Water Wars

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Motivation

Access to water essential for human life and economic activity:

- 57% of the global population lives in areas that suffer water scarcity.
  (Mekonnen and Hoekstra, 2016)
- Climate change → exacerbates the issue.
- Cooperation in water management and the potential for conflicts over water access key concern for policy-makers.
  (UN, 2023)

Accelerating water wars

Haitham Nouri , Tuesday 18 Jul 2023

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Conflict over water as farmers upstream divert rivers

RIVER DRIES, DOWNSTREAM FARMERS SUFFER

Thika residents unblock diverted River Ndarugu

Farmers say they had been given permission by a chief to block the river and use the water for irrigation

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SUB-SAHARAN AFRICA | LAND AND FOOD

Communal Conflicts Across the Kenyan-Ugandan Border

Livestock raiding and competition for water and pastures lead to cycles of reciprocal violence between pastoralist groups in the Kenyan-Ugandan border region. More frequent and severe droughts as well as the proliferation of weapons from war-torn neighbour countries are further aggravating this situation.

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World

As water falls short, conflict between herders and farmers sharpens

Conflicts over water

1) Resources and land appropriation.

2) Prevent water diversion or water blockage.

3) Cattle grazing:
   - Pastors VS pastors.
   - Pastors VS Farmers (McGuirk Nunn 2024; Eberle Rohner Thoenig 2023).

This paper

Q: Does water scarcity increase conflicts over water resources?

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- *Novel approach to detect conflicts related to water resources:*
  - **Where?** Granular data on rivers network:
    - up-downstream relationship
    - water flow
  - **When?** Rainfall shocks (droughts) in neighborhood.

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- *Novel approach to detect conflicts related to water resources:*
  - **Where?** Granular data on rivers network:
    - up-downstream relationship
    - water flow
  - **When?** Rainfall shocks (droughts) in neighborhood.
- *Focus on Africa:*
  - Largely agrarian.
  - Ethnic grievances (more difficult to share).
  - Lack of infrastructures (e.g. irrigation).
  - Weak states.

Main Findings

- ⋆ Rivers network structure is important to understand climate - water conflicts nexus.
- ⋆ Droughts downstream increase conflicts in water rich areas upstream.

  $\Longrightarrow$ Increase up to 7.3% of mean level of conflicts in high water presence cells.
- ⋆ Economic value of water (agriculture), difficult cooperation (ethnic grievances), desertification and weak institutions $\rightarrow$ relevant for the issue.

Contributions to the literature

- **Climate change, weather shocks and conflict** Burke, Hsiang and Miguel, 2015; Sarsons, 2015; Harari and La Ferrara, 2018; ...

  ⇝ Control of freshwater resources as a specific mechanism Eberle et al, 2020; McGuirk and Nunn, 2023

  ⇝ Rivers network as exact structure of spatial spillovers König et al, 2017; McGuirk and Nunn, 2023; Couttenier et al. (2023)

- **Natural resources and conflict** Dube and Vargas, 2013; Berman et al, 2017; McGuirk and Burke, 2020; Adhvaryu et al, 2021; ...

  ⇝ Water as a resource curse

- **Rivers-Freshwater & conflict**: Eberle 2020 WP; Döring 2019 Polit Geogr; Gleditsch et al Polit Geogr 2014; Almer et al. 2017 JEEM

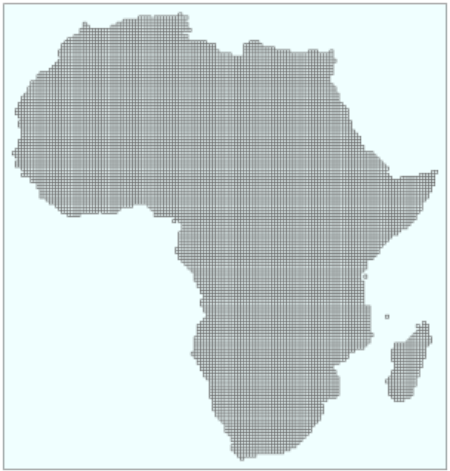
  ⇝ Use water disaggregated data.

