (0.48)	0.711 (0.61)	0.647 (0.56)	-0.0733 (-0.06)
State	7.370** (2.23)	7.432** (2.23)	7.425** (2.23)	7.465** (2.24)	7.175** (2.15)	7.213** (2.17)
Years since outbreak	0.294 (0.95)	0.360 (1.16)	0.369 (1.19)	0.320 (1.03)	0.335 (1.09)	0.383 (1.24)
Cross-border	2.220 (0.70)	2.312 (0.72)	2.353 (0.74)	2.495 (0.78)	2.549 (0.80)	2.011 (0.63)
Petrol	-6.328*** (-2.75)					-8.813*** (-3.25)
Coal		0.651 (0.67)				0.706 (0.40)
Gold			0.873 (0.97)			1.558 (0.94)
Diamond				-0.582 (-0.67)		0.376 (0.40)
Copper					1.354 (1.05)	0.887 (0.67)
Constant	-12.45 (-1.43)	-12.23 (-1.40)	-11.90 (-1.36)	-13.47 (-1.53)	-12.49 (-1.43)	-9.731 (-1.11)
$\hat{\lambda}$	0.233*** (2.59)	0.257*** (2.85)	0.261*** (2.90)	0.249*** (2.77)	0.245*** (2.72)	0.252*** (2.81)
$\hat{\rho}$	-0.0693 (-1.17)	-0.0742 (-1.26)	-0.0780 (-1.32)	-0.0684 (-1.16)	-0.0667 (-1.13)	-0.0877 (-1.47)
$\hat{\sigma}^2$	1500.1*** (21.15)	1511.8*** (21.15)	1510.8*** (21.15)	1512.0*** (21.15)	1511.0*** (21.16)	1489.8*** (21.15)
N	896	896	896	896	896	896
No. of sites	55	26	95	55	67	298
No. of polygons with sites	122	40	72	66	10	182

SAR model and no row-standardisation (MLE, *dependent variable: CTI*)

	Row-standardised				Without row-standardisation			
	All (1)	State (2)	Non-state (3)	Resources (4)	All (5)	State (6)	Non-state (7)	Resources (8)
Population density(log)	3.015*** (3.52)	0.516 (0.27)	3.310*** (3.68)	3.085*** (3.63)	2.886*** (3.32)	0.684 (0.36)	3.423*** (3.75)	2.962*** (3.44)
Minorities	0.886** (2.43)	1.231** (2.30)	0.588 (1.20)	0.956** (2.36)	0.971*** (2.66)	1.296** (2.44)	0.831* (1.67)	1.032** (2.56)
Area (sq.km, log)	1.208* (1.84)	-1.071 (-0.81)	1.413* (1.95)	1.648*** (2.61)	1.232* (1.87)	-1.393 (-1.03)	1.467** (1.99)	1.660*** (2.62)
Elevation (log)	0.511 (0.43)	-0.203 (-0.08)	1.603 (1.26)	0.0330 (0.03)	-0.00192 (-0.00)	0.580 (0.22)	0.388 (0.30)	-0.466 (-0.38)
State	6.408** (1.98)			5.566* (1.73)	7.023** (2.16)			6.086* (1.90)
Years since outbreak	0.408 (1.29)	-1.080** (-2.49)	2.445*** (5.35)	0.325 (1.03)	0.337 (1.06)	-1.087** (-2.51)	2.369*** (5.11)	0.265 (0.84)
Cross-border	2.436 (0.75)	-8.033 (-1.22)	3.298 (0.94)	3.042 (0.95)	2.159 (0.66)	-7.256 (-1.10)	3.577 (1.01)	2.773 (0.86)
Resources	2.730 (0.69)	17.42*** (2.73)	-5.336 (-1.10)		2.629 (0.66)	17.70*** (2.77)	-4.649 (-0.95)	
Petrol				-11.05** (-2.22)				-11.46** (-2.31)
Coal				-15.44** (-2.28)				-15.23** (-2.24)
Gold				9.961* (1.71)				9.796* (1.68)
Diamond				1.019 (0.15)				1.662 (0.24)
Copper				30.44** (2.30)				31.22** (2.36)
Constant	-9.927 (-1.07)	56.52*** (2.94)	-31.82*** (-3.21)	-8.650 (-0.96)	-2.557 (-0.29)	52.33*** (2.90)	-15.69 (-1.60)	-1.880 (-0.22)
$\hat{\lambda}$	0.200** (2.39)	-0.134 (-0.90)	0.510*** (6.06)	0.174** (2.11)	0.0124** (2.14)	-0.157 (-1.16)	0.0291*** (4.32)	0.0114** (1.98)
$\hat{\sigma}^2$	1515.7*** (21.17)	1660.1*** (11.36)	1271.3*** (17.86)	1479.6*** (21.17)	1517.7*** (21.17)	1656.7*** (11.36)	1306.3*** (17.86)	1480.4*** (21.17)
N	896	258	638	896	896	258	638	896

Summary of Findings

- **More densely populated conflict zones are associated with higher CTI (significant for non-state actors)**

- **The number of minorities is positively linked to CTI for state actors**

- **State actors are associated with higher CTI**

- **However, in longer lasting conflicts it seems that the CTI's of non-state actors catch up with the CTI's of state actors.**

Summary of Findings

- Higher CTI's seem to spread from actor to actor

- Resources as a whole, i.e., aggregating together petrol, coal, gold, diamond and copper, appear to have a positive association with CTI's of state actors

- However, once we disaggregate resources the only robust association seems to be between petrol and lower CTI's

- More research into resources would be useful

Summary of Findings

- Access to mineral resources increases states' CTI

- Energy sources (petrol & coal) reduce CTI

- Gold and copper mines increase CTI

- No evidence of any effect of diamond mines