- **Introduction**
- **Data**
- **Empirical strategy & Main Results**
- **Heterogeneity**
- **Conclusions**

Data

Data

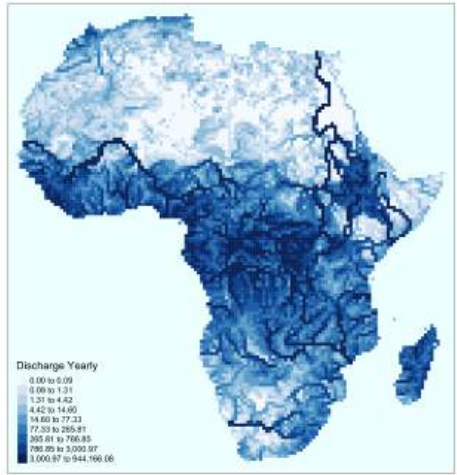
- Panel at $0.5° \times 0.5°$ cell-year level for period 1997-2021.



Data

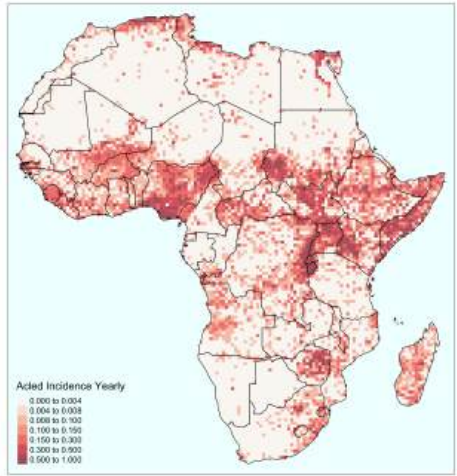
- ⋆ Panel at $0.5° \times 0.5°$ cell-year level for period 1997-2021.

- Hydrology
  - Discharge: Volume rate of water flow, $0.05° \times 0.05°$ ERA5
  - Rivers network: Upstream/Downstream relationships HydroSHEDS



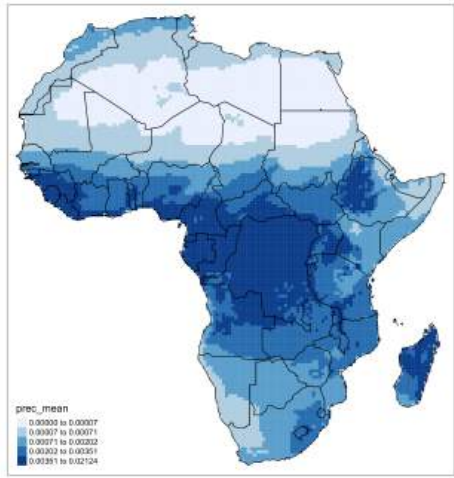
Data

- ⋆ Panel at $0.5° \times 0.5°$ cell-year level for period 1997-2021.
- Hydrology
- Conflicts
  - ACLED: violent events 1997-2021.



Data

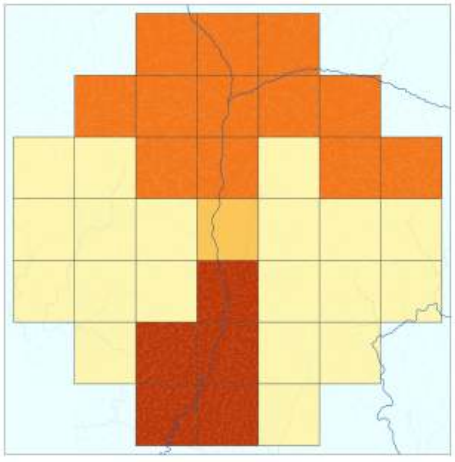
- ⋆ Panel at $0.5° \times 0.5°$ cell-year level for period 1997-2021.
- Hydrology
- Conflicts
- Rainfall
  - Yearly precipitation ERA5 1951-2021
  - **Shock:** calendar year rainfall $\leq$ 15th percentile of a location's long-run rainfall distribution (as in Burke et al. 2015 EJ and Corno et al. 2020 ECMA)



Variables Definition

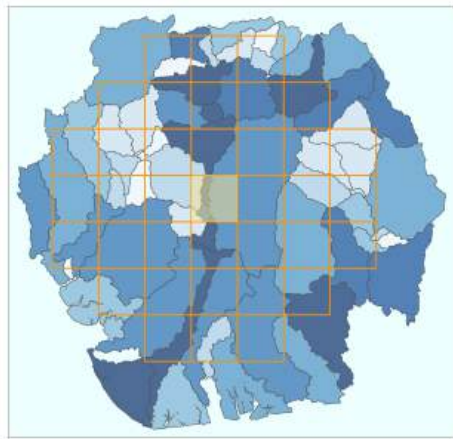
- Neighborhood: all cells within 180 km radius

  (Harari and La Ferrara, 2018)



Variables Definition

- Upstream/downstream relationships:
  - Overlap grid cells with basins.
  - For each cells select basin with highest discharge → unique identifier up-down.



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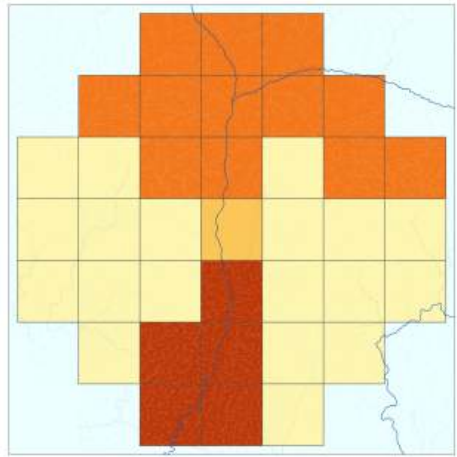
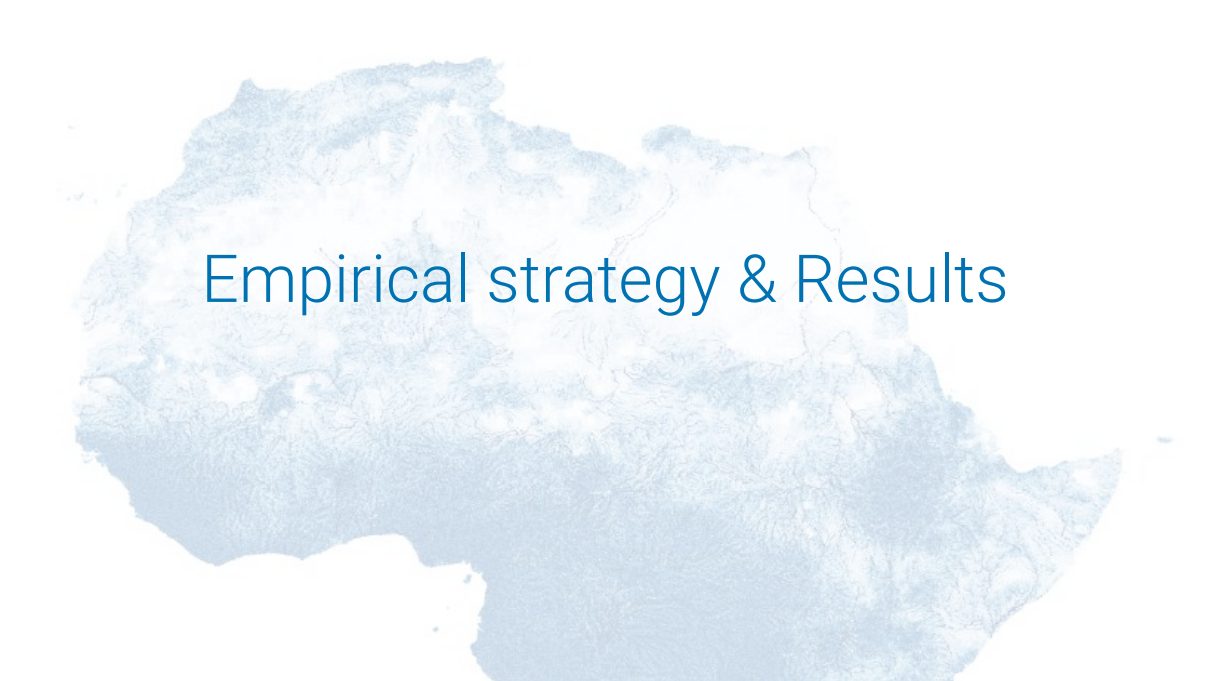
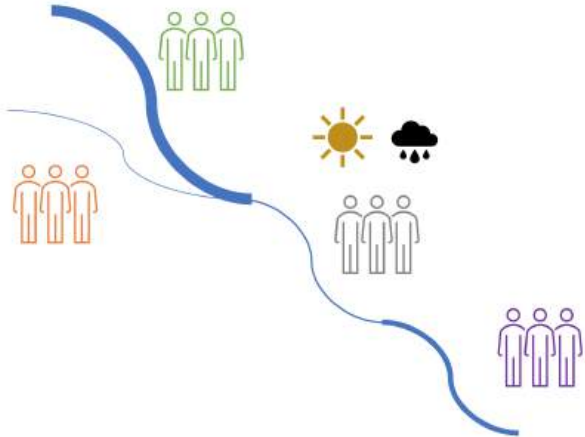


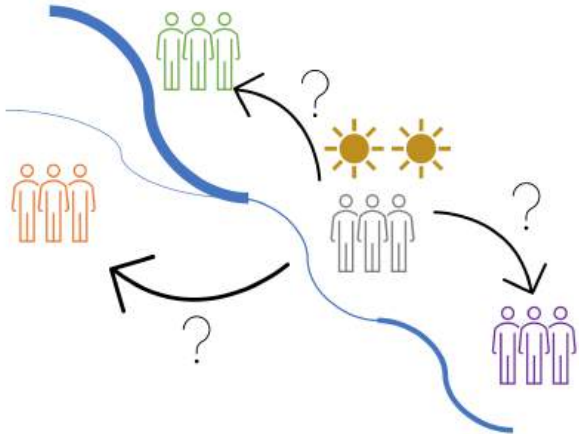


Empirical strategy & Results

Framework



Framework



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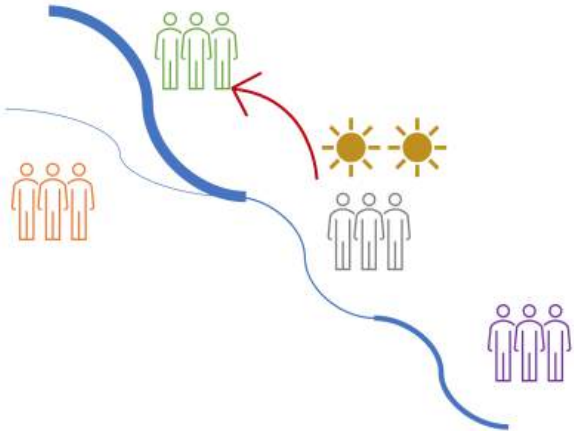


Econometric Specification

$$y_{it} = \gamma_1 Shock_{it}^{Own} + \gamma_2 \text{Water Rich}_{it} + \beta_1 Shock_{it}^{Down} + \beta_2 Shock_{it}^{Down} \times \text{Water Rich}_{it} + \lambda_1 Shock_{it}^{Up} + \lambda_2 Shock_{it}^{Up} \times \text{Water Rich}_{it} + \mu_i + \mu_{ct} + \varepsilon_{it}$$

- $y_{it} \in (0, 1)$: conflict incidence.
- *Shock Own:* rainfall shock in own cell *i*.
- *Shock Down:* rainfall shock in a neighboring downstream cell.
- *Shock Up:* rainfall shock in a neighboring upstream cell.
- *Water Rich:* own water richness.
- μ: cell and country-year fixed effects.

Water Richness

H: *Water rich cells experience more conflict than water poor cells when low rainfall in a neighbouring (downstream) cell* ($\beta_2 > 0$)

1. **Water Amount:** log of average water discharge present in the cell in a given year.

Water Discharge

	Incidence (ACLED)				
	(1)	(2)	(3)	(4)	(5)
Water Discharge	0.0010	0.0007	0.0010	0.0009	0.0009
	(0.0009)	(0.0010)	(0.0009)	(0.0009)	(0.0009)
Water Discharge × Shock Down	0.0011***		0.0011***		0.0012***
	(0.0004)		(0.0004)		(0.0004)
Water Discharge × Shock Up		0.0003		0.0003	-0.0002
		(0.0005)		(0.0005)	(0.0005)
Shock Down	0.0008		0.0010		0.0009
	(0.0017)		(0.0018)		(0.0018)
Shock Up		-0.0018		-0.0024	-0.0014
		(0.0020)		(0.0021)	(0.0021)
Shock Own			-0.0005	0.0020	0.0000
			(0.0017)	(0.0016)	(0.0017)
Cell FE	✓	✓	✓	✓	✓
Country-Year FE	✓	✓	✓	✓	✓
Dep. Var. Mean	0.08201	0.08201	0.08201	0.08201	0.08201
R^2	0.42101	0.42095	0.42101	0.42096	0.42101
Cells	10,228	10,228	10,228	10,228	10,228
Observations	255,700	255,700	255,700	255,700	255,700

Water richness

H: *Water rich cells experience more conflict than water poor cells when low rainfall in a neighboring (downstream) cell* ($\beta_2 > 0$)

1. **Water Amount:** log of average water discharge present in the cell in a given year.
2. **Water Monopolist:** own cell has $\geq$ water than any other cell in neighbourhood in a year.
3. **Water Monopolist +:** own cell has $\geq$ water than any other cell in neighbourhood & $\geq$ water than continent-year median.

All Measures

	Incidence (ACLED)		
	Water Discharge	Water Monopolist	Water Monopolist +
	(1)	(2)	(3)
Water Measure	0.0009	0.0120	0.0151
	(0.0009)	(0.0098)	(0.0106)
Water Measure × Shock Down	0.0012***	0.0181	0.0336**
	(0.0004)	(0.0123)	(0.0170)
Water Measure × Shock Up	-0.0002	-0.0020	-0.0046
	(0.0005)	(0.0118)	(0.0144)
Shock Own	0.0000	-0.0004	-0.0004
	(0.0017)	(0.0017)	(0.0017)
Shock Down	0.0009	0.0049***	0.0048***
	(0.0018)	(0.0015)	(0.0015)
Shock Up	-0.0014	-0.0018	-0.0018
	(0.0021)	(0.0017)	(0.0017)
Cell FE	✓	✓	✓
Country-Year FE	✓	✓	✓
Dep. Var. Mean	0.08201	0.08201	0.08201
R^2	0.42101	0.42101	0.42103
Cells	10,228	10,228	10,228
Observations	255,700	255,700	255,700

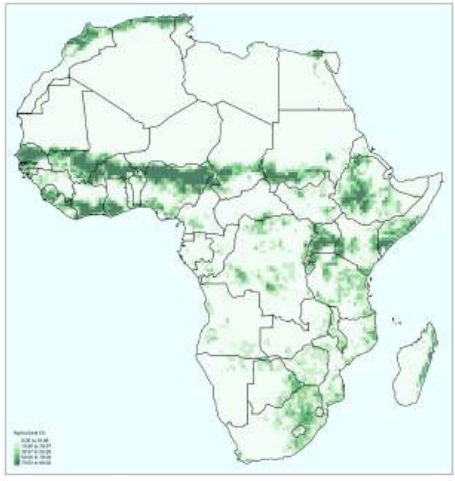
Sensitivity Analysis

- **Inference**: allow for spatial correlation
- Alternative **conflict** types
- Alternative **conflict** data: UCDP ged
- Additional **controls**: population, temperature, lagged conflict
- Alternative **radius**
- Alternative **rainfall shocks**


Heterogeneity

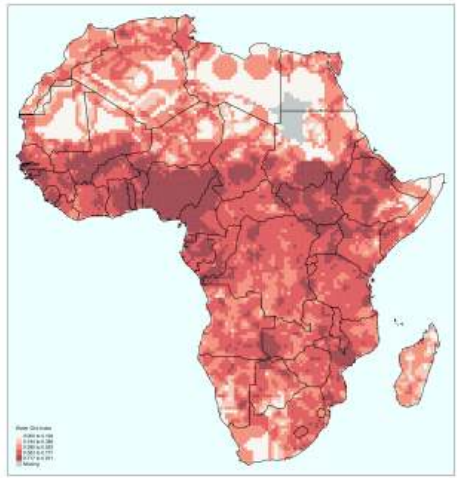
Heterogeneity

- Agriculture: water is more valuable.



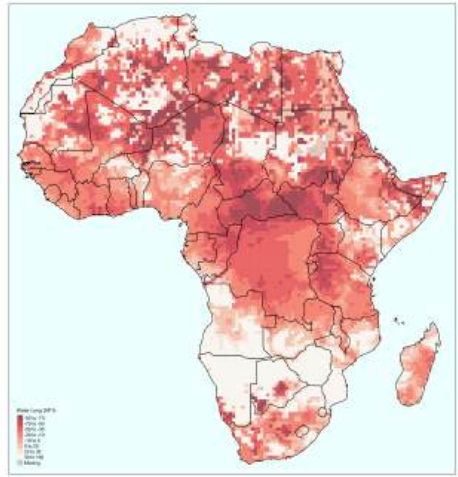
Heterogeneity

- Agriculture: water is more valuable.
- Ethnic grievances: higher cooperation costs. Inequality in water ownership between groups:
  - Polarization index.
  - Gini index.
  - Theil index.



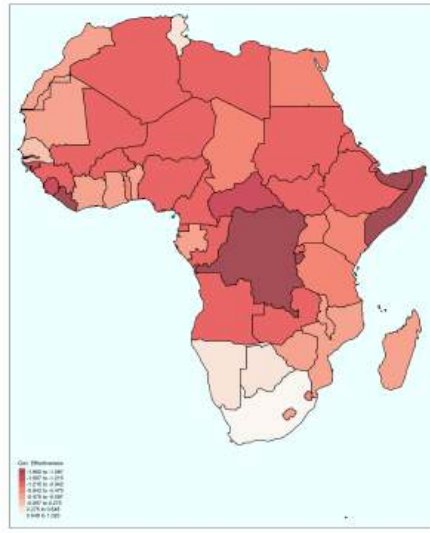
Heterogeneity

- Agriculture: water is more valuable.
- Ethnic grievances: higher cooperation costs.
- Water stress: long-run change in water presence.

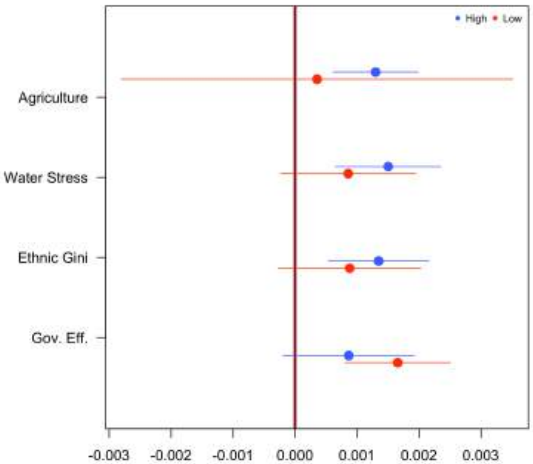


Heterogeneity

- Agriculture: water is more valuable.
- Ethnic grievances: higher cooperation costs.
- Water stress: long-run change in water presence.
- Institutional quality:
  - Democracy.
  - Rule of law.
  - Government effectiveness.
  - Corruption.



Heterogeneity



Conclusions

Conclusions

What does generate spillover effects in the climate-conflicts relationship?

- ⋆ New disaggregated data: up-downstream relationship and water richness.
- ⋆ Rivers network structure is a transmission channel of climate shocks.
- ⋆ Control of water resources is a determinant of conflict.

Next steps:

- Seasonal variation.
- Disentangle pastors-farmers conflicts.
- Quantification for future scenarios.

Thank you!

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Water Discharge Conley

	Incidence (ACLED)				
	(1)	(2)	(3)	(4)	(5)
Water Discharge	0.0010	0.0007	0.0010	0.0009	0.0009
	(0.0013)	(0.0013)	(0.0012)	(0.0012)	(0.0012)
Water Discharge × Shock Down	0.0011**		0.0011**		0.0012**
	(0.0006)		(0.0006)		(0.0006)
Water Discharge × Shock Up		0.0003		0.0003	-0.0002
		(0.0006)		(0.0006)	(0.0006)
Shock Down	0.0008		0.0010		0.0009
	(0.0024)		(0.0024)		(0.0023)
Shock Up		-0.0018		-0.0024	-0.0014
		(0.0025)		(0.0025)	(0.0024)
Shock Own			-0.0005	0.0020	0.0000
			(0.0021)	(0.0021)	(0.0021)
Cell FE	✓	✓	✓	✓	✓
Country-Year FE	✓	✓	✓	✓	✓
Dep. Var. Mean	0.08201	0.08201	0.08201	0.08201	0.08201
R^2	0.42101	0.42095	0.42101	0.42096	0.42101
Cells	10,228	10,228	10,228	10,228	10,228
Observations	255,700	255,700	255,700	255,700	255,700

ACLED Conflict Categories

	Incidence (ACLED)	Incidence Battles	Incidence Violence	Incidence Protests	Incidence Riots
	(1)	(2)	(3)	(4)	(5)
Water Discharge	0.0009	0.0013*	-0.0008	0.0006	-0.0006
	(0.0009)	(0.0008)	(0.0008)	(0.0007)	(0.0006)
Water Discharge × Shock Down	0.0012***	0.0013***	0.0011***	0.0001	0.0001
	(0.0004)	(0.0004)	(0.0004)	(0.0003)	(0.0003)
Water Discharge × Shock Up	-0.0002	-0.0003	0.0002	0.0002	0.0005
	(0.0005)	(0.0004)	(0.0004)	(0.0003)	(0.0003)
Shock Own	0.0000	0.0004	-0.0011	-0.0011	-0.0030**
	(0.0017)	(0.0015)	(0.0015)	(0.0013)	(0.0012)
Shock Down	0.0009	0.0005	0.0001	-0.0004	-0.0010
	(0.0018)	(0.0016)	(0.0015)	(0.0014)	(0.0012)
Shock Up	-0.0014	-0.0032*	-0.0011	-0.0007	-0.0016
	(0.0021)	(0.0018)	(0.0018)	(0.0016)	(0.0014)
Cell FE	✓	✓	✓	✓	✓
Country-Year FE	✓	✓	✓	✓	✓
Dep. Var. Mean	0.08201	0.05431	0.05570	0.04152	0.03507
R^2	0.42101	0.36651	0.38268	0.39875	0.37082
Cells	10,228	10,228	10,228	10,228	10,228
Observations	255,700	255,700	255,700	255,700	255,700

Water Discharge GED

	Incidence (GED Geo3)		
	Water Discharge	Water Monopolist	Water Monopolist +
	(1)	(2)	(3)
Water Measure	-0.0003	0.0147**	0.0129*
	(0.0006)	(0.0072)	(0.0070)
Water Measure × Shock Down	0.0005*	0.0143*	0.0305**
	(0.0003)	(0.0086)	(0.0124)
Water Measure × Shock Up	-0.0004	-0.0018	-0.0058
	(0.0003)	(0.0079)	(0.0095)
Shock Own	0.0012	0.0012	0.0012
	(0.0011)	(0.0011)	(0.0011)
Shock Down	0.0001	0.0017*	0.0016*
	(0.0011)	(0.0010)	(0.0010)
Shock Up	-0.0007	-0.0021*	-0.0021**
	(0.0013)	(0.0011)	(0.0011)
Cell FE	✓	✓	✓
Country-Year FE	✓	✓	✓
Dep. Var. Mean	0.03039	0.03039	0.03039
R^2	0.28764	0.28768	0.28771
Cells	10,228	10,228	10,228
Observations	337,524	337,524	337,524

Additional Controls

	Incidence (ACLED)			
	(1)	(2)	(3)	(4)
Water Discharge	0.0009	0.0013	0.0015	0.0008
	(0.0009)	(0.0010)	(0.0010)	(0.0009)
Water Discharge × Shock Down	0.0012***	0.0012***	0.0012***	0.0011**
	(0.0004)	(0.0004)	(0.0004)	(0.0004)
Water Discharge × Shock Up	-0.0001	-0.0002	-0.0002	-0.0002
	(0.0005)	(0.0005)	(0.0005)	(0.0005)
Shock Own	0.0000	-0.0004	-0.0006	-0.0002
	(0.0017)	(0.0017)	(0.0017)	(0.0017)
Shock Down	0.0009	0.0007	0.0005	0.0004
	(0.0018)	(0.0018)	(0.0018)	(0.0018)
Shock Up	-0.0014	-0.0015	-0.0015	-0.0002
	(0.0021)	(0.0021)	(0.0021)	(0.0020)
Log pop.	0.0046			
	(0.0048)			
Temp.		0.0044**		
		(0.0022)		
Temp. (day)			0.0059***	
			(0.0020)	
Lagged Incidence				0.1701***
				(0.0051)
Cell FE	✓	✓	✓	✓
Country-Year FE	✓	✓	✓	✓
Dep. Var. Mean	0.08201	0.08201	0.08201	0.08366
R^2	0.42102	0.42103	0.42104	0.44153
Cells	10,228	10,228	10,228	10,228
Observations	255,700	255,700	255,700	245,472

Radius 200 Km

	Incidence (ACLED)		
	Water Discharge	Water Monopolist	Water Monopolist +
	(1)	(2)	(3)
Water Measure	0.0009	0.0104	0.0093
	(0.0009)	(0.0106)	(0.0112)
Water Measure × Shock Down	0.0010**	0.0217*	0.0341**
	(0.0004)	(0.0123)	(0.0168)
Water Measure × Shock Up	-0.0001	-0.0053	-0.0061
	(0.0005)	(0.0114)	(0.0133)
Shock Own	0.0003	-0.0001	-0.0001
	(0.0017)	(0.0017)	(0.0017)
Shock Down	0.0008	0.0042***	0.0041***
	(0.0018)	(0.0015)	(0.0015)
Shock Up	-0.0018	-0.0018	-0.0019
	(0.0020)	(0.0017)	(0.0017)
Cell FE	✓	✓	✓
Country-Year FE	✓	✓	✓
Dep. Var. Mean	0.08201	0.08201	0.08201
R^2	0.42100	0.42100	0.42101
Cells	10,228	10,228	10,228
Observations	255,700	255,700	255,700

Radius 160 Km

	Incidence (ACLED)		
	Water Discharge	Water Monopolist	Water Monopolist +
	(1)	(2)	(3)
Water Measure	0.0009	0.0102	0.0125
	(0.0009)	(0.0080)	(0.0087)
Water Measure × Shock Down	0.0014***	0.0133	0.0224
	(0.0005)	(0.0109)	(0.0144)
Water Measure × Shock Up	-0.0001	-0.0059	-0.0066
	(0.0005)	(0.0104)	(0.0125)
Shock Own	-0.0001	-0.0005	-0.0005
	(0.0017)	(0.0017)	(0.0017)
Shock Down	0.0002	0.0049***	0.0049***
	(0.0020)	(0.0016)	(0.0016)
Shock Up	-0.0015	-0.0015	-0.0016
	(0.0022)	(0.0018)	(0.0018)
Cell FE	✓	✓	✓
Country-Year FE	✓	✓	✓
Dep. Var. Mean	0.08201	0.08201	0.08201
R^2	0.42102	0.42100	0.42101
Cells	10,228	10,228	10,228
Observations	255,700	255,700	255,700

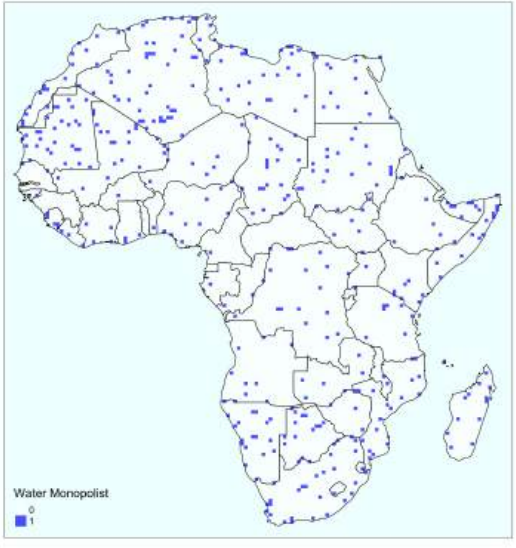
Rainfall shocks G10

	Incidence (ACLED)		
	Water Discharge	Water Monopolist	Water Monopolist +
	(1)	(2)	(3)
Water Measure	0.0010	0.0125	0.0163
	(0.0009)	(0.0095)	(0.0104)
Water Measure × Shock Down	0.0014***	0.0275**	0.0458***
	(0.0005)	(0.0137)	(0.0172)
Water Measure × Shock Up	0.0003	-0.0073	-0.0104
	(0.0005)	(0.0120)	(0.0138)
Shock Own	0.0006	0.0002	0.0002
	(0.0020)	(0.0020)	(0.0020)
Shock Down	-0.0003	0.0043**	0.0043**
	(0.0022)	(0.0017)	(0.0017)
Shock Up	-0.0008	0.0009	0.0009
	(0.0024)	(0.0020)	(0.0020)
Cell FE	✓	✓	✓
Country-Year FE	✓	✓	✓
Dep. Var. Mean	0.08201	0.08201	0.08201
R^2	0.42102	0.42101	0.42103
Cells	10,228	10,228	10,228
Observations	255,700	255,700	255,700

Rainfall shocks G20

	Incidence (ACLED)		
	Water Discharge	Water Monopolist	Water Monopolist +
	(1)	(2)	(3)
Water Measure	0.0010	0.0095	0.0115
	(0.0010)	(0.0100)	(0.0108)
Water Measure × Shock Down	0.0013***	0.0218**	0.0386***
	(0.0004)	(0.0104)	(0.0143)
Water Measure × Shock Up	-0.0007	-0.0009	-0.0027
	(0.0005)	(0.0105)	(0.0128)
Shock Own	0.0031**	0.0028*	0.0028*
	(0.0015)	(0.0015)	(0.0015)
Shock Down	-0.0031*	0.0008	0.0008
	(0.0017)	(0.0014)	(0.0014)
Shock Up	0.0003	-0.0023	-0.0023
	(0.0019)	(0.0016)	(0.0016)
Cell FE	✓	✓	✓
Country-Year FE	✓	✓	✓
Dep. Var. Mean	0.08201	0.08201	0.08201
R^2	0.42100	0.42100	0.42103
Cells	10,228	10,228	10,228
Observations	255,700	255,700	255,700

Water Monopolist



Water Monopolist +